POLAND'S
NATIONAL INVENTORY REPORT
2018

Greenhouse Gas Inventory
for 1988-2016

Submission under
the UN Framework Convention on Climate Change
and its Kyoto Protocol

Warsaw, February 2018

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Reporting entity:

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

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CONTENTS

EXECUTIVE SUMMARY

ES.1. Background information on greenhouse gas inventories, climate change and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

ES.1.1. Background information on greenhouse gas inventories and climate change

Poland contributes to the activities towards climate change mitigation undertaken by the international community – as a signatory to the United Nations Framework Convention on Climate Change since 1994 and to the Kyoto Protocol – since 2002. In the first commitment period under the Kyoto Protocol, Poland committed to reduce greenhouse gas emissions in 2008–2012 by 6%, compared to the base year. In the second commitment period, established in the Doha Amendment, the European Union, its Member States and Iceland committed to reduce their average annual greenhouse gas emissions in the years 2013–2020 under the joint fulfilment of commitments. The common reduction target was expressed as a commitment to achieve average annual emissions of 80% of the total emissions of all countries in the base years[1].

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 the main gases (CO_2, CH_4 and N_2O). Different base years have been established for other groups of gases: 1995 for HFCs, PFCs and sulphur hexafluoride (SF_6) and 2000 for the nitrogen trifluoride (NF_3).

The underlying report, presenting the results of national greenhouse gas inventory for 2016, in line with the trend since 1988, has been 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 emission of 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) which are reported in five categories: 1. *Energy*, 2. *Industrial Processes and Product Use* (IPPU), 3. *Agriculture*, 4. *Land Use, Land Use Change and Forestr*y (LULUCF) and 5. *Waste*. Also information on emissions of sulphur dioxide (SO_2) and the following GHG precursors: carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC) is reported in CRF tables.

Methodologies used to calculate emissions and sinks of GHGs are those published by the Intergovernmental Panel on Climate Change (IPCC) in 2006, namely *2006 Guidelines for National Greenhouse Gas Inventories* what is in accordance with the provisions of the decision 24/CP.19. Pursuant 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 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 as 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 regulations, according to the provisions of the Act of 17 July 2009 on the system to manage

[1] *Poland's Seventh National Communication and Third Biennial Report under UNFCCC*. 2017.

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 the Environment.

ES.1.2. Background information on supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

The European Union (EU) and its Member States, and Iceland have agreed (agreement under Article 4 of the Kyoto Protocol) to fulfil jointly their quantified emission limitation and reduction commitment (QELRC) for the second commitment period of the Kyoto Protocol. The joint QELRC for the EU is 80% (Annex I to the Doha Amendment) what relates to 20% emission reduction on a yearly average comparing to the base year during the period 2013 – 2020. So the assigned amount of the Parties of the agreement (EU, its Member States and Iceland) will be calculated jointly based on the sum of the base year or period emissions for the EU Member States and Iceland in accordance with Article 3, paragraphs 7bis, 8 and 8bis.

Poland's Assigned Amount is 1,592,338,962 tonnes CO_2eq and relates only to the non-ETS emissions (see chapter 2.3.6) what results from summing up the Annual Emission Allocations (AEAs) for years 2013-2020 as established under the EU Effort Sharing Decision (406/2009/EC), and determined in the Commission decision 2017/1471 as well as adjusted in the decision 2013/634/EU for 2013-2020.

The Poland's commitment period reserve (CPR), calculated as 90% of annual emission allocations given above, amounts to 1,433,105,066 tonnes CO_2 eq.

ES.2. Summary of national emission and removal related trends, including KP–LULUCF activities

ES.2.1. Summary of national emission and removal related trends

The GHG emissions for the base year (see chapter ES.1) and for 2016, expressed as CO_2 equivalent, are presented in table S.1. In 2016 the total national emission of GHG amounted to 397.71 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 2016 emissions have decreased by 30.4%.

Table S.1. National emissions of greenhouse gases for the base year and 2016

Pollutant	Emission in CO_2 eq. [kt]		(2016-base)/base [%]
	Base year	2016	
CO_2 (with LULUCF)	454 743.19	293 014.79	-35.56
CO_2 (without LULUCF)	470 884.68	322 233.95	-31.57
CH_4 (with LULUCF)	70 837.29	46 940.75	-33.73
CH_4 (without LULUCF)	70 793.13	46 895.92	-33.76
N_2O (with LULUCF)	29 492.29	20 752.53	-29.63
N_2O (without LULUCF)	29 322.00	19 530.00	-33.39
HFCs	134.69	8 955.35	6 548.73
PFCs	171.97	13.21	-92.32
Unspecified mix of HFCs and PFCs	NA,NO	NA,NO	NA,NO
SF_6	29.12	77.03	164.50
NF_3	NA,NO	NA,NO	NA,NO
TOTAL net emission (with LULUCF)	555 408.56	369 753.67	-33.43
TOTAL without LULUCF	571 335.59	397 705.47	-30.39

Carbon dioxide is the main GHG in Poland with the share of 81.02% in national emissions in 2016. Methane and nitrous oxide contribute respectively with: 11.8% and 4.9% share. All F-gases are responsible for 2.3% of total GHG emissions. Percentage share of GHG in national total emissions (excluding category 4. LULUCF) in 2016 is presented at figure S.1.

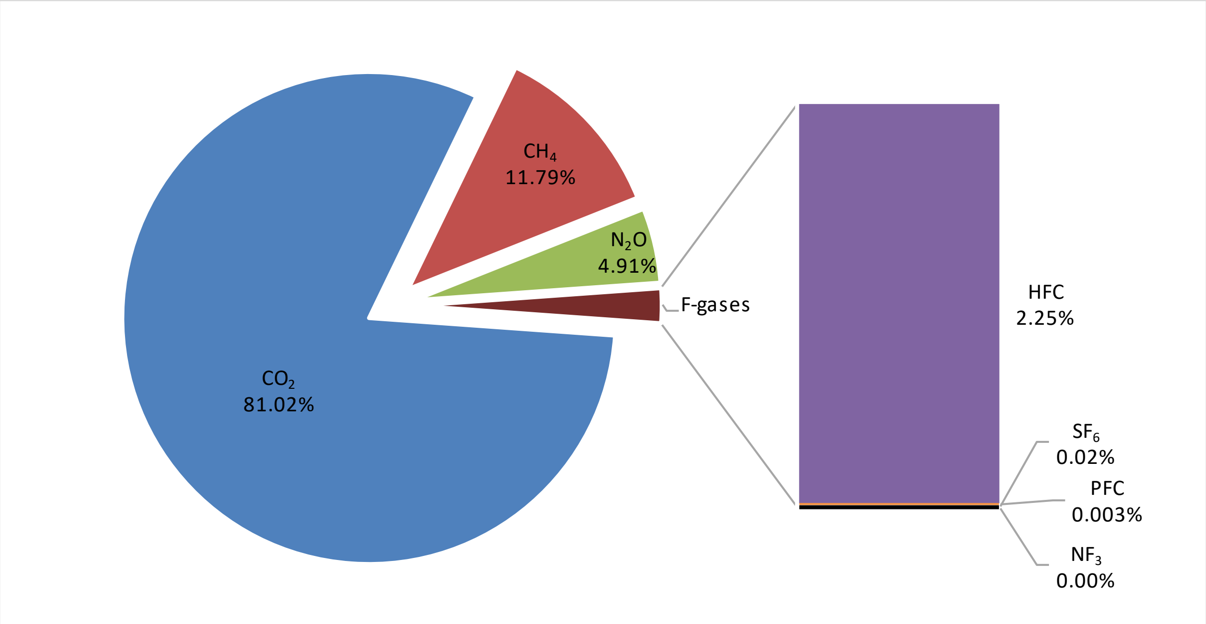

Figure S.1. Percentage share of greenhouse gases in national total emission in 2016 (excluding category 4. LULUCF)

The trend of aggregated GHG emissions follows the trend of emissions of 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 economic changes, especially in heavy industry. 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. Slow decline in emissions (up to 2002) characterized the succeeding years, when still energy efficiency policies and measures were implemented, and then slight increase up to 2007 caused by animated economic development. In 2008-2011 stabilisation in emissions has been noted with distinct decrease in 2009 related to world economic slow-down. Since 2012 GHG emissions in Poland do not exceed 400 Mt CO_2 eq. (tab. S.2 and fig. S.2).

Since 2005 Poland has taken part in the European Union's Emission Trading System, being one of the flexible mechanisms supporting measures for limiting the greenhouse gas emissions. The share of emissions related to installations covered by EU ETS in the national emissions in 2005−2016 amounted to about 51% on average. One should notice, that since 2013 the scope of the EU ETS has expanded with new industries (like production of selected chemicals) and new greenhouse gases (nitrous oxide) (fig. S.2).

Table S.2. National emissions of greenhouse gases for 1988–2016 by gases [kt CO_2 eq.]

GHG	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO_2 (with LULUCF)	454 743.19	430 262.91	348 207.93	353 060.10	364 656.44	359 689.92	354 046.85	345 063.73	340 695.90	332 147.62	296 848.83	290 810.49	283 772.07	288 901.16	271 408.23
CO_2 (without LULUCF)	470 884.68	451 250.78	376 038.71	373 378.20	363 718.93	364 565.34	359 611.08	361 303.85	375 304.64	366 570.12	337 341.53	327 652.45	317 097.26	313 545.67	305 730.54
CH_4 (with LULUCF)	70 837.29	70 477.65	65 163.70	60 460.96	58 670.74	56 944.15	56 250.56	54 816.91	54 092.50	53 924.41	52 133.63	51 188.40	49 858.19	51 648.49	50 032.63
CH_4 (without LULUCF)	70 793.13	70 433.53	65 119.50	60 415.77	58 625.98	56 901.71	56 209.37	54 770.68	54 055.65	53 885.91	52 098.55	51 150.51	49 824.76	51 615.00	49 996.82
N_2O (with LULUCF)	29 492.29	30 765.14	27 495.60	23 047.67	21 545.25	22 846.96	22 458.09	23 468.68	23 584.49	23 485.76	23 259.84	22 547.12	22 916.03	23 103.94	21 992.06
N_2O (without LULUCF)	29 322.00	30 553.68	27 312.64	22 842.49	21 285.44	22 260.44	22 143.18	23 121.02	23 247.79	23 151.40	22 895.51	22 174.03	22 533.42	22 690.55	21 581.12
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	134.69	335.49	481.02	569.32	780.47	1 366.50	1 925.34	2 505.93
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	197.34	207.33
Unspecified mix of HFCs and PFCs	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	NA,NO	NA,NO
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	22.86	23.29
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	NA,NO	NA,NO
TOTAL (with LULUCF)	**555 220.03**	**531 653.20**	**441 009.11**	**436 710.04**	**445 007.05**	**439 625.89**	**432 921.54**	**423 685.10**	**418 893.26**	**410 235.08**	**373 010.41**	**365 518.69**	**358 112.53**	**365 799.13**	**346 169.47**
TOTAL (without LULUCF)	**571 147.07**	**552 385.50**	**468 612.72**	**456 777.77**	**443 764.98**	**443 872.35**	**438 129.67**	**439 531.34**	**453 128.46**	**444 284.72**	**413 103.70**	**401 949.67**	**391 021.68**	**389 996.76**	**380 045.03**

Table S.2. (cont.) National emissions of greenhouse gases for 1988–2016 by gases [kt CO_2 eq.]

GHG	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
CO_2 (with LULUCF)	281 236.35	274 185.82	274 255.51	293 818.33	299 616.82	293 239.08	282 048.11	301 071.61	293 808.86	286 833.32	280 381.80	276 285.98	282 252.92	293 014.79
CO_2 (without LULUCF)	318 415.56	322 538.95	321 668.85	334 622.82	334 365.69	327 448.21	314 144.58	332 130.71	331 694.64	324 216.62	319 911.26	307 555.13	310 615.14	322 233.95
CH_4 (with LULUCF)	50 376.23	49 991.79	50 455.48	50 666.73	50 004.50	49 760.99	48 597.21	48 605.86	47 496.75	47 194.30	47 454.61	46 960.51	47 513.20	46 940.75
CH_4 (without LULUCF)	50 338.02	49 955.96	50 420.30	50 625.92	49 972.91	49 724.37	48 565.38	48 572.11	47 463.55	47 160.31	47 414.97	46 922.87	47 476.84	46 895.92
N_2O (with LULUCF)	22 220.35	22 743.52	22 927.13	23 442.73	24 270.35	23 720.84	20 602.73	20 337.84	20 684.62	20 834.41	20 945.45	20 839.66	20 027.47	20 752.53
N_2O (without LULUCF)	21 795.56	22 299.96	22 476.08	22 974.45	23 746.85	23 179.28	20 025.07	19 707.84	20 039.24	20 116.80	20 202.31	19 754.86	18 930.85	19 530.00
HFCs	3 078.00	3 733.23	4 556.73	5 408.05	6 009.80	6 334.89	6 289.67	7 006.36	7 622.60	7 959.91	8 356.09	8 978.00	8 969.07	8 955.35
PFCs	201.08	205.07	187.41	193.58	184.63	163.12	17.97	17.07	16.22	15.41	14.64	13.90	13.21	13.21
Unspecified mix of HFCs and PFCs	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	NO,NA
SF_6	20.72	22.36	26.80	33.20	31.16	32.87	37.60	35.37	39.02	41.92	47.54	52.79	77.03	77.03
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	NO,NA
TOTAL (with LULUCF)	**357 132.72**	**350 881.79**	**352 409.06**	**373 562.62**	**380 117.26**	**373 251.79**	**357 593.29**	**377 074.11**	**369 668.06**	**362 879.27**	**357 200.11**	**353 130.84**	**358 852.91**	**369 753.67**
TOTAL (without LULUCF)	**393 848.93**	**398 755.53**	**399 336.17**	**413 858.03**	**414 311.04**	**406 882.74**	**389 080.27**	**407 469.46**	**406 875.27**	**399 510.97**	**395 946.81**	**383 277.54**	**386 082.14**	**397 705.47**

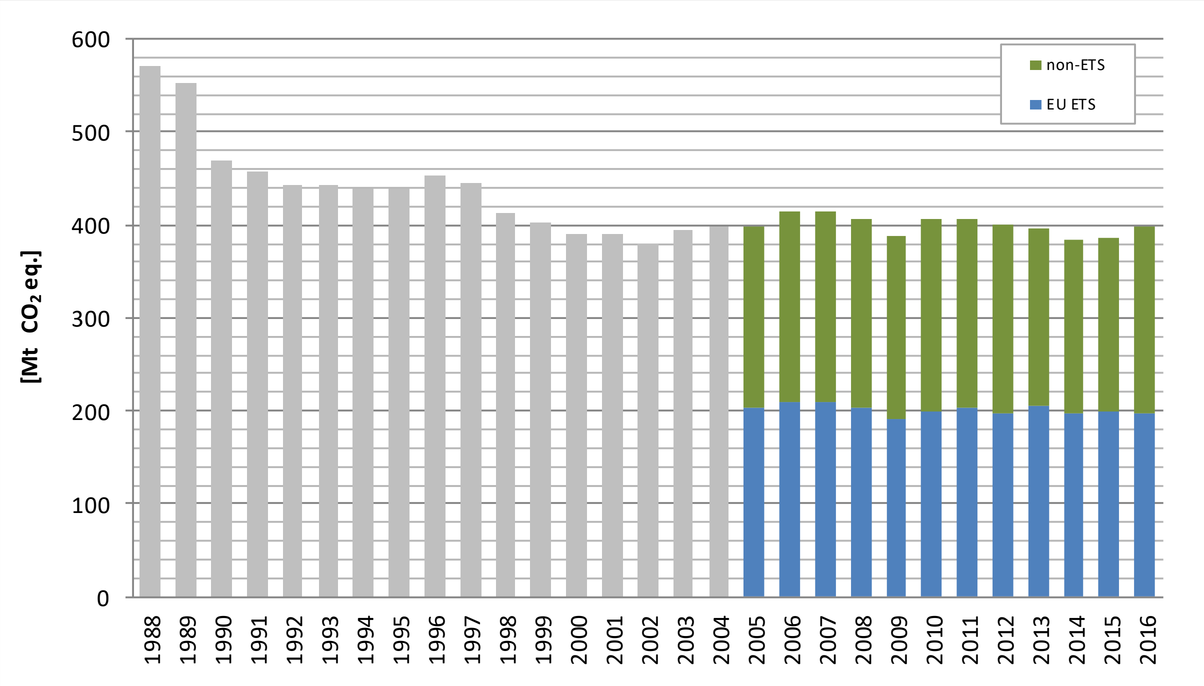

Figure S.2. Trend of aggregated GHGs emissions excluding category 4 for 1988-2016

ES.2.2. KP-LULUCF activities

The emissions and removals balance of greenhouse gases for the period 2008-2016, to related activities of land use, land use change and forestry (LULUCF) under Article 3.3 and 3.4 of the Kyoto Protocol is presented in table S.3. For activities related to afforestation/reforestation and forest management estimated balance is negative, what means the activity is considered as a net CO_2 sink.

Table S.3. The emissions and removals balance of greenhouse gases for the period 2008-2016 for selected activities of land use, land use change and forestry (LULUCF) [Mt CO_2 eq.]

Activity	2008	2009	2010	2011	2012	2013	2014	2015	2016
4.KP. A.1. Afforestation/ Reforestation	-2.37	-2.46	-2.58	-2.67	-2.78	-2.84	-2.82	-2.85	-2.83
4.KP. A.2. Deforestation	0.24	0.25	0.26	0.23	0.25	0.20	0.32	0.30	5.52
4.KP. B.1. Forest Management	-37.97	-35.72	-34.55	-41.15	-40.68	-42.74	-35.69	-31.73	-37.83
4.KP. B.2 Cropland management	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
4.KP. B.3 Grazing land management	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
4.KP. B.4 Revegetation	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

ES.3. Overview of source and sink category emission estimates and trends, including KP-LULUCF activities

ES.3.1. GHG inventory

Total GHG emissions presented in CO_2 equivalent for the base year and for 2016 together with change between 2016 and 1988 by main categories are given in table S.5 and figure 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 37.1%) 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 5.9 million to 5.9 or sheep population from 0.2 million to 239 thousand in 1988-2016). Next category with high emission reduction in 1988-2016 is 1. *Energy* (by about 31.0%) 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.4. GHG emissions according to main sectors in base year and in 2016

	Total [kt eq. CO_2]		(2016-base)/base [%]
	Base year	2016	
TOTAL with LULUCF	555 408.56	369 753.67	-33.4
TOTAL without LULUCF	571 335.59	397 705.47	-30.4
1. Energy	474 966.26	327 545.38	-31.0
2. Industrial Processes and Product Use	31 386.74	28 653.05	-8.7
3. Agriculture	47 835.68	30 073.60	-37.1
4. Land-Use, Land-Use Change and Forestry	-15 927.04	-27 951.80	75.5
5. Waste	17 146.91	11 433.43	-33.3

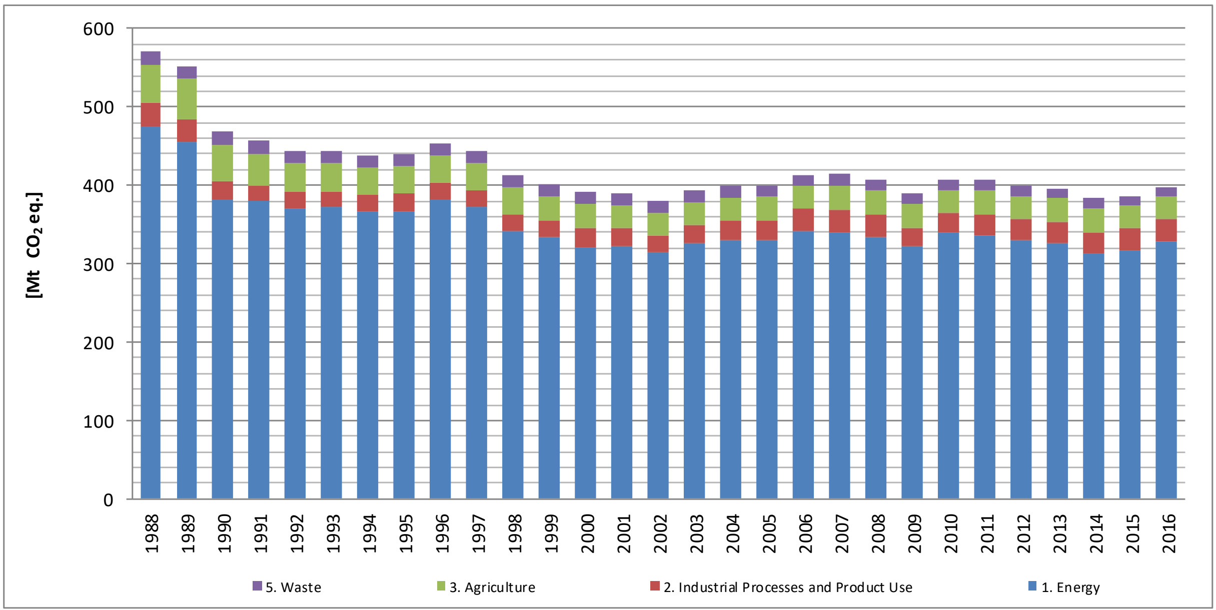

Figure S.3. Trend of aggregated GHGs emissions (excluding category 4) for 1988–2016 according to source categories

Table S.5. National emissions of greenhouse gases for 1988–2016 by source categories [kt CO_2 eq.]

IPCC sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1. Energy	474 966.26	454 551.79	381 999.86	380 030.81	371 207.28	373 248.96	366 397.75	366 666.00	381 854.85	371 600.85	342 235.47	333 702.79	321 024.75	322 050.52	314 468.98
2. Industrial Processes	31 198.21	30 235.92	22 693.33	20 092.42	19 695.46	19 309.78	21 255.05	22 691.59	22 040.45	22 956.50	21 380.10	20 583.30	23 790.48	22 461.90	20 782.50
3. Agriculture	47 835.68	50 519.18	47 155.60	40 119.67	36 523.26	35 210.83	34 783.91	34 732.58	34 006.84	34 591.23	34 335.88	32 596.07	31 005.77	30 614.99	29 929.56
4. Land-Use, Land-Use Change and Forestry	-15 927.04	-20 732.30	-27 603.61	-20 067.73	1 242.07	-4 246.46	-5 208.13	-15 846.24	-34 235.20	-34 049.64	-40 093.29	-36 430.98	-32 909.15	-24 197.63	-33 875.56
5. Waste	17 146.91	17 078.61	16 763.92	16 534.88	16 338.98	16 102.78	15 692.96	15 441.17	15 226.31	15 136.14	15 152.25	15 067.51	15 200.68	14 869.35	14 863.99
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
TOTAL (with LULUCF)	**555 220.03**	**531 653.20**	**441 009.11**	**436 710.04**	**445 007.05**	**439 625.89**	**432 921.54**	**423 685.10**	**418 893.26**	**410 235.08**	**373 010.41**	**365 518.69**	**358 112.53**	**365 799.13**	**346 169.47**
TOTAL (without LULUCF)	**571 147.07**	**552 385.50**	**468 612.72**	**456 777.77**	**443 764.98**	**443 872.35**	**438 129.67**	**439 531.34**	**453 128.46**	**444 284.72**	**413 103.70**	**401 949.67**	**391 021.68**	**389 996.76**	**380 045.03**

Table S.5. (cont.) National emissions of greenhouse gases for 1988–2016 by source categories [kt CO_2 eq.]

IPCC sector	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1. Energy	325 913.38	329 565.88	330 165.29	341 727.65	339 001.17	333 238.10	322 146.71	339 150.58	335 836.48	329 878.93	326 099.88	312 408.35	316 129.01	327 545.38
2. Industrial Processes	23 654.54	25 448.34	25 418.64	27 938.78	30 496.58	29 071.56	22 981.10	25 001.34	27 847.24	26 824.63	26 572.14	28 177.72	28 534.72	28 653.05
3. Agriculture	29 364.19	29 354.21	29 511.99	30 221.10	30 854.09	30 928.18	30 232.31	29 717.72	30 088.15	29 956.20	30 497.88	30 397.67	29 557.34	30 073.60
4. Land-Use, Land-Use Change and Forestry	-36 716.22	-47 873.74	-46 927.11	-40 295.41	-34 193.78	-33 630.95	-31 486.98	-30 395.35	-37 207.21	-36 631.70	-38 746.70	-30 146.70	-27 229.23	-27 951.80
5. Waste	14 916.82	14 387.10	14 240.24	13 970.50	13 959.20	13 644.91	13 720.15	13 599.82	13 103.40	12 851.22	12 776.90	12 293.81	11 861.07	11 433.43
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
TOTAL (with LULUCF)	**357 132.72**	**350 881.79**	**352 409.06**	**373 562.62**	**380 117.26**	**373 251.79**	**357 593.29**	**377 074.11**	**369 668.06**	**362 879.27**	**357 200.11**	**353 130.84**	**358 852.91**	**369 753.67**
TOTAL (without LULUCF)	**393 848.93**	**398 755.53**	**399 336.17**	**413 858.03**	**414 311.04**	**406 882.74**	**389 080.27**	**407 469.46**	**406 875.27**	**399 510.97**	**395 946.81**	**383 277.54**	**386 082.14**	**397 705.47**

Carbon dioxide emissions

The CO_2 emissions (excluding category 4) in 2016 were estimated as 322.23 million tonnes. This is 31.6% lower than in the base year. CO_2 emission (excluding category 4) accounted for 81.02% of total GHG emissions in Poland in 2016. The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission with 92.5% share in 2016. The shares of the main subcategories were as follows: *Energy industries* – 50.4%, *Manufacture Industries and Construction* – 9.0%, *Transport* – 16.2% and *Other Sectors* – 16.9%. *Industrial Processes* contributed to the total CO_2 emission with 5.8% share in 2016. *Mineral industry* (especially *Cement Production*) is the main emission source in this sector (fig. S.4). The CO_2 removal in LULUCF sector in 2016, was calculated to be approximately 29.2 million tonnes. It means that app. 9.1% of the total CO_2 emissions are offset by CO_2 uptake by forests.

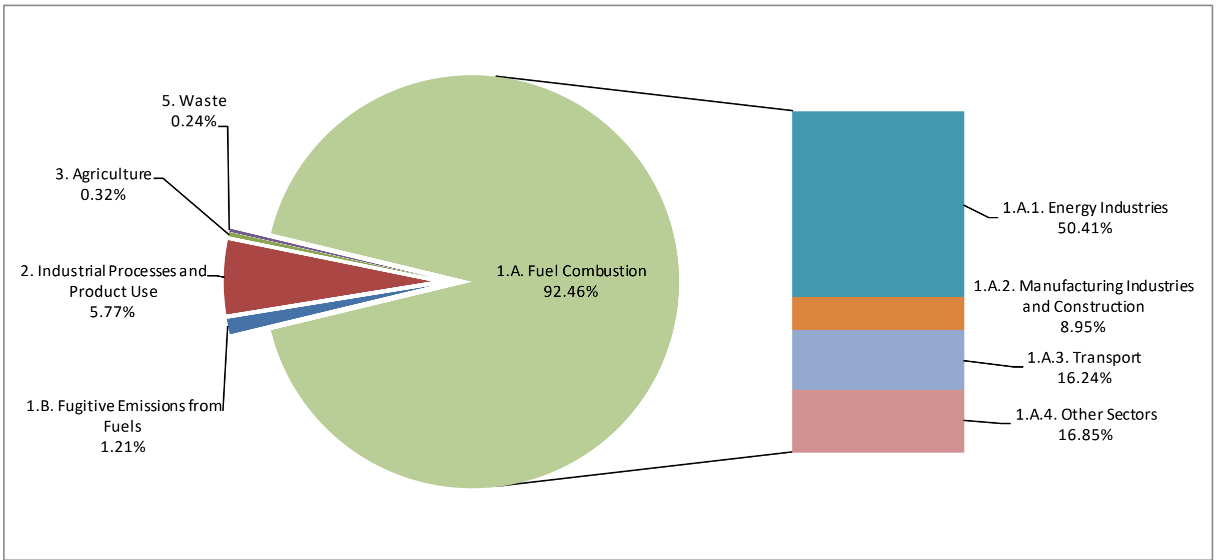

Figure S.4. Carbon dioxide emission (excluding category 4) in 2016 by sector

Methane emissions

The CH_4 emission (excluding category 4) amounted to 1 875.84 kt in 2016 i.e. 46.90 million tonnes of CO_2 equivalents. Compared to the base year, the emission in 2016 was lower by 33.8%. The contribution of CH_4 to the national total GHG emission amounted to 11.8% in 2016. Three of the main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed with 41.5%, 29.6% and 20.6% share to the national methane emission in 2016, respectively. The emission from the first mentioned sector came from underground mines (36.1% of total CH_4 emission) and Oil and Natural Gas system (5.4% of total CH_4 emission). The emission from *Enteric Fermentation* (3.A) dominated in *Agriculture* and amounted to app. 26.2% of total CH_4 emission in 2016. Waste disposal sites were responsible for 19.1% of the total methane emission and Wastewater Handling for 1.1% of total CH_4 emission (fig. S.5).

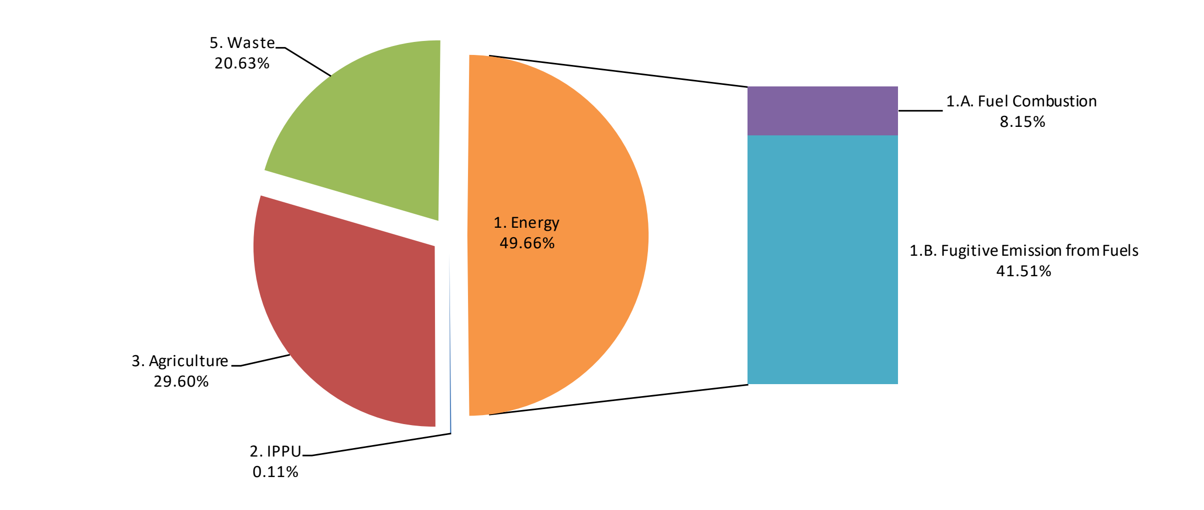

Figure S.5. Methane emission (excluding category 4) in 2016 by sector

Nitrous oxide emissions

The nitrous oxide emissions (excluding category 4) in 2016 amounted to 65.54 kt i.e. 19.53 million tonnes of CO_2 equivalent. The emission was app. 33.4% lower than the respective figure for the base year. N_2O emission constituted 4.9% of the national total GHG emission in 2016. The main N_2O emission sources and their shares in total N_2O emission in 2016 were as follows: *Agricultural Soils* – 67.2%, *Manure Management* – 10.3%, *Chemical Industry* – 4.3% and *Fuel Combustion* – 12.5% (fig. S.6).

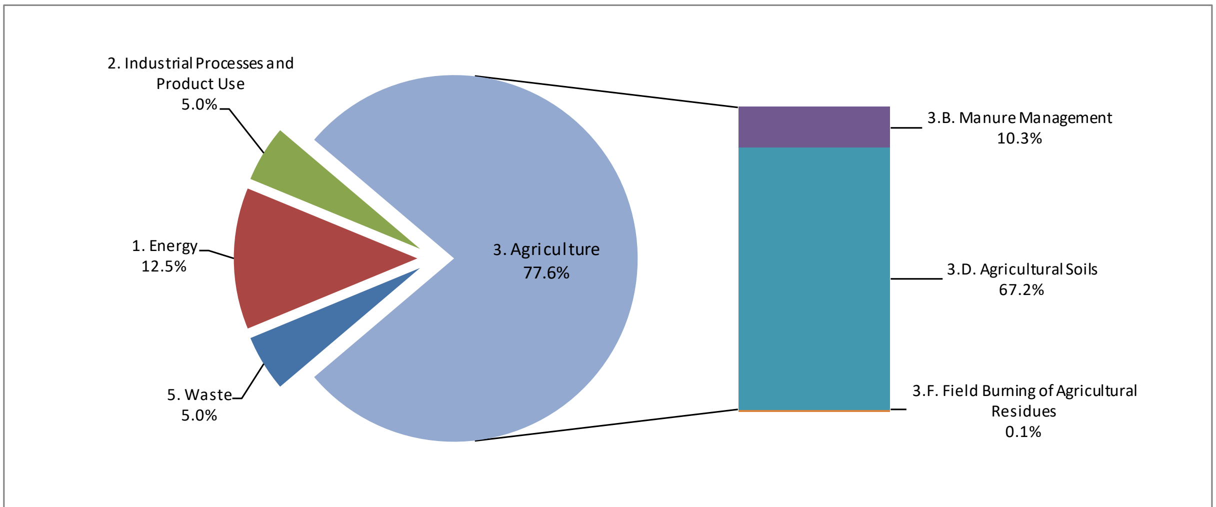

Figure S.6. Nitrous oxide emission (excluding category 4) in 2016 by sector

Emissions of fluorinated gases

The total emission of industrial gases (HFCs, PFCs and SF_6) in 2016 was estimated at 9 045.59 kt CO_2 eq., and accounted for 2.3% of total GHG emissions in 2016. Industrial gases emissions were by 2593.9% higher comparing to the base year (table S.1). 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 emissions in total 2016 emission were respectively as follows: 2.25%, 0.003% and 0.019%. NF_3 emissions did not occur.

EU Climate and energy package (ETS and ESD emissions)

EU member states, being the Parties to the Kyoto Protocol, have reached the agreement to fulfil their commitments jointly in the second KP period under so called EU Climate and Energy Package. To meet the obligations, the EU legislation divided all the emission sources into two main sectors: EU ETS and so-called non-ETS. Poland (nor any other EU member state) does not have any specific reduction target for 2013-2020 imposed on emissions coming from sources included in EU ETS, as such a limit has only been imposed on the whole EU ETS on the EU level (*cap*). The installations are individually responsible for their own emissions within the overall limit. The GHG emissions from sources included in EU ETS (electricity and heat production, industry) are reported directly by installations. On average ETS emissions in Poland are responsible for 51% of national total emissions.

The emissions from other sources than those included in EU ETS (including other GHG from EU ETS sources) constitute the non-ETS emissions. As already mentioned, Poland will fulfil its obligations jointly with other EU member states. Considering what was said above about EU ETS, this joint fulfilment is regulated by *Decision No 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020* (ESD decision). According to above mentioned decision member states have specific emission targets imposed only on the non-ETS emissions - the Polish ESD target amounts to +14% in 2020 comparing to 2005. The total ESD emissions in 2013-2016 in Poland comparing to targets result in overachievement amounting to -28 Mt CO_2 eq.

ES.3.2. KP-LULUCF activities

Estimated emissions and removals of greenhouse gases for the period 2008-2016, associated with the LULUCF activities under Article 3.3 and 3.4 of the Kyoto Protocol are presented in Table ES.3. in Section ES.2.2.

Estimated sink associated with the afforestation activity, increased almost by 20% as compared to 2008. At the same time emissions associated with deforestation increased significantly due to higher area of forest land exclusions for non-forestry and non agricultural purposes in 2016. The size of net absorption for forest management activity for the year 2016 is comparable with that in 2008.

PART I:
ANNUAL INVENTORY SUBMISSION

1. INTRODUCTION

1.1. Background information on greenhouse gas inventories, climate change and supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

1.1.1. 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 combating 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 the main gases (CO_2, CH_4 and N_2O). Different base years have been established for other groups of gases: 1995 for HFCs, PFCs and sulphur hexafluoride (SF_6) and 2000 for the nitrogen trifluoride (NF_3).

The underlying report presenting the results of national greenhouse gas inventory for 2016, 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) 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. Also information on emissions of sulphur dioxide (SO_2) and the following GHG precursors: carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC) is reported in CRF tables.

Methodologies used to calculate emissions and sinks of GHGs are those published by the Intergovernmental Panel on Climate Change (IPCC) in 2006, namely *2006 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 regulations, 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 as amended)*, is the National Centre for Emissions Management (KOBiZE) in the Institute of Environmental Protection - National Research Institute, supervised by the Minister of the Environment.

1.1.2. Background information on supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

The European Union (EU) and its Member States, and Iceland have agreed (agreement under Article 4 of the Kyoto Protocol) to fulfil jointly their quantified emission limitation and reduction commitment (QELRC) for the second commitment period of the Kyoto Protocol. The joint QELRC for the EU is 80% (Annex I to the Doha Amendment) what relates to 20% emission reduction on a yearly average comparing to the base year during the period 2013 – 2020. So the assigned amount of the Parties of the agreement (EU, its Member States and Iceland) will be calculated jointly based on the sum of the base year or period emissions for the EU Member States and Iceland in accordance with Article 3, paragraphs 7bis, 8 and 8bis.

Poland's Assigned Amount is 1,592,338,962 tonnes CO_2eq and relates only to the non-ETS emissions (see chapter 2.3.6), as Poland is going to fulfil its emission reduction target jointly with the EU. Poland's AA is equal to the annual emission allocations (AEAs) as established under the EU Effort Sharing Decision (406/2009/EC) and determined in the Commission decision 2017/1471 and adjusted in the decision 2013/634/EU for 2013-2020.

The Poland's commitment period reserve (CPR), calculated as 90% of annual emission allocations given above, amounts to 1,433,105,066 tonnes CO_2eq.

The detailed additional information required by the Kyoto Protocol is presented in Part II of the NIR.

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

The ***Act of 17 July 2009 on the system to manage the emissions of greenhouse gases and other substances*** (*Journal of Laws No 130 item 1070 as amended)* 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 the EU and international commitments and will allow for cost-effective reductions of the emission. Pursuant to the above mentioned law, 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:

- carries 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,
- elaborates 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,
- elaborates emission reports and projections for GHG and air pollutants,
- manages the national registry for Kyoto Protocol units,
- acts as the national EU Emission Trading Scheme administrator.

The Minister of the Environment supervises the activity and performance of the National Centre for Emissions Management.

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

The emission calculation, choices of activity data, emission factors and methodology are performed by the Emission Inventory and Reporting Unit in the National Centre for Emissions Management. To ensure consistency of the reported data the inventories established on a yearly basis for the purpose of both conventions: CLRTAP and UNFCCC and the EU obligations apply the same activity data sets covering first of all energy balances, but also industrial and agricultural production, land use and waste management.

The National Centre collaborates 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 different emission and activity data sources, among which the most important are:

- individual data of entities participating in the European Union Emission Trading System (EU-ETS). These independently verified data are included in the GHG inventory for some IPCC subcategories (e.g. in some subsectors in industrial processes);
- data submitted by entities to the E-PRTR database pursuant to Regulation (EC) no 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC;
- aggregated data collected by operators under Article 3(6) of Regulation (EC) No 842/2006;
- emission data submitted by individual entities to the National Database on Emissions – the biggest database with individual emission reports available in Poland.

Since early 2000s, data from individual entities in the EU member States are gathered and publicized in the European Pollutant Release and Transfer Register (E-PRTR, earlier called EPER – European Pollutant Emission Register). The usefulness of E-PRTR data for the inventory preparation needs is limited, as in most cases the register contains only fragmentary information based on part of the installations belonging to a given sector or emitting certain greenhouse gas. Nevertheless, they can be helpful to a certain extent in a process of data cross-checking, what is possible especially if the E-PRTR data cover a whole sector or gas. Polish national inventory system includes this database as a potential source of valuable data and the inventory team has been granted full access to the Polish PRTR reporting system.

Also the National Database on Emissions, that contains ca. 40 thousand reports yearly on about 80 different GHGs and pollutants, is helpful in the inventory preparation process, it cannot however replace the inventory assessments as such, as it doesn't cover all the emission sources (i.a. it doesn't contain individual transport and households) and the methodology for emission calculation is not homogenous.

The three existing independent emission databases mentioned above enable crosschecking of emission data and improving their quality. This is even more possible as two of them (the EU ETS database and the National Database on Emissions) are run by the same institution that also prepares the inventories (KOBiZE in the Institute of Environmental Protection) and – as was said – the third one (E-PRTR) is open to the public.

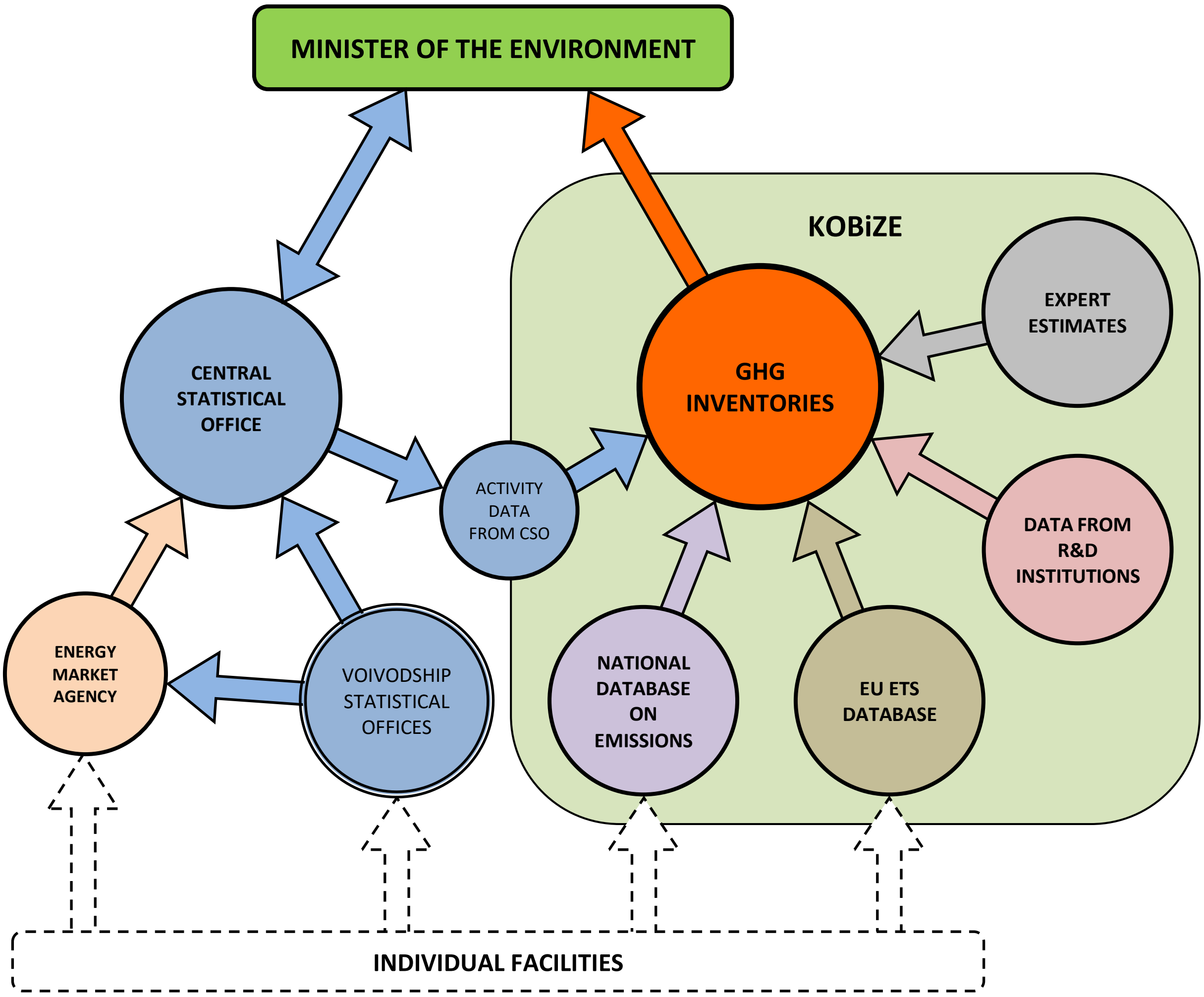

Figure 1.1. National GHG emissions inventory system scheme

The National Centre for Emissions Management, as the entity 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 *2006 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 have 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 on QA/QC procedures 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 EMEP/EEA. 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; in very detailed categories, estimates made by individual industries or market players can be also useful if available,
- 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 in a database in KOBIZE, which is constantly updated and extended to meet the ever changing requirements for emission reporting, with respect to UNFCCC and CLTRAP as well as their protocols.

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 official fuel balances elaborated by Central Statistical Office and reported to Eurostat pursuant to Article 4 of Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics.

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 applies 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 a 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 and Central Statistical Office (GUS) databases. The activity data that are not available in the GUS have been worked out in experts studies commissioned specifically for the GHG emission inventory purposes.

Table 1.1. Hard coal consumption in 2016

National fuel balance	Hard coal (Eurostat)	
	kt	TJ
In	79 084	1 905 429
From national sources	70 784	1 701 096
1) Indigenous production	70 386	1 691 500
2) Transformation output or return	398	9 596
3) Stock decrease	0	0
Import	8 300	204 333
Out	79 084	1 905 429
National consumption	74 642	1 783 075
1) Transformation input	56 923	1 336 023
a) input for secondary fuel production	13 097	386 987
b) fuel combustion	43 826	949 036
2) Direct consumption	17 719	447 052
Non-energy use	154	4 244
Combusted directly	17 565	442 807
Combusted in Poland	61 390	1 391 844
Stock increase	-4 732	-108 844
Export	9 097	242 172
Losses and statistical differences	77	-10 975
Net calorific value	MJ/kg	22.67

Eurostat database containing domestic data provided by GUS is the main source of activities for *Energy* sector (Annex 4). The data on fuel consumption in *Road Transportation* subcategory were also taken from the 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 assessment established in accordance with 2006 IPCC GLs following quantitative Approach 1 and qualitative criteria. In 2016, 34 sources were identified as Poland's key categories excluding LULUCF and 42 including LULUCF while in 1988 - 22 and 25 respectively with the application of quantitative approach. Analysis with use of qualitative criteria identified no additional categories as key sources.

About 76.5% of GHG emissions in 2016 (excluding LULUCF) were generated in the sector 1.A *Energy,* of which four the biggest source categories: 1.A.1 *Energy Industries (Solid fuels)*, 1.A.3.b *Road Transportation (Fossil fuels)*, 1.A.4 *Other Sectors (Solid fuels)* and 1.B.1 *Fugitive emissions from Solid Fuels* generate 63.3% of Poland's GHG emissions (excluding LULUCF). This category is of significant influence on a country's total GHG emissions in terms of both: level and trend of emissions.

Table 1.2 presents the general information on identified key categories in the national inventory for 2016. Those categories contribute to 97.0% of the GHG emission (without LULUCF). The complete tables with level and trend assessments for 1988 and 2016 are given in Annex 1.

Table 1.2. Key category analysis results in 2016 (without LULUCF)

No.	IPCC Source Categories	GHG	Identification criteria (Level, Trend, Qualitative)			Comments
1	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	L	T		
2	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	L	T		
3	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CO_2		T		
4	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	L	T		
5	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	L	T		
6	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	L	T		
7	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO_2	L	T		
8	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	L	T		
9	1.A.3.b Road Transportation	CO_2	L	T		
10	1.A.3.c Railways	CO_2		T		
11	1.A.3.e Other Transportation	CO_2		T		
12	1.A.4 Other Sectors - Biomass	CH_4		T		
13	1.A.4 Other Sectors - Gaseous Fuels	CO_2	L	T		
14	1.A.4 Other Sectors - Liquid Fuels	CO_2	L	T		
15	1.A.4 Other Sectors - Solid Fuels	CO_2	L	T		
16	1.A.4 Other Sectors - Solid Fuels	CH_4	L	T		
17	1.B.1 Fugitive emissions from Solid Fuels	CH_4	L			
18	1.B.1 Fugitive emissions from Solid Fuels	CO_2	L			
19	1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH_4		T		
20	1.B.2.d Fugitive Emissions from Fuels - Other	CO_2	L	T		
21	2.A.1 Cement Production	CO_2	L	T		
22	2.A.2 Lime Production	CO_2		T		
23	2.A.4 Other Process Uses of Carbonates	CO_2	L	T		
24	2.B.1 Ammonia Production	CO_2	L	T		
25	2.B.2 Nitric Acid Production	N_2O		T		
26	2.C.1 Iron and Steel Production	CO_2	L	T		
27	2.F.1 Refrigeration and Air conditioning	F-gases	L	T		
28	3.A Enteric Fermentation	CH_4	L	T		
29	3.B Manure Management	N_2O	L			
30	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	L	T		
31	3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	L			
32	3.G Liming	CO_2		T		
33	5.A Solid Waste Disposal	CH_4	L	T		
34	5.D Wastewater Treatment and Discharge	CH_4		T		

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

Uncertainty evaluation made for 2016 is based on calculations and national expert's judgments/ estimations as well as opinions expressed by international experts during the review led 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 2016 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 8.

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 25, and for nitrous oxide 298. Carbon dioxide is the main GHG in Poland with the 81.02% (excluding category 4) share in 2016, while the methane contributes with 11.8% (excluding category 4) to the national total. Nitrous oxide contribution is 4.9% (excluding category 4) and all industrial GHG together contribute 2.3%. Percentage shares of individual GHGs in national total emissions in 2016 are presented in table 2.1. and figure 2.1.

Table 2.1. Greenhouse gas emissions in 2016 in CO_2 eq.

Pollutant	2016	
	Emission in CO_2 eq. [kt]	Share [%]
CO_2 (with LULUCF)	293 014.79	79.25
CO_2 (without LULUCF)	322 233.95	81.02
CH_4 (with LULUCF)	46 940.75	12.70
CH_4 (without LULUCF)	46 895.92	11.79
N_2O (with LULUCF)	20 752.53	5.61
N_2O (without LULUCF)	19 530.00	4.91
HFCs	8 955.35	2.25
PFCs	13.21	0.00
Mix HFC i PFC	NA,NO	NA,NO
SF_6	77.03	0.02
NF_3	NA,NO	NA,NO
TOTAL net emission (with LULUCF)	369 753.67	100.00
TOTAL without LULUCF	397 705.47	100.00

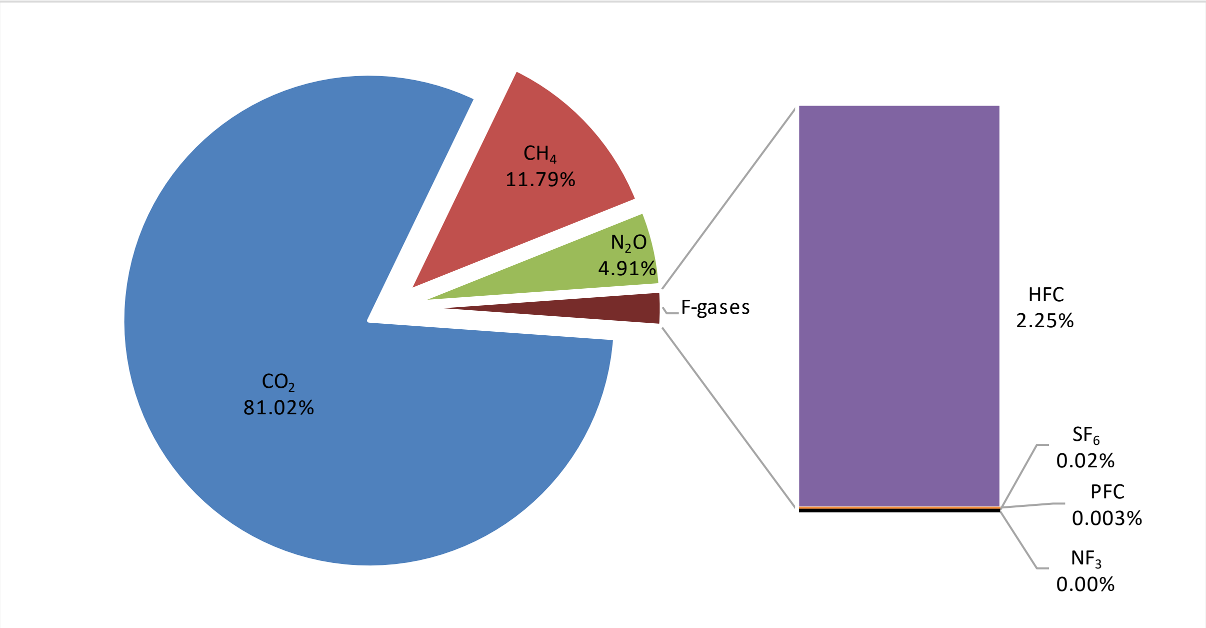

Figure 2.1. Percentage share of greenhouse gases in national total emission in 2016 (excluding LULUCF)

Emissions of main GHGs in 2016, 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 2016 [kt]

GHG	CO_2	CH_4	N_2O
TOTAL without LULUCF	322 233.95	1 875.84	65.54
TOTAL with LULUCF	293 014.79	1 877.63	69.64
1. Energy	301 820.80	931.53	8.18
A. Fuel Combustion	297 929.67	152.81	8.17
1. Energy Industries	162 449.99	4.15	2.52
2. Manufacturing Industries and Construction	28 842.59	4.21	0.58
3. Transport	52 329.80	4.60	1.88
4. Other Sectors	54 307.28	139.86	3.20
5. Other	IE, NO	IE, NO	IE, NO
B. Fugitive Emissions from Fuels	3 891.13	778.72	0.002
1. Solid Fuels	2 048.15	677.51	NA
2. Oil and Natural Gas	1 842.99	101.21	0.00
2. Industrial Processes and Product Use	18 584.91	2.04	3.26
A. Mineral Industry	10 393.52	NA	NA
B. Chemical Industry	4 902.81	1.48	2.82
C. Metal Industry	2 551.77	0.56	NA
D. Other Production	736.81	NE	NE
G. Other	NO	NO	0.4
3. Agriculture	1 040.09	555.20	50.85
A. Enteric Fermentation	NE	491.09	NE
B. Manure Management	NE	63.13	6.75
D. Agricultural Soils	NE	NA	44.06
F. Field Burning of Agricultural Residues	NE	0.99	0.04
G. Liming	663.34	NA	NA
H. Urea application	376.75	NA	NA
4. Land Use, Land-Use Change and Forestry	-29 219.16	1.79	0.01
A. Forest Land	-36 519.30	1.57	0.006
B. Cropland	733.07	IE, NO	NO,NA
C. Grassland	-940.65	0.22	0.00
D. Wetlands	4 495.22	0.00	0.00
E. Settlements	7 247.04	NA, NO	NA, NO
F. Other Land	NA, NO	NA, NO	NA, NO
G. HWP	-4 234.53	NA, NO	NA, NO
5. Waste	788.15	387.07	3.25
A. Solid Waste Disposal	NO,NA	359.11	NO,NA
B. Biological Treatment of Solid Waste	NO,NA	7.94	0.48
C. Incineration and Open Burning of Waste	788.15	0.00	0.22
D. Wastewater Treatment and Discharge	NO,NA	20.02	2.55

Table 2.3. Emissions of industrial gases: HFCs, PFCs and SF_6 in 2016 [kt eq. CO_2]

2016	HFCs	PFCs	SF_6	Total in eq. CO_2
Total Industrial gases [kt eq. CO_2]	8 955.35	13.21	77.03	9 045.59
C. Metal Industry	NE	NO	4.15	4.15
4. Magnesium production	NE	NO	4.15	4.15
F. Consumption of Halocarbons and SF_6	8 955.35	13.21	NO	8 968.56
1. Refrigeration and Air Conditioning Equipment	8 449.45	NO	NO	8 449.45
2. Foam Blowing	300.88	NO	NO	300.88
3. Fire Extinguishers	78.75	13.21	NA	91.96
4. Aerosols	125.82	NA	NA	125.82
G. Other product manufacture and use	NO	NO	72.88	72.88
1. Electrical equipment	NO	NO	72.88	72.88

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 2016 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. 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. Slow decline in emissions (up to 2002) characterized the succeeding years, when still energy efficiency policies and measures were implemented, and then slight increase up to 2007 caused by animated economic development. In 2008-2011 stabilisation in emissions has been noted with distinct decrease in 2009 related to world economic slow-down. Since 2012 GHG emissions in Poland do not exceed 400 Mt CO_2 eq. (figure 2.2 and tables 2.5 and 2.6).

Since 2005 Poland has taken 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 from installations covered by EU ETS in the national emissions in 2005−2016 amounted to about 51% on average. 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) (figure 2.2).

Table 2.4. Percentage shares of individual source sectors in 2016 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	93.67	49.66	12.47
A. Fuel Combustion	92.46	8.15	12.47
1. Energy Industries	50.41	0.22	3.84
2. Manufacturing Industries and Construction	8.95	0.22	0.88
3. Transport	16.24	0.25	2.87
4. Other Sectors	16.85	7.46	4.88
5. Other	IE, NO	IE, NO	IE, NO
B. Fugitive Emissions from Fuels	1.21	41.51	0.003
1. Solid Fuels	0.64	36.12	NA
2. Oil and Natural Gas	0.57	5.40	0.003
2. Industrial Processes and Product Use	5.77	0.11	4.98
A. Mineral Industry	3.23	NA	NA
B. Chemical Industry	1.52	0.08	4.30
C. Metal Industry	0.79	0.03	NA
D. Other Production	0.23	NE	NE
G. Other	NO	NO	0.68
3. Agriculture	0.32	29.60	77.59
A. Enteric Fermentation	NE	26.18	NE
B. Manure Management	NE	3.37	10.30
D. Agricultural Soils	NE	NA	67.23
F. Field Burning of Agricultural Residues	NE	0.05	0.06
G. Liming	0.21	NA	NA
H. Urea application	0.12	NA	NA
4. Land Use, Land-Use Change and Forestry	-	-	-
A. Forest Land	-	-	-
B. Cropland	-	-	-
C. Grassland	-	-	-
D. Wetlands	-	-	-
E. Settlements	-	-	-
F. Other Land	-	-	-
G. HWP	-	-	-
5. Waste	0.24	20.63	4.96
A. Solid Waste Disposal	NO,NA	19.14	NO,NA
B. Biological Treatment of Solid Waste	NO,NA	0.42	0.73
C. Incineration and Open Burning of Waste	0.24	0.00	0.34
D. Wastewater Treatment and Discharge	NO,NA	1.07	3.89

Table 2.5. National emissions of greenhouse gases for 1988–2016 by gases [kt CO_2 eq.]

GHG	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CO_2 (with LULUCF)	454 743.19	430 262.91	348 207.93	353 060.10	364 656.44	359 689.92	354 046.85	345 063.73	340 695.90	332 147.62	296 848.83	290 810.49	283 772.07	288 901.16	271 408.23
CO_2 (without LULUCF)	470 884.68	451 250.78	376 038.71	373 378.20	363 718.93	364 565.34	359 611.08	361 303.85	375 304.64	366 570.12	337 341.53	327 652.45	317 097.26	313 545.67	305 730.54
CH_4 (with LULUCF)	70 837.29	70 477.65	65 163.70	60 460.96	58 670.74	56 944.15	56 250.56	54 816.91	54 092.50	53 924.41	52 133.63	51 188.40	49 858.19	51 648.49	50 032.63
CH_4 (without LULUCF)	70 793.13	70 433.53	65 119.50	60 415.77	58 625.98	56 901.71	56 209.37	54 770.68	54 055.65	53 885.91	52 098.55	51 150.51	49 824.76	51 615.00	49 996.82
N_2O (with LULUCF)	29 492.29	30 765.14	27 495.60	23 047.67	21 545.25	22 846.96	22 458.09	23 468.68	23 584.49	23 485.76	23 259.84	22 547.12	22 916.03	23 103.94	21 992.06
N_2O (without LULUCF)	29 322.00	30 553.68	27 312.64	22 842.49	21 285.44	22 260.44	22 143.18	23 121.02	23 247.79	23 151.40	22 895.51	22 174.03	22 533.42	22 690.55	21 581.12
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	134.69	335.49	481.02	569.32	780.47	1 366.50	1 925.34	2 505.93
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	197.34	207.33
Unspecified mix of HFCs and PFCs	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	NA,NO	NA,NO
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	22.86	23.29
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	NA,NO	NA,NO
TOTAL (with LULUCF)	**555 220.03**	**531 653.20**	**441 009.11**	**436 710.04**	**445 007.05**	**439 625.89**	**432 921.54**	**423 685.10**	**418 893.26**	**410 235.08**	**373 010.41**	**365 518.69**	**358 112.53**	**365 799.13**	**346 169.47**
TOTAL (without LULUCF)	**571 147.07**	**552 385.50**	**468 612.72**	**456 777.77**	**443 764.98**	**443 872.35**	**438 129.67**	**439 531.34**	**453 128.46**	**444 284.72**	**413 103.70**	**401 949.67**	**391 021.68**	**389 996.76**	**380 045.03**

Table 2.5. (cont.) National emissions of greenhouse gases for 1988–2016 by gases [kt CO_2 eq.]

GHG	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
CO_2 (with LULUCF)	281 236.35	274 185.82	274 255.51	293 818.33	299 616.82	293 239.08	282 048.11	301 071.61	293 808.86	286 833.32	280 381.80	276 285.98	282 252.92	293 014.79
CO_2 (without LULUCF)	318 415.56	322 538.95	321 668.85	334 622.82	334 365.69	327 448.21	314 144.58	332 130.71	331 694.64	324 216.62	319 911.26	307 555.13	310 615.14	322 233.95
CH_4 (with LULUCF)	50 376.23	49 991.79	50 455.48	50 666.73	50 004.50	49 760.99	48 597.21	48 605.86	47 496.75	47 194.30	47 454.61	46 960.51	47 513.20	46 940.75
CH_4 (without LULUCF)	50 338.02	49 955.96	50 420.30	50 625.92	49 972.91	49 724.37	48 565.38	48 572.11	47 463.55	47 160.31	47 414.97	46 922.87	47 476.84	46 895.92
N_2O (with LULUCF)	22 220.35	22 743.52	22 927.13	23 442.73	24 270.35	23 720.84	20 602.73	20 337.84	20 684.62	20 834.41	20 945.45	20 839.66	20 027.47	20 752.53
N_2O (without LULUCF)	21 795.56	22 299.96	22 476.08	22 974.45	23 746.85	23 179.28	20 025.07	19 707.84	20 039.24	20 116.80	20 202.31	19 754.86	18 930.85	19 530.00
HFCs	3 078.00	3 733.23	4 556.73	5 408.05	6 009.80	6 334.89	6 289.67	7 006.36	7 622.60	7 959.91	8 356.09	8 978.00	8 969.07	8 955.35
PFCs	201.08	205.07	187.41	193.58	184.63	163.12	17.97	17.07	16.22	15.41	14.64	13.90	13.21	13.21
Unspecified mix of HFCs and PFCs	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	NO,NA
SF_6	20.72	22.36	26.80	33.20	31.16	32.87	37.60	35.37	39.02	41.92	47.54	52.79	77.03	77.03
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	NO,NA
TOTAL (with LULUCF)	**357 132.72**	**350 881.79**	**352 409.06**	**373 562.62**	**380 117.26**	**373 251.79**	**357 593.29**	**377 074.11**	**369 668.06**	**362 879.27**	**357 200.11**	**353 130.84**	**358 852.91**	**369 753.67**
TOTAL (without LULUCF)	**393 848.93**	**398 755.53**	**399 336.17**	**413 858.03**	**414 311.04**	**406 882.74**	**389 080.27**	**407 469.46**	**406 875.27**	**399 510.97**	**395 946.81**	**383 277.54**	**386 082.14**	**397 705.47**

Table 2.6. National emissions of greenhouse gases for 1988–2016 by source categories [kt CO_2 eq.]

IPCC sector	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1. Energy	474 966.26	454 551.79	381 999.86	380 030.81	371 207.28	373 248.96	366 397.75	366 666.00	381 854.85	371 600.85	342 235.47	333 702.79	321 024.75	322 050.52	314 468.98
2. Industrial Processes	31 198.21	30 235.92	22 693.33	20 092.42	19 695.46	19 309.78	21 255.05	22 691.59	22 040.45	22 956.50	21 380.10	20 583.30	23 790.48	22 461.90	20 782.50
3. Agriculture	47 835.68	50 519.18	47 155.60	40 119.67	36 523.26	35 210.83	34 783.91	34 732.58	34 006.84	34 591.23	34 335.88	32 596.07	31 005.77	30 614.99	29 929.56
4. Land-Use, Land-Use Change and Forestry	-15 927.04	-20 732.30	-27 603.61	-20 067.73	1 242.07	-4 246.46	-5 208.13	-15 846.24	-34 235.20	-34 049.64	-40 093.29	-36 430.98	-32 909.15	-24 197.63	-33 875.56
5. Waste	17 146.91	17 078.61	16 763.92	16 534.88	16 338.98	16 102.78	15 692.96	15 441.17	15 226.31	15 136.14	15 152.25	15 067.51	15 200.68	14 869.35	14 863.99
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
TOTAL (with LULUCF)	**555 220.03**	**531 653.20**	**441 009.11**	**436 710.04**	**445 007.05**	**439 625.89**	**432 921.54**	**423 685.10**	**418 893.26**	**410 235.08**	**373 010.41**	**365 518.69**	**358 112.53**	**365 799.13**	**346 169.47**
TOTAL (without LULUCF)	**571 147.07**	**552 385.50**	**468 612.72**	**456 777.77**	**443 764.98**	**443 872.35**	**438 129.67**	**439 531.34**	**453 128.46**	**444 284.72**	**413 103.70**	**401 949.67**	**391 021.68**	**389 996.76**	**380 045.03**

Table 2.6. (cont.) National emissions of greenhouse gases for 1988–2016 by source categories [kt CO_2 eq.]

IPCC sector	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
1. Energy	325 913.38	329 565.88	330 165.29	341 727.65	339 001.17	333 238.10	322 146.71	339 150.58	335 836.48	329 878.93	326 099.88	312 408.35	316 129.01	327 545.38
2. Industrial Processes	23 654.54	25 448.34	25 418.64	27 938.78	30 496.58	29 071.56	22 981.10	25 001.34	27 847.24	26 824.63	26 572.14	28 177.72	28 534.72	28 653.05
3. Agriculture	29 364.19	29 354.21	29 511.99	30 221.10	30 854.09	30 928.18	30 232.31	29 717.72	30 088.15	29 956.20	30 497.88	30 397.67	29 557.34	30 073.60
4. Land-Use, Land-Use Change and Forestry	-36 716.22	-47 873.74	-46 927.11	-40 295.41	-34 193.78	-33 630.95	-31 486.98	-30 395.35	-37 207.21	-36 631.70	-38 746.70	-30 146.70	-27 229.23	-27 951.80
5. Waste	14 916.82	14 387.10	14 240.24	13 970.50	13 959.20	13 644.91	13 720.15	13 599.82	13 103.40	12 851.22	12 776.90	12 293.81	11 861.07	11 433.43
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
TOTAL (with LULUCF)	**357 132.72**	**350 881.79**	**352 409.06**	**373 562.62**	**380 117.26**	**373 251.79**	**357 593.29**	**377 074.11**	**369 668.06**	**362 879.27**	**357 200.11**	**353 130.84**	**358 852.91**	**369 753.67**
TOTAL (without LULUCF)	**393 848.93**	**398 755.53**	**399 336.17**	**413 858.03**	**414 311.04**	**406 882.74**	**389 080.27**	**407 469.46**	**406 875.27**	**399 510.97**	**395 946.81**	**383 277.54**	**386 082.14**	**397 705.47**

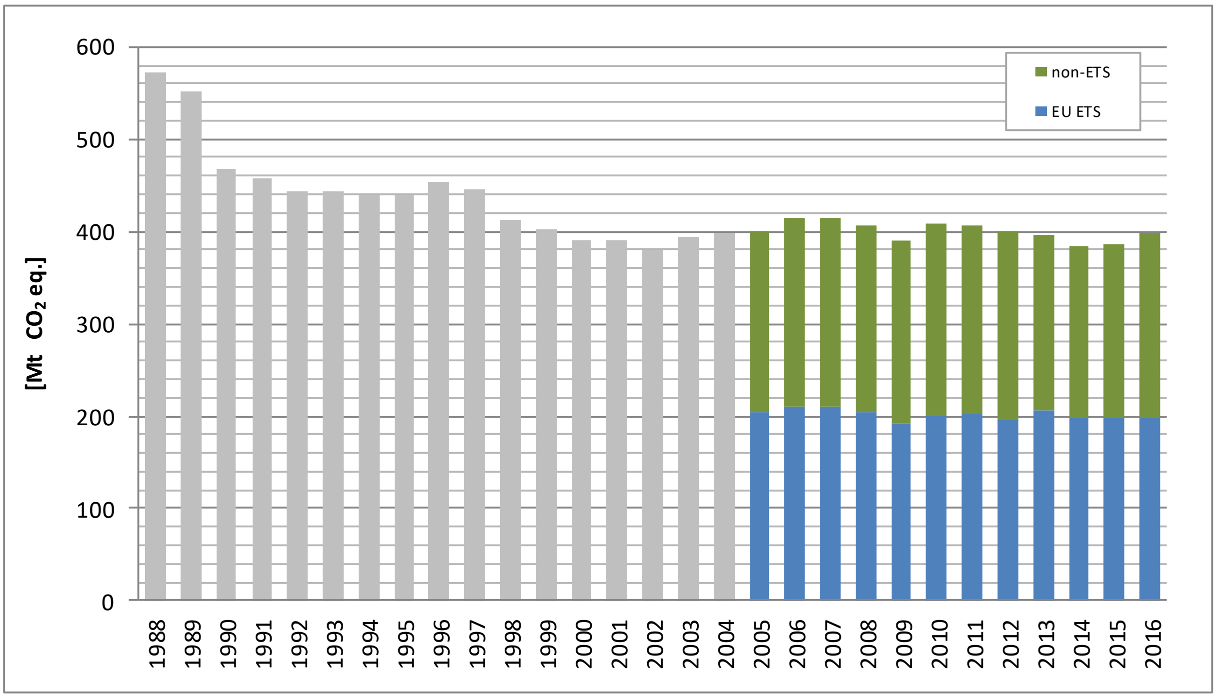

Figure 2.2. Trend of aggregated GHGs emissions (excluding category 4) for 1988–2016

2.2. Description and interpretation of emission trends by gas

Carbon dioxide (CO_2)

In 2016, the CO_2 emissions (without LULUCF) were estimated to be 322.23 million tonnes, while - when sector 4. LULUCF is included - the figure reaches 293.01 million tonnes (table 2.1). CO_2 share in total GHG emissions in 2016 amounted to 81.02%. The main CO_2 emission source is *Fuel Combustion* (1.A) subcategory. This sector contributed to the total CO_2 emission (without LULUCF) with 92.5% share in 2016 (fig. 2.3). The shares of the main subcategories in 1.A were as follows: *Energy industries* - 50.4%, *Manufacture Industries and Construction* – 9.0%, *Transport* – 16.2% and *Other Sectors* – 16.9%. Sector 2. *Industrial Processes* contributed to the total CO_2 emission with 5.8% share in 2016. *Mineral industry* (especially *Cement Production*) is the main emission source in this sector. The CO_2 emission/removal in LULUCF sector in 2016, was calculated to be approximately 29.2 million tonnes. It means that app. 9.1% of the total CO_2 emissions are offset by CO_2 uptake by forests.

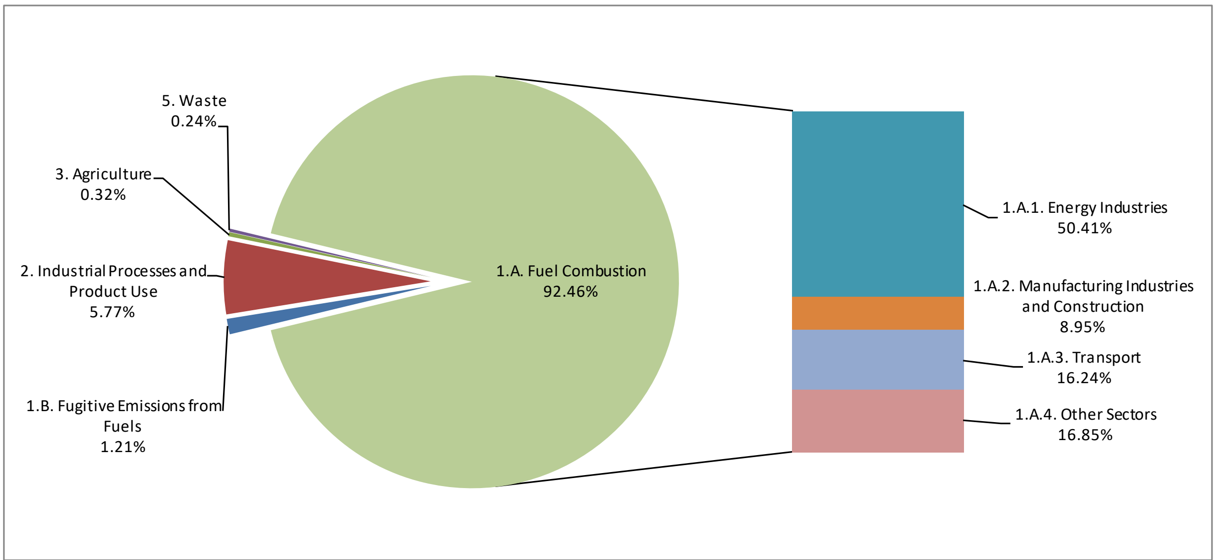

Figure 2.3. Carbon dioxide emission (excluding category 4) in 2016 by sector

Methane (CH_4)

The CH_4 emission (excluding category 4) amounted to 1 875.84 kt in 2016 i.e. 46.90 million tonnes of CO_2 equivalents (table 2.1). CH_4 share in total GHG emissions in 2016 amounted to 11.8%. Three of main CH_4 emission sources include the following categories: *Fugitive Emissions from Fuels, Agriculture* and *Waste*. They contributed with 41.5%, 29.6% and 20.6% shares to the national methane emission in 2016, respectively (fig. 2.4). The emission from the first mentioned sector was covered by emission from *Underground Mines* (app. 36.1% of total CH_4 emission) and *Oil and Natural Gas* system (about 5.4% of total emission). The emission from *Enteric Fermentation* dominated in *Agriculture* and amounted to app. 26.2% of total methane emission in 2016. *Disposal sites* contributed to 20.6% of the methane emission.

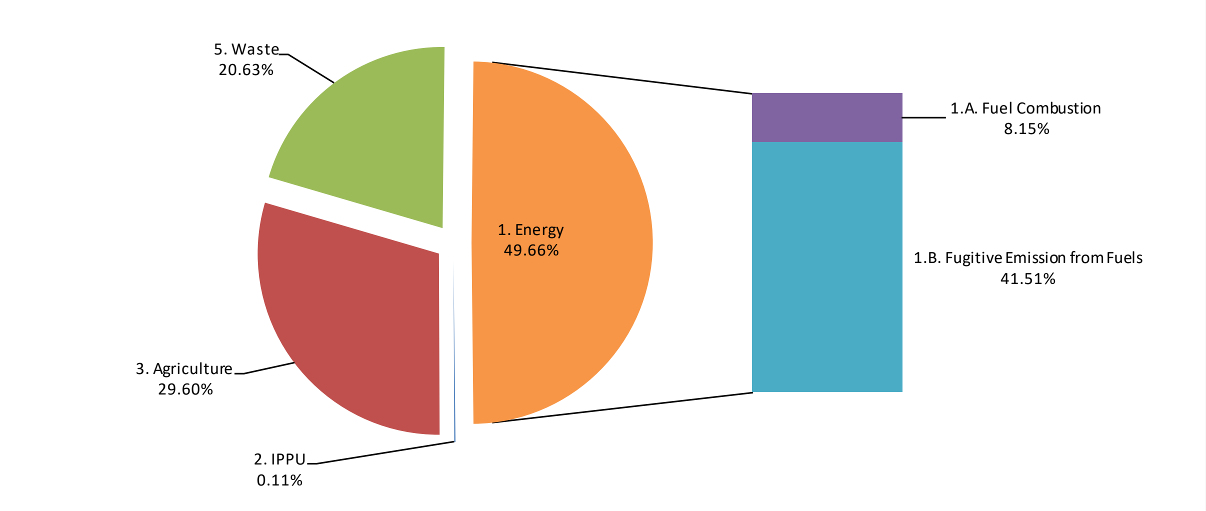

Figure 2.4. Methane emission (excluding category 4) in 2016 by sector

Nitrous oxide (N_2O)

The nitrous oxide emissions (excluding category 4) in 2016 were 65.54 kt i.e. 19.53 million tonnes of CO_2 equivalents (table 2.2). N_2O share in total GHG emissions in 2016 amounted to 4.9%. The main N_2O emission sources and their shares in total N_2O emission in 2016 are: *Agricultural Soils* – 67.2%, *Manure Management* – 10.3%, *Chemical Industry* – 5.0% and *Fuel Combustion* – 12.5% (fig. 2.5).

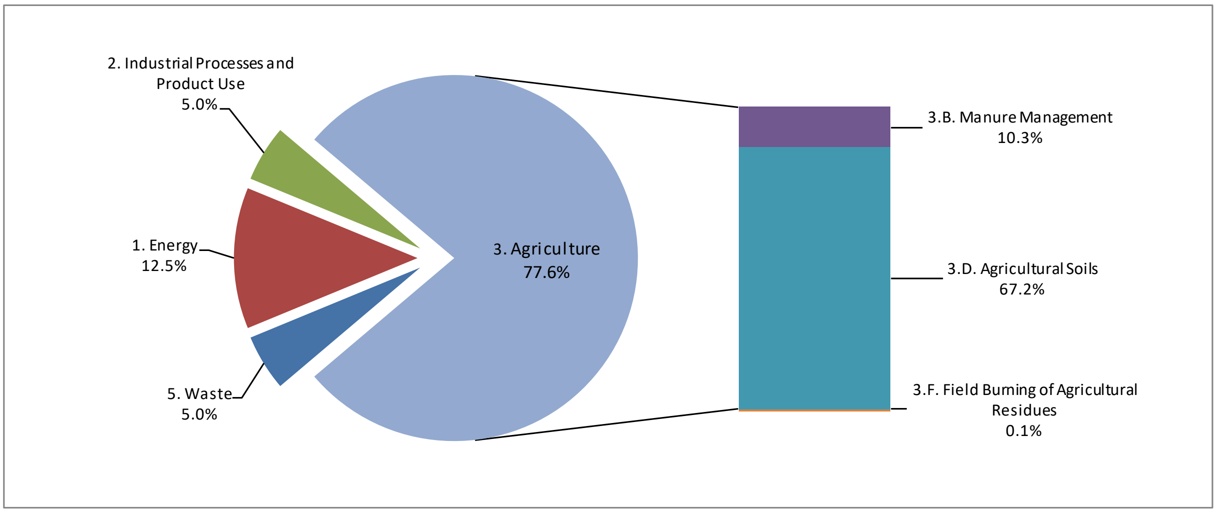

Figure 2.5. Nitrous oxide emission (excluding category 4) in 2016 by sector

Industrial gases

The total emission of industrial gases (HFCs, PFCs SF_6 and NF_3) in 2016 was 9 045.59 kt CO_2 equivalent what accounts for 2.3% of total GHG emissions share in 2016. 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 2016 GHG emissions was respectively as follows: 2.25%, 0.003% and 0.019%. NF_3 emissions did not occur.

The total emissions in 2016 according to groups of industrial gases are as follows: HFCs – 8.96 million tonnes of CO_2 equivalents, PFCs – 0.01 million tonnes of CO_2 equivalents and SF_6 – 0.05 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 in figure 2.6. Compared to the base year, the percentage share of CO_2 (excluding category 4) in 2016 decreased slightly from 82.42% to 81.02%.

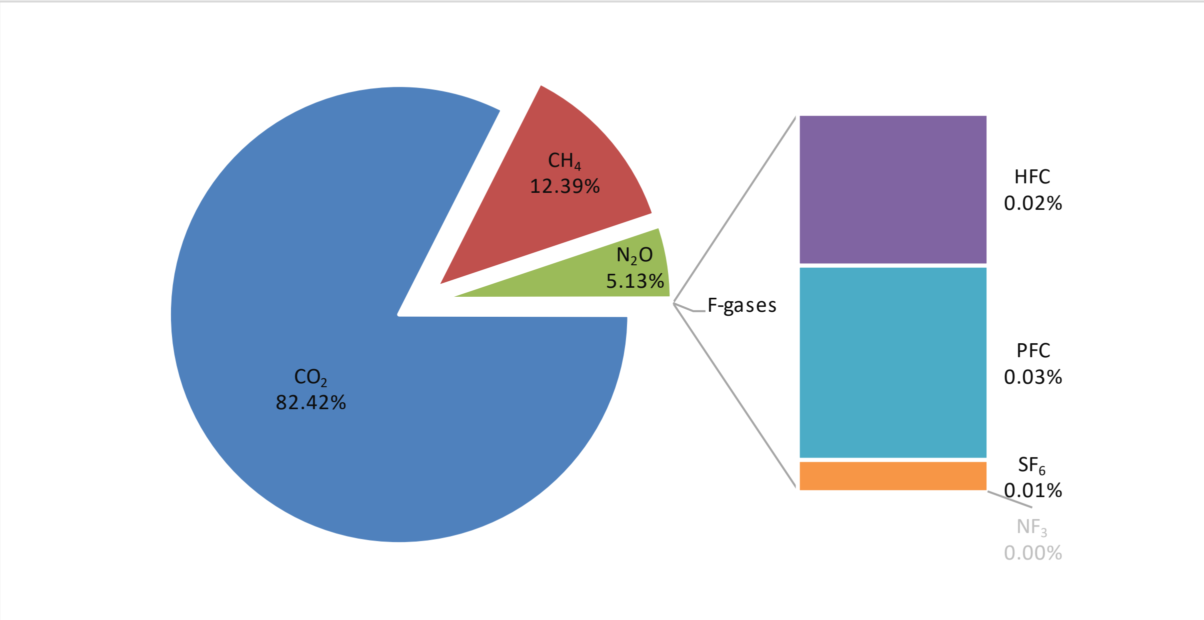

Figure 2.6. Percentage share of national greenhouse gas emissions in base year excluding emission from category 4

Table 2.7. Greenhouse gas emissions in 2016 with respect to base year (1988 and 1995 for F-gases)

Pollutant	Emission in CO_2 eq. [kt]		(2016-base)/base [%]
	Base year	2016	
CO_2 (with LULUCF)	454 743.19	293 014.79	-35.56
CO_2 (without LULUCF)	470 884.68	322 233.95	-31.57
CH_4 (with LULUCF)	70 837.29	46 940.75	-33.73
CH_4 (without LULUCF)	70 793.13	46 895.92	-33.76
N_2O (with LULUCF)	29 492.29	20 752.53	-29.63
N_2O (without LULUCF)	29 322.00	19 530.00	-33.39
HFCs	134.69	8 955.35	6 548.73
PFCs	171.97	13.21	-92.32
Unspecified mix of HFCs and PFCs	NA,NO	NA,NO	NA,NO
SF_6	29.12	77.03	164.50
NF_3	NA,NO	NA,NO	NA,NO
TOTAL net emission (with LULUCF)	555 408.56	369 753.67	-33.43
TOTAL without LULUCF	571 335.59	397 705.47	-30.39

Comparison of GHG emissions in 2016 and the base year given in table 2.7 indicates significant drop in all gases, except HFCs and SF_6, especially in CO_2 and methane emissions, where decrease reached ca. 31.6% and 33.8% respectively in 1988-2016 (excluding LULUCF). This was mainly caused by significant changes in fuel mix as well as serious drop in coal mining livestock population.

Carbon dioxide

CO_2 emission (excluding category 4) decreased by app. 31.6% from the base year (1988) to 2016.
The following changes took place in the structure of fuel use:

- share of solid fuels decreased from 80.1% in the base year to 52.9% in 2016,
- share of liquid fuels increased from 11.7% in the base year to 25.0% in 2016,
- share of gaseous fuels increased from 6.2% in the base year to 13.2% in 2016.

Methane

CH_4 emission (excluding category 4) decreased by app. 33.8% from the base year (1988) to 2016. The reasons for that are as follows:

- the decrease in emission from *Enteric Fermentation* by 44.1%,
- the decrease in *Fugitive Emission* by 21.9%,
- the decrease in emission from *Waste* by 39.3%.

Nitrous oxide

The nitrous oxide emissions (excluding category 4) in 2016 were app. 33.4% lower than the respective figure for the base year (1988) what was caused mostly by diminishing agricultural production. At the same time the share of *Manure Management* decreased from 10.7% in the base year 1988 to 10.3% in 2016, share of *Agricultural Soils* increased from 61.1% in the base year 1988 to 67.2% in 2016 and *Chemical Industry* decreased from 16.4% in the base year 1988 to 4.3% in 2016.

Industrial gases: HFCs, PFCs, NF_3 and SF_6

HFCs emissions in 2016 were 65.5 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 2016 were by 92.3% lower than in base year (1995). The PFCs emission changes between 2016 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 2016 were higher by about 164.5% 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 with app. 31.6% to the national total in 2016. 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 2016 by main categories. In 2016 total GHG emissions accounted for 397.71 million tonnes CO_2 eq. excluding sector 4. *LULUCF*. Comparing to the base year emissions in 2016 decreased by 30.4%.

Table 2.8. GHG emissions by main sector in the base year and in 2016

	Total [kt eq. CO_2]		(2016-base)/base [%]
	Base year	2016	
TOTAL with LULUCF	555 408.56	369 753.67	-33.4
TOTAL without LULUCF	571 335.59	397 705.47	-30.4
1. Energy	474 966.26	327 545.38	-31.0
2. Industrial Processes and Product Use	31 386.74	28 653.05	-8.7
3. Agriculture	47 835.68	30 073.60	-37.1
4. Land-Use, Land-Use Change and Forestry	-15 927.04	-27 951.80	75.5
5. Waste	17 146.91	11 433.43	-33.3

2.3.1. Energy

The emission of GHGs from *Energy* sector in 2016 was 327.5 million tonnes of CO_2 equivalent. CO_2 emission share amounted to 92.1% 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 energy sector, highly energy consuming.

Table 2.9. GHG emissions from sub-sectors in category 1. *Energy* in 2016

GHG emission categories	GHG emission [kt CO_2 eq.]	% share in the total emission from sector 1. *Energy*	% share in total GHG emission		
			CO_2	CH_4	N_2O
1. TOTAL ENERGY	327 545.38	100.0	92.1	7.1	0.7
A. Fuel Combustion	304 185.82	92.9	91.0	1.2	0.7
1. Energy Industries	163 304.52	49.9	49.6	0.0	0.2
2. Manufacturing Industries and Construction	29 120.39	8.9	8.8	0.0	0.1
3. Transport	53 004.92	16.2	16.0	0.0	0.2
4. Other Sectors	58 755.99	17.9	16.6	1.1	0.3
5. Other	0.00	0.0	0.0	0.0	0.0
B. Fugitive Emissions from Fuels	23 359.56	7.1	1.2	5.9	0.0
1. Solid Fuels	18 985.79	5.8	0.6	5.2	0.0
2. Oil and Natural Gas and other emissions from energy production	4 373.77	1.3	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 2016. CO_2 is dominating among GHGs – it's contribution reaches 64.9%. 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 2016

GHG emission categories	GHG emission [kt CO_2 eq.]	% share in the total emission from sector 2. *IPPU*	% share in total GHG emission			
			CO_2	CH_4	N_2O	HFC, PFC and SF_6
2. TOTAL INDUSTRIAL PROCESSES AND PRODUCT USE	28 653.05	100.0	64.9	0.2	3.4	31.6
A. Mineral Industry	10 393.52	36.3	36.3	0.0	0.0	0.0
B. Chemical Industry	5 779.13	20.2	17.1	0.1	2.9	0.0
C. Metal Industry	2 569.85	9.0	8.9	0.0	0.0	0.0
D. Non-energy products from fuels and solvent use	736.81	2.6	2.6	0.0	0.0	0.0
F. Product uses as substitutes for ODS	8968.56	31.3	0.0	0.0	0.0	31.3
G. Other product manufacture and use	205.19	0.7	0.0	0.0	0.5	0.3

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 2016 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 2016

GHG emission categories	GHG emission [kt CO_2 eq.]	% share in the total emission from sector 3. *Agriculture*	% share in total GHG emission	
			CH_4	N_2O
3. TOTAL AGRICULTURE	30 073.60	100.0	46.2	50.4
A. Enteric Fermentation	12 277.14	40.8	40.8	0.0
B. Manure Management	3 590.27	11.9	5.2	6.7
D. Agricultural Soils	13 129.49	43.7	0.0	43.7
F. Field Burning of Agricultural Residues	36.61	0.1	0.1	0.0
G. Liming	663.34	2.2	0.0	0.0
H. Urea application	376.75	1.3	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 2016 (with 84.6% share). The main part of GHG emissions came from 6.A *Solid waste disposal*.

Table 2.12. GHG emissions from *Waste* in 2016

GHG emission categories	GHG emission [kt CO_2 eq.]	% share in the total emission from sector 5. *Waste*	% share in total GHG emission		
			CO_2	CH_4	N_2O
5. TOTAL WASTE	11 433.43	100	6.9	84.6	8.5
A. Solid Waste Disposal	8 977.70	78.5	0.0	78.5	0.0
B. Biological Treatment of Solid Waste	340.35	3.0	0.0	1.7	1.2
C. Incineration and Open Burning of Waste	854.35	7.5	6.9	0.0	0.6
D. Wastewater Treatment and Discharge	1 261.03	11.0	0.0	4.4	6.7

2.3.5. EU Climate and energy package (ETS and ESD emissions)

EU member states, being the Parties to the Kyoto Protocol, have reached the agreement to fulfil their commitments jointly in the second KP period under the so called EU Climate and Energy Package. To meet the obligations, the EU legislation divided all the emission sources into two main sectors: EU ETS and so-called non-ETS. Poland (nor any other EU member state) does not have any specific reduction target for 2013-2020 imposed on emissions coming from sources included in EU ETS, as such a limit has only been imposed on the whole EU ETS on the EU level (*cap*). The installations directly are responsible for their individual emissions within the overall limit.

The emissions from sources included in EU ETS (electricity and heat production, heavy industry) are reported directly by installations. The sum of all the reported emissions by installations in Poland constitutes the emission of the Polish part of EU ETS. Those reports show the emission of CO_2 mainly (a small part of N_2O emission is also included). Total emissions in this sector from stationary installations in the second commitment period of the KP fluctuate from 205.7 Mt CO_2 eq. in 2013 up to 198.1 Mt of CO_2 eq. in 2016.

The joint target under so called Effort Sharing Decision (ESD) is regulated by *Decision No 406/2009/EC of the European Parliament and of the Council on the effort of Member States to reduce their* *greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020* (ESD decision). Pursuant to the ESD decision, the European Commission adopted yearly emission limits for the EU member states in its Commission Decision 2017/1471 of 10 August 2017 amending decision 2013/162/EU of 26 March 2013 (Annex II). The limits have been corrected in the Commission implementing decision 2013/634/EU of 31 October 2013 (Annex II). According to above mentioned decision member states have specific emission targets imposed only on the non-ETS emissions - the Polish ESD target amounts to +14% in 2020 comparing to 2005. The total ESD emissions in 2013-2016 in Poland comparing to targets result in overachievement amounting to -28 Mt CO_2 eq.

2.4. Description and interpretation of emission trends for KP-LULUCF inventory in aggregate, by activity and by gas

The emissions and removals balance of greenhouse gases for the period 2008-2016, to related activities of land use, land use change and forestry (LULUCF) under Article 3.3 and 3.4 of the Kyoto Protocol is presented in Tables 2.13-2.15. For activities related to afforestation/reforestation and forest management estimated balance is negative, what means the activity is considered as a net CO_2 sink.

Table 2.13. The emissions and removals balance of greenhouse gases for the period 2008-2016 for selected activities of land use, land use change and forestry (LULUCF) [kt CO_2]

Activity	2008	2009	2010	2011	2012	2013	2014	2015	2016
4.KP. A.1. Afforestation/ Reforestation	-2368	-2460	-2582	-2668	-2783	-2845	-2818	-2852	-2836
4.KP. A.2. Deforestation	245	255	263	226	248	203	316	301	5522
4.KP. B.1. Forest Management	-38 002	-35 757	-34 583	-41 187	-40 715	-42 777	-35 727	-31 771	-37 869
4.KP. B.2 Cropland management	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
4.KP. B.3 Grazing land management	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
4.KP. B.4 Revegetation	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

Estimated sink associated with the afforestation activity, increased by about 20% as compared to 2008. The emissions associated with deforestation as compared to 2008, increased significantly in 2016 comparing to 2008 reaching 5.5 Mt CO_2. Such increase was caused by the higher area of forest land exclusions for non-forestry and non agricultural purposes. The size of net absorption for forest management activity for the year 2016 is comparable to 2008 value (decrease by 0.36%).

Table 2.14. The emissions and removals balance of greenhouse gases for the period 2008-2016 for selected activities of land use, land use change and forestry (LULUCF) [kt CH_4]

Activity	2008	2009	2010	2011	2012	2013	2014	2015	2016
4.KP.A.1. Afforestation/ Reforestation	0.08	0.08	0.09	0.09	0.09	0.11	0.1	0.1	0.11
4.KP.A.2. Deforestation	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.KP.B.1. Forest Management	1.14	1.15	1.20	1.18	1.20	1.39	1.29	1.27	1.46
4.KP.B.2. Cropland management	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
4.KP.B.3. Grazing land management	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
4.KP.B.4. Revegetation	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

Table 2.15. The emissions and removals balance of greenhouse gases for the period 2008-2016 for selected activities of land use, land use change and forestry (LULUCF) [kt N_2O]

Activity	2008	2009	2010	2011	2012	2013	2014	2015	2016
4.KP.A.1. Afforestation/ Reforestation	0.0006	0.0009	0.0005	0.0007	0.0017	0.0004	0.0007	0.0014	0.0004
4.KP.A.2. Deforestation	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
4.KP.B.1. Forest Management	0.0092	0.0134	0.0068	0.009	0.0232	0.0048	0.0092	0.0186	0.0056
4.KP.B.2. Cropland management	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
4.KP.B.3. Grazing land management	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
4.KP.B.4. Revegetation	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

3. ENERGY (CRF SECTOR 1)

3.1. Overview of sector

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

IPCC Source Categories	GHG	Identification criteria (Level, Trend, Qualitative)		
1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	L	T	
1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	L	T	
1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CO_2		T	
1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	L	T	
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	L	T	
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	L	T	
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO_2	L	T	
1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	L	T	
1.A.3.b Road Transportation	CO_2	L	T	
1.A.3.c Railways	CO_2		T	
1.A.3.e Other Transportation	CO_2		T	
1.A.4 Other Sectors - Biomass	CH_4		T	
1.A.4 Other Sectors - Gaseous Fuels	CO_2	L	T	
1.A.4 Other Sectors - Liquid Fuels	CO_2	L	T	
1.A.4 Other Sectors - Solid Fuels	CO_2	L	T	
1.A.4 Other Sectors - Solid Fuels	CH_4	L	T	
1.B.1 Fugitive emissions from Solid Fuels	CH_4	L		
1.B.1 Fugitive emissions from Solid Fuels	CO_2	L		
1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH_4		T	
1.B.2.d Fugitive Emissions from Fuels - Other	CO_2	L	T	

Share of these subcategories in total Poland's GHG emissions amounts ca. 81.29%.

Figure 3.1.1 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 2016 ca. 76.49%.

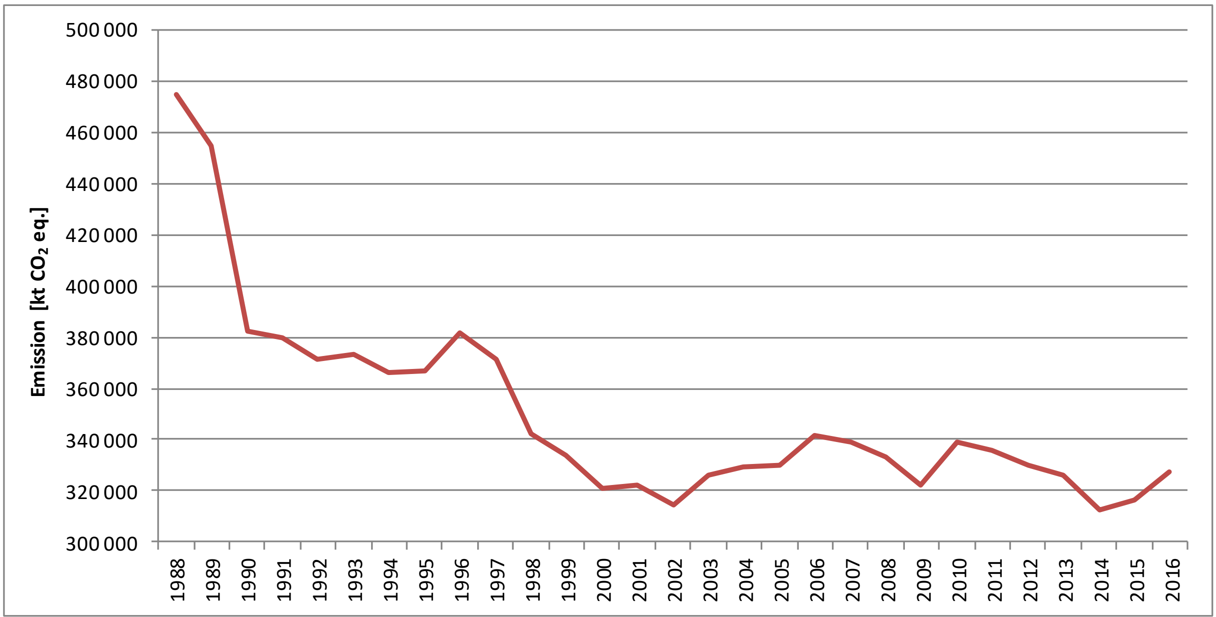

Figure 3.1.1. GHG emission trend in period 1988-2016 in sector *Energy*

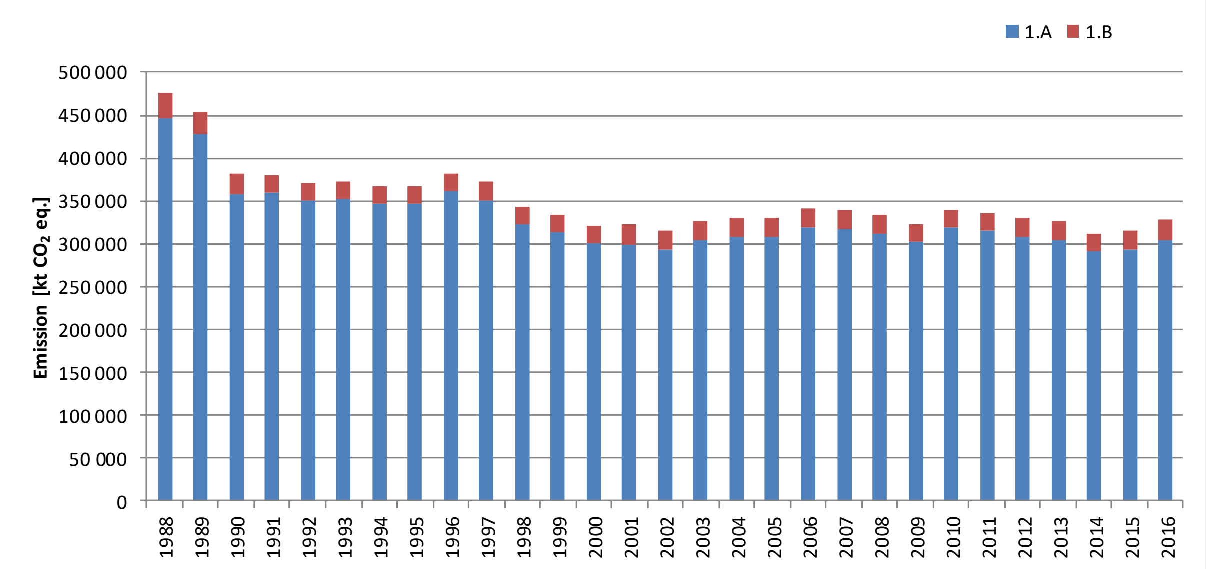

Figure 3.1.2. GHG emission trend in period 1988-2016 in subsectors 1.A and 1.B

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 sector in total GHG emission in 2016 is 76.49%. Subsector 1.A.1 *Energy Industries* is by far the largest contributor to emissions from fuel combustion (see figure 3.1.3).

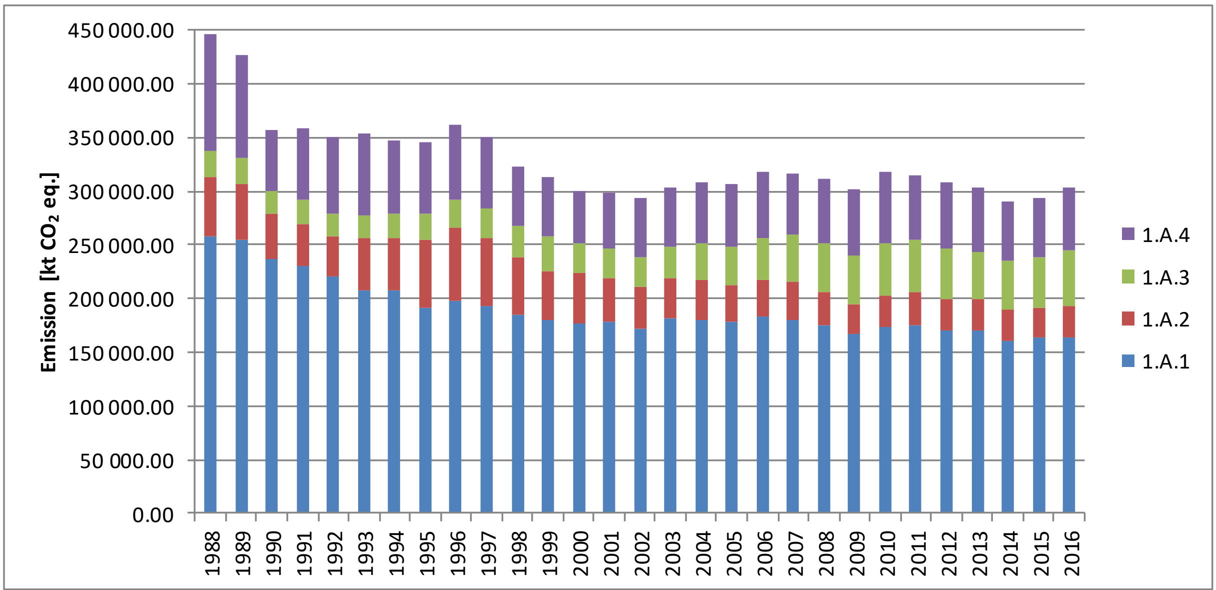

Figure 3.1.3. GHG emissions from fuel combustion in 1988-2016 according to subcategories

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.

It should be mentioned here, in response to the ERT recommendation, that CO_2 EF for gasoline applied in road transportation sector in previous submissions was not implemented for combustion processes in stationary sources. The reason is that since 2017 Submission new methodology for 1.A.3 category applying the COPERT model with its emission factors has been used, which is not relevant for stationary combustion as CS one.

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 1988-2016

Estimation of CO_2 emission from fuel combustion in stationary sources for the years 1988-2015 is based on methodology corresponding to methodology applied for 2016 (that methodology is presented above). For the years: 1990-2015 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 1988-2016 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 23 360 kt in 2016 and decreased since 1988 by 17%. Figure 3.1.4 shows emissions from 1.B.1 and 1.B.2 subcategories in period 1988-2016.

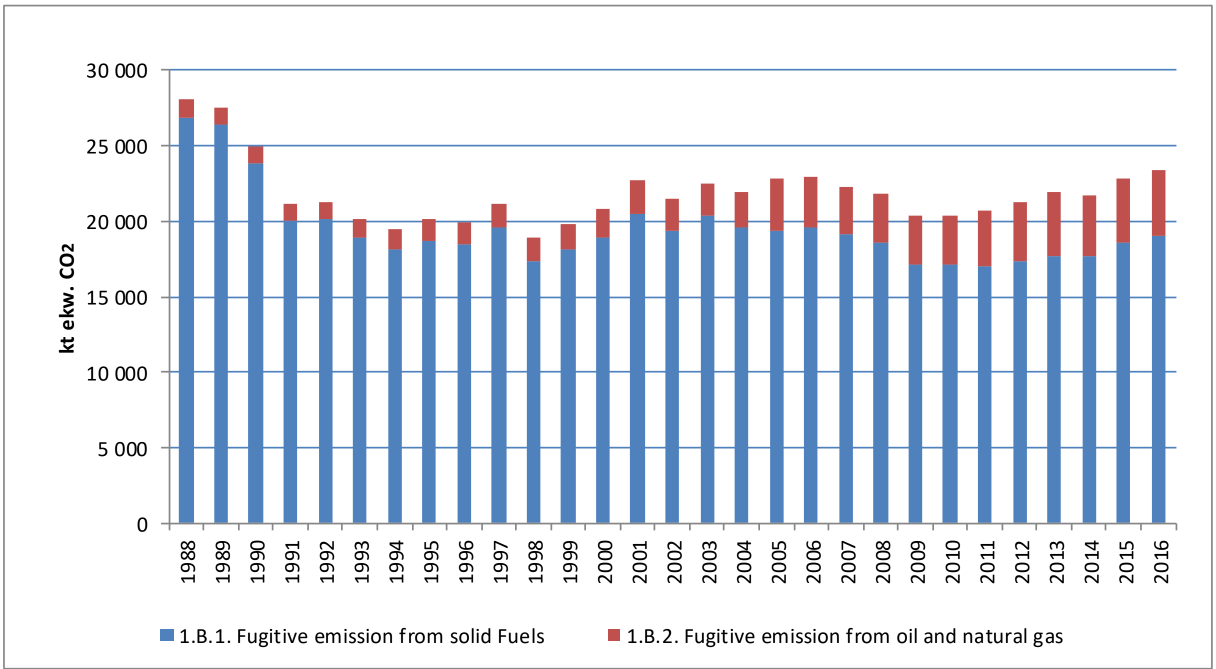

Figure 3.1.4. GHG emissions from 1.B.1 and 1.B.2 subcategories in 1988-2016

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 and its secondary products.

CO_2 emissions from fuel combustion were estimated based on recommended IPCC methodology [IPCC 2006, equation 6.1]:

$$CO_{2\,Emissions} = \sum_i \left[\left((AP_i \times CF_i \times CC_i) 10^{-3} - EC_i \right) COF_i \times 44/12 \right]$$

where:
i – fuel type
AP – apparent consumption of fuel, TJ or kt
CF – conversion factor for the fuel to energy unit, TJ/kt
CC – carbon content, t C/TJ
EC – excluded carbon, kt C
COF – carbon oxidation factor
44/12 – mass ratio of CO_2/C

CO_2 emissions were estimated based on adjusted fuel consumption data and default oxidation factors. National carbon emission factors were assumed for hard coal and lignite (based on empirical functions described in chapter 3.2.1). For fuels used in transport (gasoline, jet kerosene, diesel oil, LPG) average emission factors were applied from subcategories of 1.A. For other fuels default carbon emission factors were applied.

Apparent consumption of fuels was calculated as below:

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

Data about production, imports, exports, international bunkers and stock change are based on Eurostat database. For calculations only data in energy unit (TJ) were used, therefore conversion factors for all fuels is equal 1 TJ/kt (CRF table 1.A(b)).

Total apparent consumption was corrected by subtracting the amount of carbon (excluded 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. The quantity of carbon to be excluded is calculated according to following equation:

$$\textbf{\textit{Excluded carbon = activity data x CC x 10}}^{-3}$$

where:
activity data – non energy use of fuel and feedstock, TJ
CC – carbon content, t C/TJ

As the use of energy products for non-energy purposes can lead to emissions Poland has calculated these emission and report them under category 2.D *Non-energy products from fuels and solvent use* (chapter 4.5).

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;
- 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).

In 2016 the difference between reference and sectoral approaches in CO_2 emissions is equal 0.65%. 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 [%]
2016	299 867	297 930	0.65
2015	284 484	287 325	-0.99
2014	284 126	284 630	-0.18
2013	301 479	297 699	1.27
2012	297 952	302 039	-1.35
2011	314 412	308 628	1.87
2010	313 440	312 009	0.46
2009	297 463	295 591	0.63
2008	309 935	305 214	1.55
2007	310 710	310 753	-0.01
2006	315 209	312 476	0.87
2005	302 298	301 207	0.36
2004	300 579	301 729	-0.38
2003	303 865	297 726	2.06
2002	294 755	287 275	2.60
2001	299 104	293 735	1.83
2000	297 084	294 701	0.81
1999	316 551	307 779	2.85
1998	324 245	317 242	2.21
1997	353 207	343 550	2.81
1996	359 024	354 585	1.25
1995	346 122	339 445	1.97
1994	337 006	339 938	-0.86
1993	358 983	345 184	4.00
1992	359 771	343 741	4.66
1991	369 342	352 814	4.68
1990	373 766	351 661	6.29
1989	449 540	419 585	7.14
1988	481 728	438 752	9.80

3.2.2. International bunker fuels

3.2.2.1. International aviation

This category include emissions from flights that depart in one country and arrive in a different country.

For the years 1990-2016 data related to jet kerosene are those of the Eurostat database, while for the base year and 1989 – those of the IEA database.

Jet kerosene given in Polish statistic is reported as International aviation although include whole amount of jet kerosene used for domestic and international purposes. To split jet kerosene Eurocontrol data were used. Each year, under contract with the European Commission's Directorate-General for Climate Action, EUROCONTROL calculates the mass of fuel burnt by civil aviation flights starting from and/or finishing at airports in the Member States of the European Union (EU). This work is done in support of both the European Environment Agency (EEA) and the Member States of the EU. The calculation are made with the split on domestic and international aviation. The total amount of jet kerosene used by Poland – calculated by Eurocontrol is similar to this reported by Poland to Eurostat. To stay in line with Eurostat database (and Polish statistic) only the share of domestic and international fuel use were used based on Eurocontrol data. Below in table are given Eurocontrol data of jet kerosene used in Poland for international and domestic purposes, the share of domestic and international use and for comparison Eurostat data.

Table 3.2.2. Eurocontrol and Eurostat data of jet kerosene used in Poland and the share of domestic and international use

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Eurocontrol													
Domestic	kt	22.93	25.89	28.18	27.64	25.38	29.48	32.55	46.86	34.84	38.89	34.65	34.57
International	kt	302.09	382.61	453.50	513.39	451.76	475.87	477.58	493.48	517.22	548.54	586.05	666.24
Total	kt	325.02	408.49	481.68	541.04	477.13	505.35	510.13	540.34	552.06	587.43	620.70	700.81
Eurostat	*kt*	*311.00*	*415.00*	*432.00*	*519.00*	*470.00*	*495.00*	*485.00*	*537.00*	*524.00*	*590.00*	*646.00*	*685.40*
Share													
Domestic	%	7.05	6.34	5.85	5.11	5.32	5.83	6.38	8.67	6.31	6.62	5.58	4.93
International	%	92.95	93.66	94.15	94.89	94.68	94.17	93.62	91.33	93.69	93.38	94.42	95.07
Total	%	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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. The 5-years average, taken from the nearest years to data lack period, was evaluated as the most representative in consultations with experts in the area of transport and energy. The share 94.07% was then accepted for the whole period before 2005. Such assumption seems to be reliable and not affecting accuracy of the inventory.

For the estimation of GHG emissions from aviation bunker fuels, the same IPCC 2006 default emission factors for jet fuel were assumed as those used for emission estimation for domestic aviation: for CO_2 – 71.50 kg/GJ, for CH_4 - 0.0005 kg/GJ and for N_2O - 0.002 kg/GJ.

The fuel use data and the corresponding emission estimates of CO_2, CH_4 and N_2O for international aviation bunker for the 1988-2016 period are presented in table 3.2.2. Between 1988 and early 1990-ties dramatic decrease in fuel consumption and heavy industry production occurred triggered by significant economic changes related to political transformation from centralized to market economy. These changes affected all energy sectors and this is the main reason why Poland choose 1988 as a base year (as being more representative in trend than 1990 with collapsing industry).

Table 3.2.3. Fuel consumption and GHG emissions in international aviation in 1988-2016

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Jet Kerosene	PJ	14.12	19.42	8.70	8.98	9.75	9.71	9.83	10.60	12.46	11.16
CO_2 emission	kt	1 009	1 388	622	642	697	694	703	758	891	798
CH_4 emission	kt	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
N_2O emission	kt	0.03	0.04	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
		1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Jet Kerosene	PJ	11.37	10.15	10.80	10.64	10.44	11.29	11.08	12.43	16.71	17.49
CO_2 emission	kt	813	726	772	761	746	807	792	889	1 195	1 250
CH_4 emission	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
N_2O emission	kt	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
		2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Jet Kerosene	PJ	21.18	19.14	20.04	19.52	21.09	21.11	23.69	26.23	28.02	
CO_2 emission	kt	1 514	1 368	1 433	1 396	1 508	1 509	1 694	1 875	2 003	
CH_4 emission	kt	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	28.03	
N_2O emission	kt	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.06	

3.2.2.2. International navigation

This category include emissions from journeys that depart in one country and arrive in a different country. Includes emissions from fuels used by vessels of all flags that engaged in international water-borne navigation. Exclude consumption by fishing vessels.

1990-2016 fuel use data for fuels classified to the international marine bunker were taken directly 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 2006 default emission factors were assumed as those used for maritime navigation: for CO_2 and diesel oil 74.10 kg/GJ, for fuel oil 77.40 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 1988-2016 period are presented in table 3.2.4.

Table 3.2.4. Fuel consumption and GHG emissions in international navigation in 1988-2016

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Diesel oil	PJ	14.23	11.16	6.01	2.70	3.18	2.45	1.29	1.20	1.76	2.53
Fuel oil	PJ	9.00	9.37	10.48	3.76	6.76	3.16	4.24	4.60	5.08	6.28
CO_2 emission	kt	1 751	1 552	1 256	491	758	426	424	445	524	674
CH_4 emission	kt	0.163	0.144	0.115	0.045	0.070	0.039	0.039	0.041	0.048	0.062
N_2O emission	kt	0.046	0.041	0.033	0.013	0.020	0.011	0.011	0.012	0.014	0.018
		1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Diesel oil	PJ	2.87	4.42	1.89	0.94	1.85	1.97	1.67	4.98	3.73	2.15
Fuel oil	PJ	8.08	10.80	9.92	9.80	9.32	9.80	8.80	8.48	8.56	8.16
CO_2 emission	kt	838	1163	908	828	858	905	805	1025	939	791
CH_4 emission	kt	0.077	0.107	0.083	0.075	0.078	0.082	0.073	0.094	0.086	0.072
N_2O emission	kt	0.022	0.030	0.024	0.021	0.022	0.024	0.021	0.027	0.025	0.021
		2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Diesel oil	PJ	2.10	2.77	2.34	2.90	2.86	3.29	3.25	5.93	5.55	
Fuel oil	PJ	9.32	7.60	6.68	4.24	3.20	2.60	2.92	1.88	2.13	
CO_2 emission	kt	877	794	690	543	459	445	467	585	576	
CH_4 emission	kt	0.080	0.073	0.063	0.050	0.042	0.041	0.043	0.055	0.054	
N_2O emission	kt	0.023	0.021	0.018	0.014	0.012	0.012	0.012	0.016	0.015	

Figure 3.2.1 shows emissions of greenhouse gases from international navigation and aviation bunker in period 1988-2016.

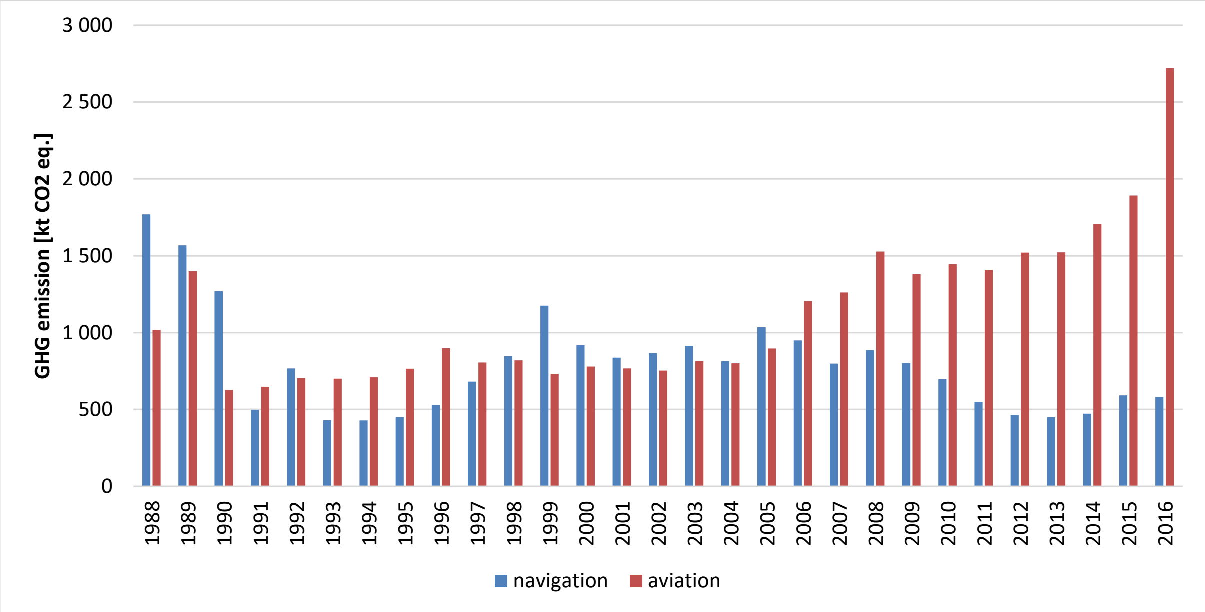

Figure 3.2.1. GHG emissions from international navigation and aviation bunker in period 1988-2016

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 emissions from lubricant and paraffin waxes use and report them under category 2.D *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) – over 94.67% in 2016.

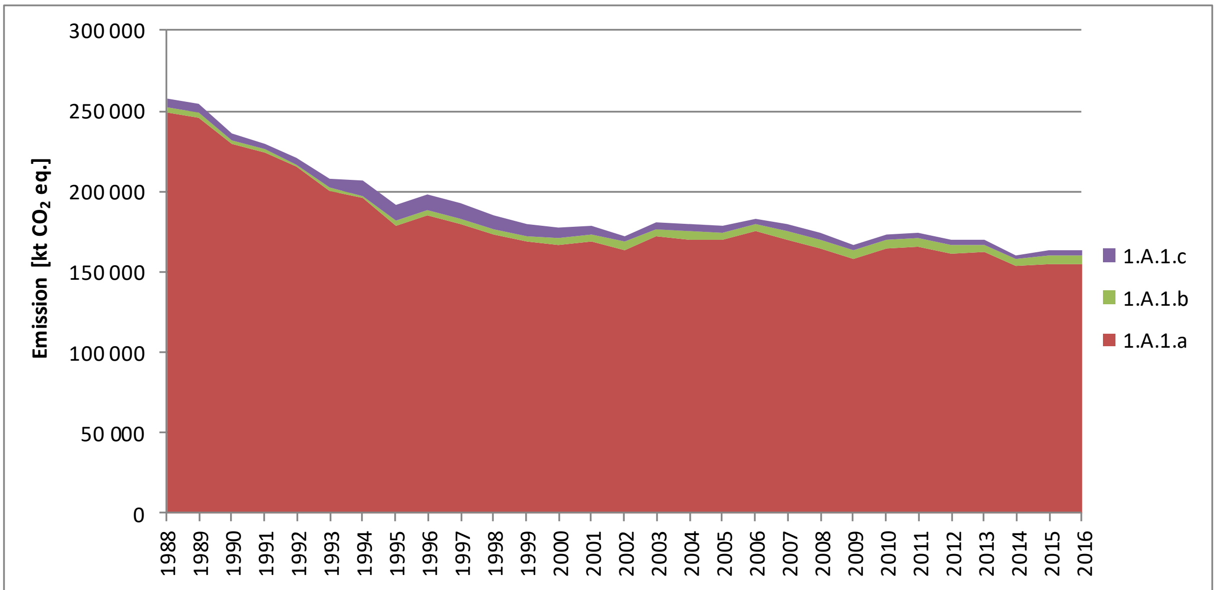

Figure 3.2.6.1. GHG emissions from *Energy Industries* in years 1988-2016 according to subcategories

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 1988-2016.

Table 3.2.6.1. Fuel consumption for the years 1988-2016 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	11.505	9.321	9.199	8.050	8.215	7.632	8.286	8.040
Gaseous Fuels	53.627	57.099	52.877	49.691	51.163	51.652	52.286	57.961
Solid Fuels	1663.282	1664.662	1717.463	1676.806	1613.352	1553.359	1607.106	1604.922
Other Fuels	0.459	0.541	0.477	0.440	0.593	0.682	0.809	0.861
Biomass	9.439	17.789	21.527	26.269	40.001	57.022	67.892	81.917
TOTAL	**1738.312**	**1749.412**	**1801.543**	**1761.256**	**1713.324**	**1670.347**	**1736.379**	**1753.701**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	7.174	6.469	5.466	5.924	6.776			
Gaseous Fuels	61.963	53.395	52.017	60.426	70.592			
Solid Fuels	1550.077	1568.382	1470.390	1477.732	1474.904			
Other Fuels	0.791	0.718	0.813	1.552	4.159			
Biomass	109.804	92.581	102.737	101.980	81.618			
TOTAL	**1729.809**	**1721.545**	**1631.423**	**1647.614**	**1638.049**			

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 2016, the use of hard coal was approx. 949 PJ i.e. about 58% of the entire energy of all fuels used in that sub-sector. Lignite made approximately 30% of the energy, accordingly. Despite the significant share of solid fuels (about 90%) in the total energy related fuel use in 1.A.1.a, a slow decreasing trend can be noticed since the late 1990s (from approx. 98% in 1998 till 90% in 2016). At the same time in last decade increased the share of biomass as well as the share of natural gas. Detailed data concerning individual fuel consumptions in 1.A.1.a subcategory for the entire period 1988-2016 was presented in Annex 2 (tab. 1).

Figure 3.2.6.2 shows CO_2 emission changes over the period 1988-2016. A significant emission decrease took place over the years 1988-1996 followed by a period of emission stabilization.

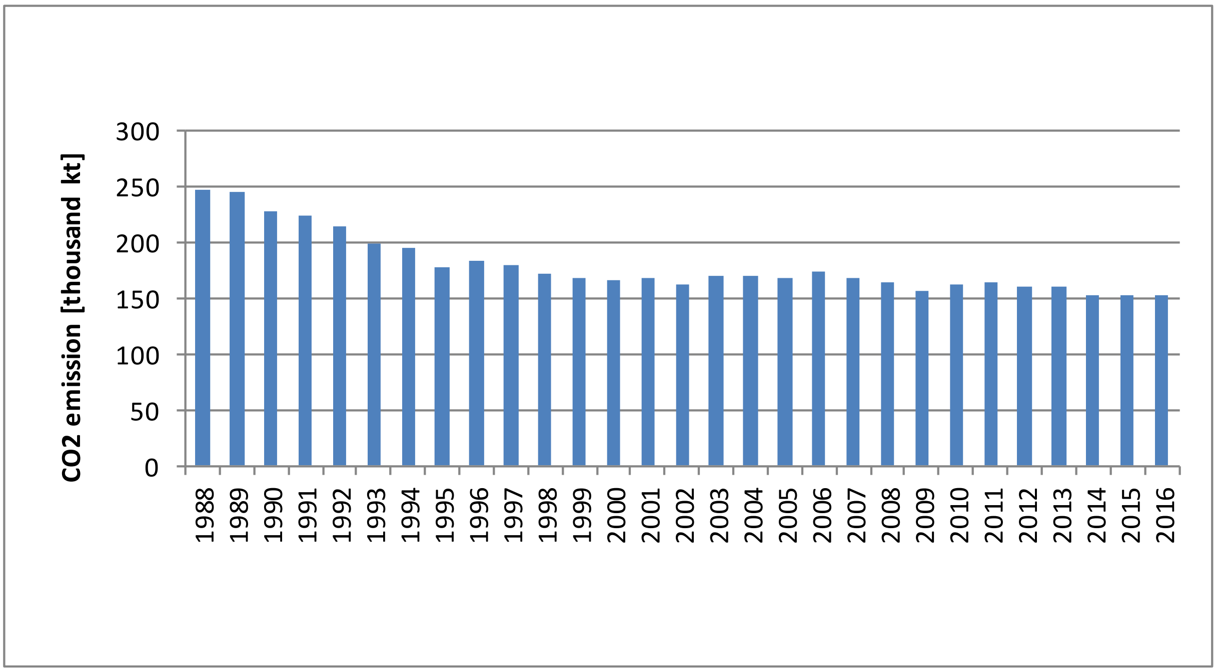

Figure 3.2.6.2. CO_2 emission for 1.A.1.a category in 1988-2016

Figure 3.2.6.3 shows emission trends for CH_4 and N_2O between the base year and 2016. 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.

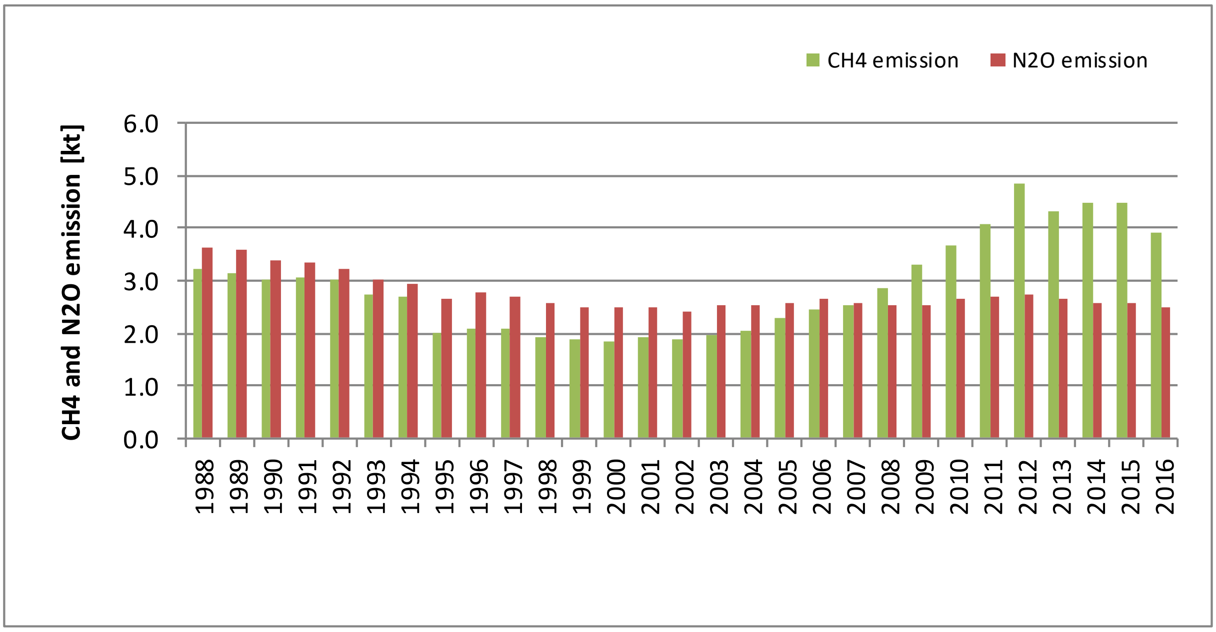

Figure 3.2.6.3. CH_4 and N_2O emissions for 1.A.1.a category in 1988-2016

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 1988-2016. Detailed data on fuel consumptions in 1.A.1.b subcategory for the entire period 1988-2016 was presented in Annex 2 (table 2).

Table 3.2.6.2. Fuel consumption in 1988-2016 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	55.979	53.915	55.858	61.194	62.085	60.608	70.009	61.737
Gaseous Fuels	15.535	14.482	14.900	20.816	18.816	17.511	19.363	27.468
Solid Fuels	0.000	0.000	0.000	0.000	0.000	0.113	0.114	0.164
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	**71.735**	**68.682**	**70.982**	**82.010**	**80.901**	**78.232**	**89.486**	**89.369**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	61.108	44.315	38.269	54.270	56.475			
Gaseous Fuels	30.638	34.779	35.103	25.957	25.802			
Solid Fuels	0.113	0.176	0.181	0.927	0.802			
Other Fuels	0.000	0.000	0.000	0.000	0.002			
Biomass	0.000	0.000	0.000	0.000	0.000			
TOTAL	**91.859**	**79.270**	**73.553**	**81.154**	**83.081**			

Figure 3.2.6.4 shows CO_2 emission changes in 1988-2016 in sub-category 1.A.1.b.

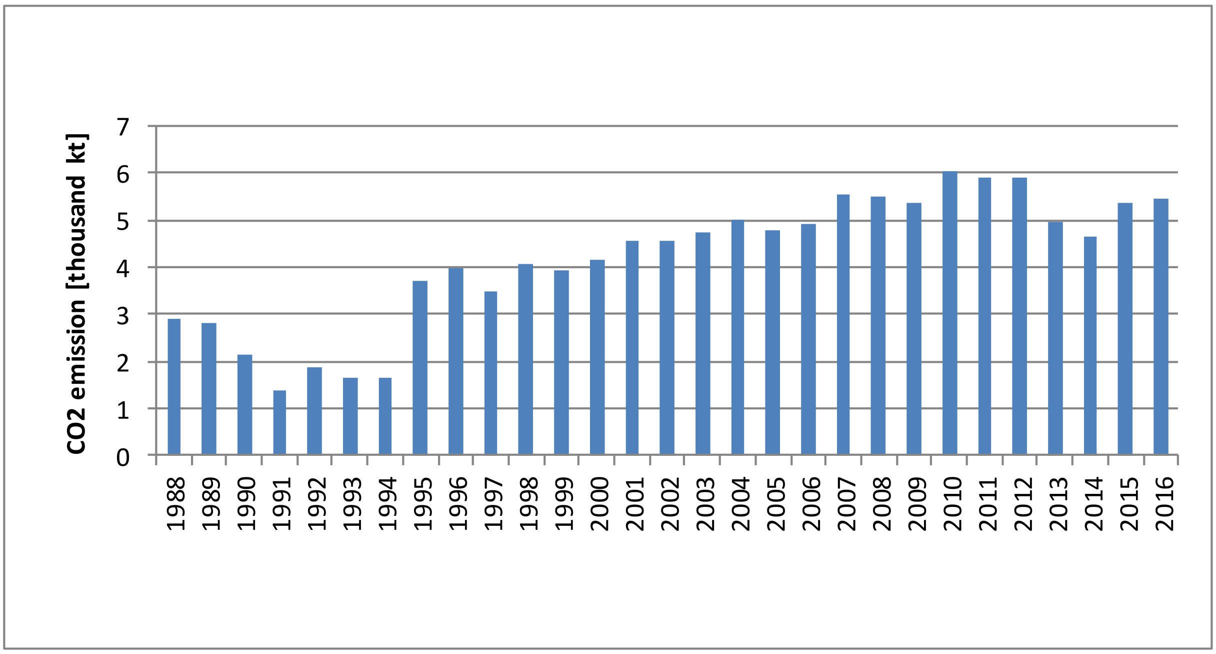

Figure 3.2.6.4. CO_2 emission for 1.A.1.b category in 1988-2016

Figure 3.2.6.5 shows the corresponding CH_4 and N_2O emission in that source sub-category between the base year and 2016.

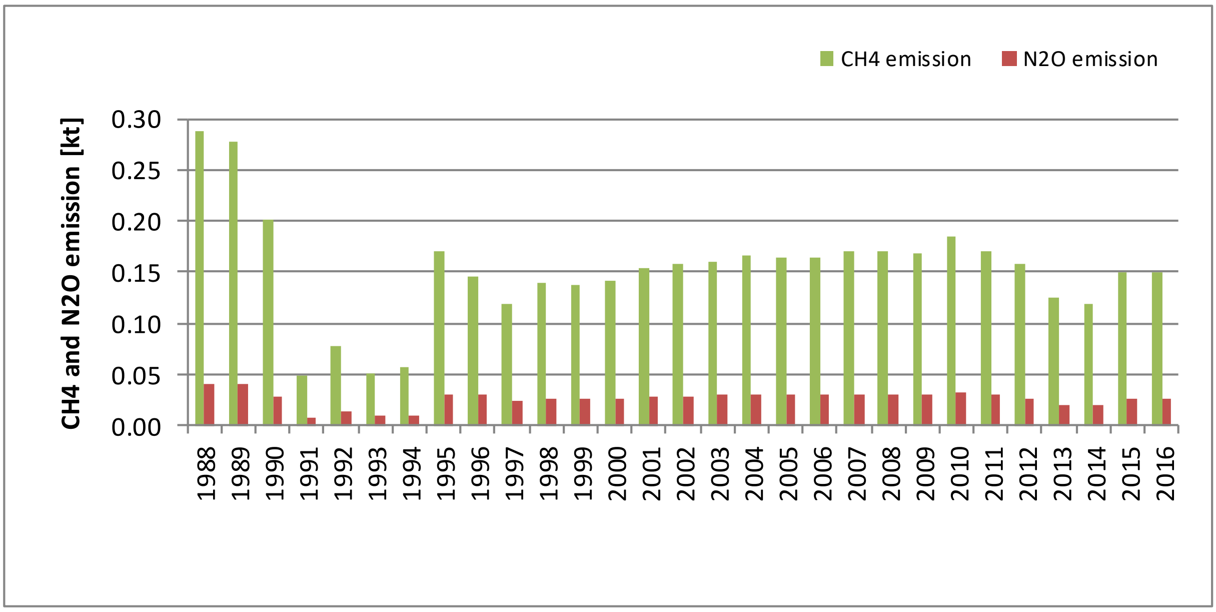

Figure 3.2.6.5. CH_4 and N_2O emissions for 1.A.1.b category in 1988-2016

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: 1988-2016. Particular fuel consumptions in 1.A.1.c subcategory for the entire period 1988-2016 were tabulated in Annex 2 (table 3).

Table 3.2.6.3. Fuel consumption in 1988-2016 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	4.200	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**	**123.966**	**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	9.805
Solid Fuels	59.914	51.066	52.353	65.137	61.482	42.905	47.342	47.419
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.010
Biomass	0.020	0.014	0.026	0.085	0.037	0.137	0.349	0.162
TOTAL	**72.565**	**62.876**	**64.155**	**76.392**	**72.203**	**53.531**	**59.769**	**59.575**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	1.574	1.891	1.429	1.892	1.445			
Gaseous Fuels	11.205	12.013	12.788	24.089	17.805			
Solid Fuels	41.875	42.633	43.055	45.297	44.233			
Other Fuels	0.001	0.002	0.002	0.002	0.003			
Biomass	0.160	0.122	0.039	0.000	0.047			
TOTAL	**54.815**	**56.661**	**57.313**	**71.280**	**63.534**			

The emission trends of CO_2, CH_4 and N_2O in the 1988-2016 period are shown in figures 3.2.6.6 and 3.2.6.7.

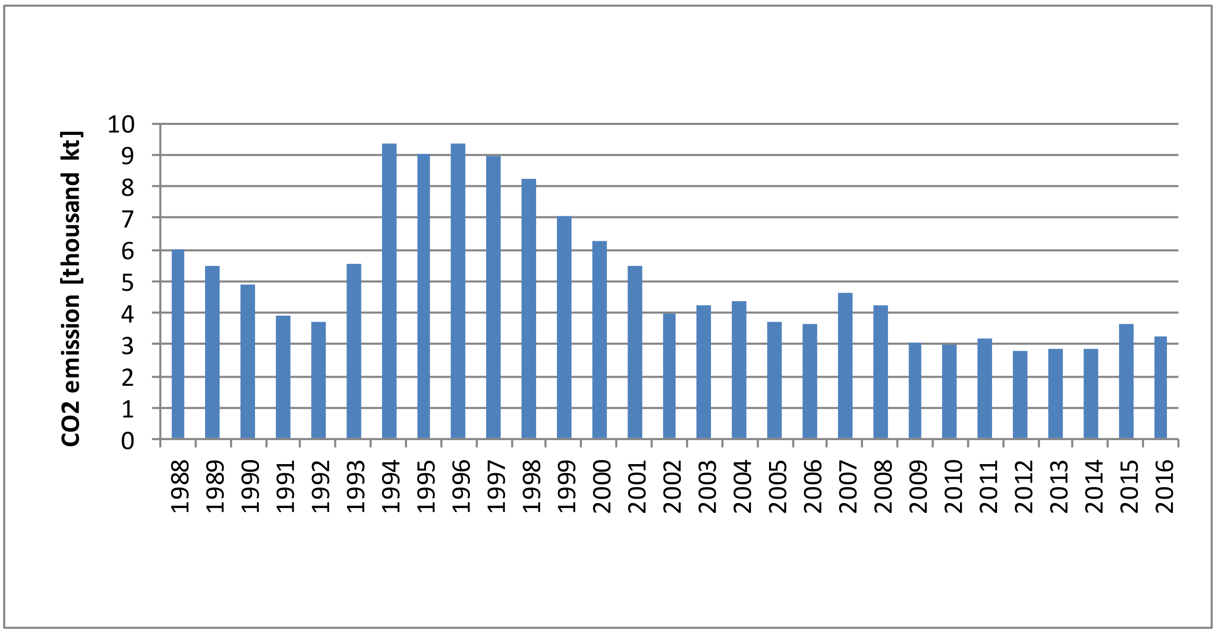

Figure 3.2.6.6. CO_2 emission for 1.A.1.c category in 1988-2016

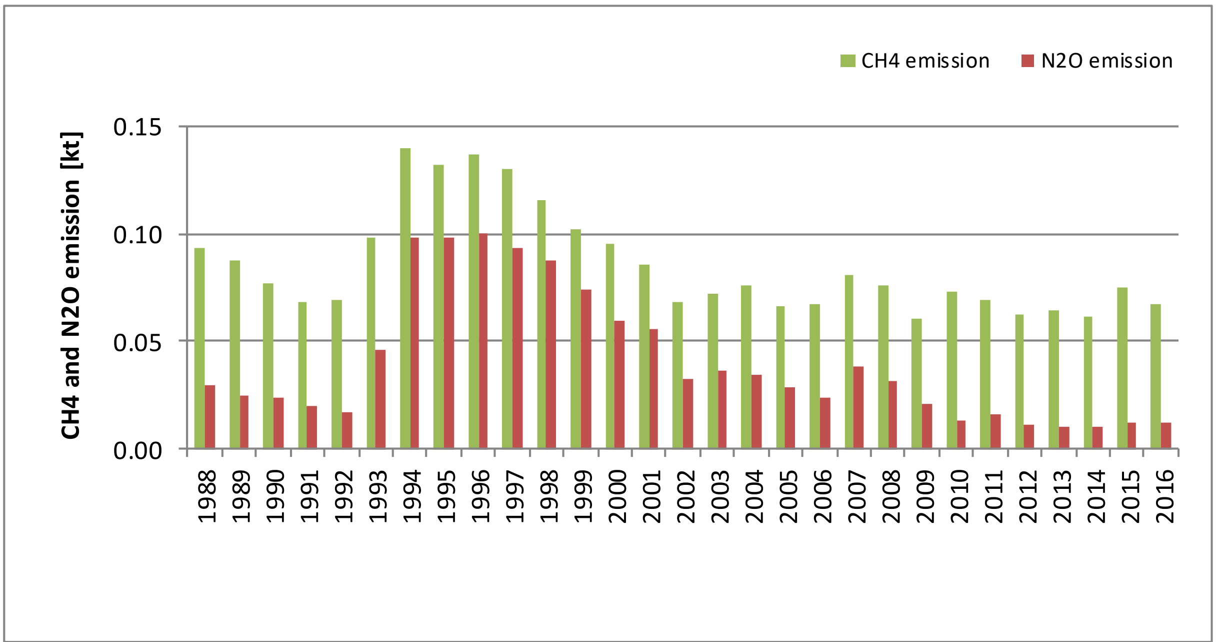

Figure 3.2.6.7. CH_4 and N_2O emissions for 1.A.1.c category in 1988-2016

3.2.6.3. Uncertainties and time-series consistency

Uncertainty analysis for the year 2016 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 1988-2015 ensured consistency for whole time-series.

2016	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 Emission uncertainty [%]	CH_4 Emission uncertainty [%]	N_2O Emission uncertainty [%]
1. Energy	**301 820.80**	**931.53**	**8.18**	1.9%	33.6%	12.3%
A. Fuel Combustion	**297 929.67**	**152.81**	**8.17**	1.9%	11.4%	12.3%
1. Energy Industries	162 449.99	4.15	2.52	2.6%	14.9%	30.5%
2. Manufacturing Industries and Construction	28 842.59	4.21	0.58	2.4%	12.1%	24.7%
3. Transport	52 329.80	4.60	1.88	5.7%	10.2%	20.1%
4. Other Sectors	54 307.28	139.86	3.20	4.3%	12.4%	16.0%
5. Other						
B. Fugitive Emissions from Fuels	**3 891.13**	**778.72**	**0.00**	9.2%	40.1%	71.8%
1. Solid Fuels	2 048.15	677.51		15.0%	46.0%	
2. Oil and Natural Gas	1 842.99	101.21	0.00	10.0%	16.5%	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). As this database covers period since 1990, IEA database before 1990 is used for years 1988 and 1989. It should be underlined that data in both databases are fully consistent and based on the same questionnaires sent by Polish national statistics. 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.

The source of data on the consumption of fuels and energy for national statistics are based on reports, which enterprises are obliged to report to the Central Statistical Office (GUS). This is done through the reporting portal. The forms for all statistical reports are available on GUS website:
http://form.stat.gov.pl/formularze/2018/index.htm.

The main energy forms are G-03 and G-02. Among enterprises obligated to this reporting there are also entities participating in the ETS system. Based on the data collected via the reporting portal, a database is created from which information for national energy balances elaboration and filling out questionnaires reporting Polish energy data to international statistical institutions (Eurostat, IEA, OECD) are taken. This ensures data consistency. Data from individual reports are subject to cross-check procedures. There are also algorithms comparing the data from the reporting year with the previous submission. Questionnaires with data on fuel and energy consumption reported to Eurostat, IEA and OECD are also subject to verification by these institutions. The questions regarding data from the entire long-term time series are directed to GUS. Doubts are clarified and, if necessary, the data is corrected (the entire adjusted trend is submitted in the questionnaire to the above-mentioned statistical organizations). Therefore the data in the mentioned databases can be treated as consistent, coherent and verified.

In the context of the information given above the drop in fuels consumption between 1989 and 1990 is not the result of source data change. Main driver of the significant decline in AD and emissions in the energy sector between these years is political system change and transformation of the economy in Poland where sudden drop in production in many energy-intensive industries occurred followed by energy efficiency measures.

One of the quality control elements of activity data check in national GHG inventories is preparation of fuel balances (see Annex 4). For the main fuels (i.e. coal, lignite) calorific values are analyzed 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.

Additional verification of data in energy sector covers 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

The were no changes in 1.A.1 subsector in the years 1988-2015.

3.2.6.6. Source-specific planned improvements

Analysis of the possibility of country specific EF elaboration for the gaseous fuels.

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 29.47%, 21.02% and 17.55% in 2016.

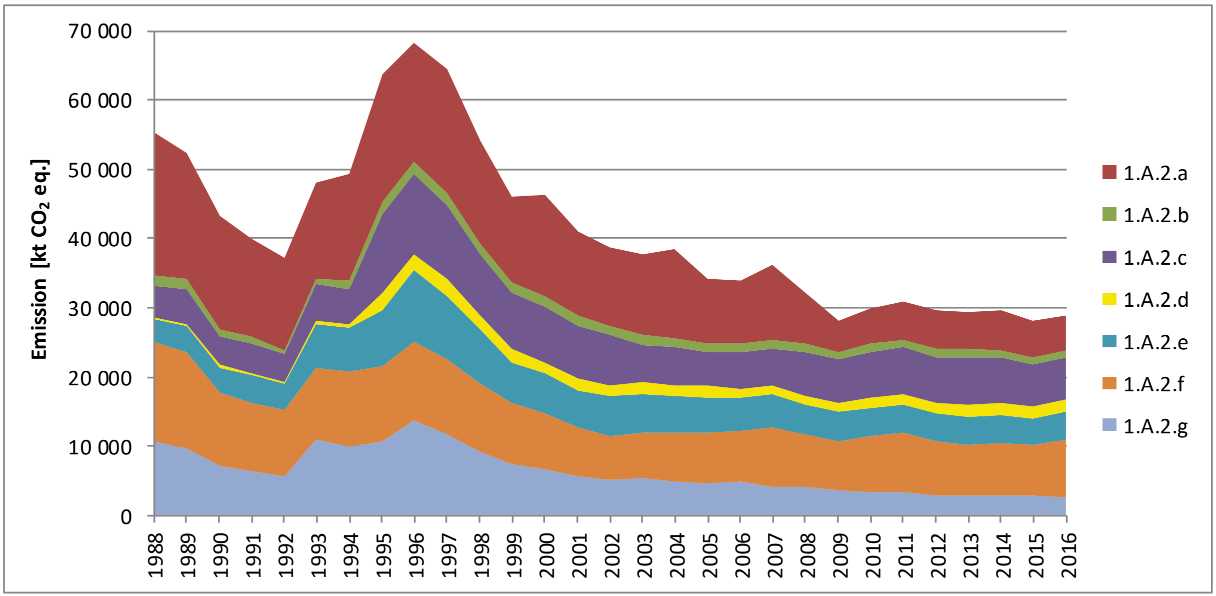

Figure 3.2.7.1. Emissions from *Manufacturing Industries and Construction* category in years 1988-2016 according to subcategories

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 3.2.7.1 shows the fuel use data in the sub-category 1.A.2.a *Iron and Steel* for the period: 1988-2016. 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 1988-2016 was presented in Annex 2 (table 4).

Table 3.2.7.1. Fuel consumption in 1988-2016 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	74.910	72.626	73.599	85.080	96.976	118.715
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**	**143.012**	**121.285**	**112.116**	**119.553**	**129.752**	**148.712**
	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	112.791	113.712	99.754	80.715	89.854	76.419	72.933	77.378
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	**141.054**	**147.318**	**125.653**	**104.348**	**113.620**	**95.749**	**88.758**	**92.522**
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Liquid Fuels	0.267	0.086	0.129	0.086	0.132	0.133	0.133	0.165
Gaseous Fuels	19.964	20.455	20.998	22.716	20.397	16.595	16.916	17.209
Solid Fuels	83.348	59.022	55.860	60.013	38.753	23.106	26.309	30.489
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	**103.583**	**79.565**	**76.988**	**82.816**	**59.283**	**39.835**	**43.358**	**47.863**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	0.199	0.121	0.197	0.196	0.222			
Gaseous Fuels	16.905	16.242	16.096	16.701	19.459			
Solid Fuels	31.593	31.916	33.112	28.569	24.716			
Other Fuels	0.000	0.000	0.000	0.000	0.000			
Biomass	0.000	0.001	0.001	0.001	0.001			
TOTAL	**48.697**	**48.280**	**49.406**	**45.467**	**44.397**			

Blast furnaces transformation efficiency assumed 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.A.2.a to 2.C.1 subcategory for individual years were as follow:

1988	12.050	**1998**	45.291	**2008**	36.584
1989	14.549	**1999**	38.295	**2009**	20.490
1990	97.056	**2000**	54.904	**2010**	23.828
1991	67.320	**2001**	46.626	**2011**	24.729
1992	66.873	**2002**	37.455	**2012**	23.291
1993	58.588	**2003**	41.101	**2013**	25.163
1994	65.168	**2004**	44.265	**2014**	31.228
1995	67.299	**2005**	28.417	**2015**	31.699
1996	58.137	**2006**	36.855	**2016**	36.241
1997	61.375	**2007**	45.773		

CO_2 emission from reallocated coke was included in emission from 2.C.1 subcategory, while the emissions of CH_4 and N_2O in 1.A.2.a category.

Similar reallocation like for coke was applied in case of coal in years starting from 2010. After 2010 the coal was used in pig iron production. Because of the coal consumption in BF process was aggregated in Eurostat energy balance in *Final Energy Consumption - Iron and Steel*, the amounts of coal used in blast furnaces process (included in C balance for BF in 2.C.1 subcategory) were deducted from 1.A.2.a category to avoid double counting.

Following amounts of coal [PJ] were reallocated between 1.A.2.a and 2.C.1 subcategories in particular years:

2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
0.957	2.326	5.977	4.205	5.465	7.998	0.000

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

Figure 3.2.7.2 shows CO_2 emissions in the 1988-2016 period. Emissions of CH_4 and N_2O in the same time period are shown in figure 3.2.7.3. Emission trends for all three gases follow closely the trends in fuel use.

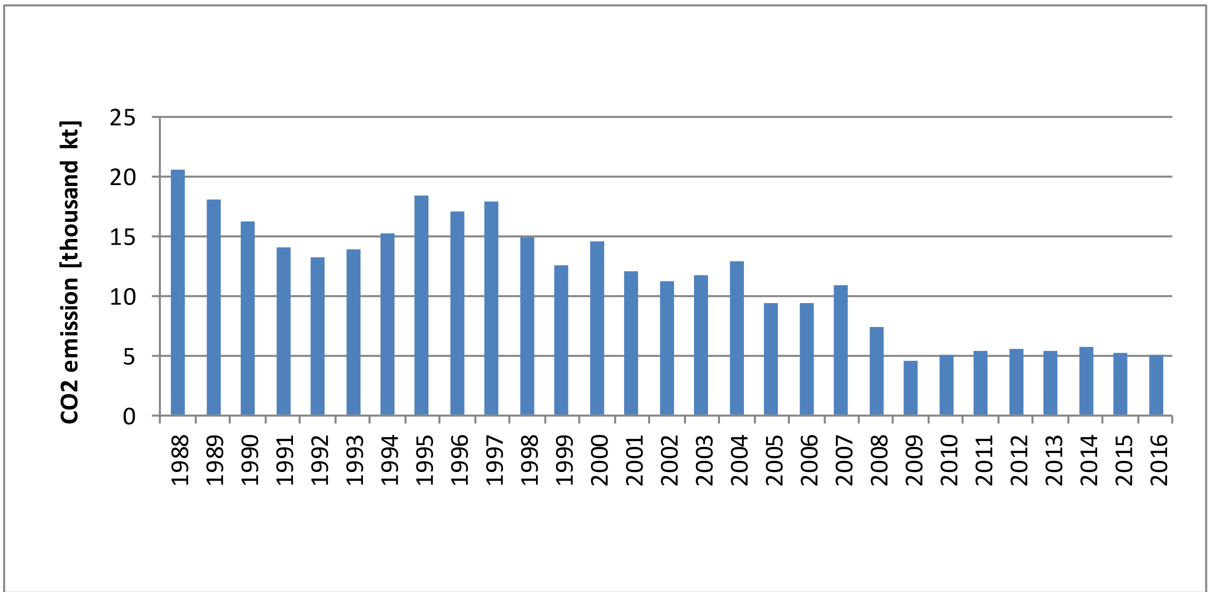

Figure 3.2.7.2. CO_2 emission for 1.A.2.a category in 1988-2016

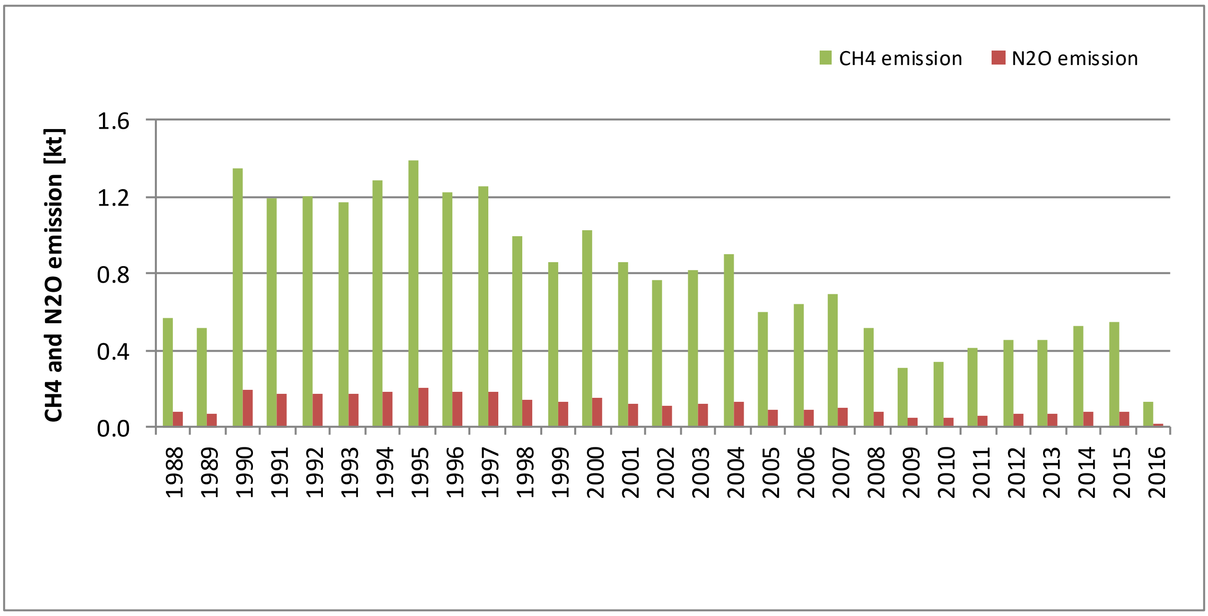

Figure 3.2.7.3. CH_4 and N_2O emissions for 1.A.2.a category in 1988-2016

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 1988-2016 period is presented in table 3.2.7.2. More detailed data concerning fuel consumptions was tabulated in Annex 2 (table 5).

Table 3.2.7.2. Fuel consumption in 1988-2016 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	6.402	6.464	6.880	6.740	6.537	5.846	6.039	6.670
Solid Fuels	8.811	6.799	7.017	7.960	7.860	7.356	7.002	7.470
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	**15.871**	**13.881**	**14.515**	**15.078**	**14.775**	**13.581**	**13.424**	**14.479**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	0.293	0.293	0.253	0.249	0.428			
Gaseous Fuels	6.890	6.703	6.950	7.225	7.226			
Solid Fuels	7.469	7.488	7.886	8.226	6.553			
Other Fuels	0.000	0.000	0.000	0.000	0.000			
Biomass	0.000	0.000	0.000	0.000	0.000			
TOTAL	**14.652**	**14.484**	**15.089**	**15.700**	**14.207**			

Emissions of the main greenhouse gases in 1.A.2.b between the base year and 2016 are shown in figures 3.2.7.4 and 3.2.7.5.

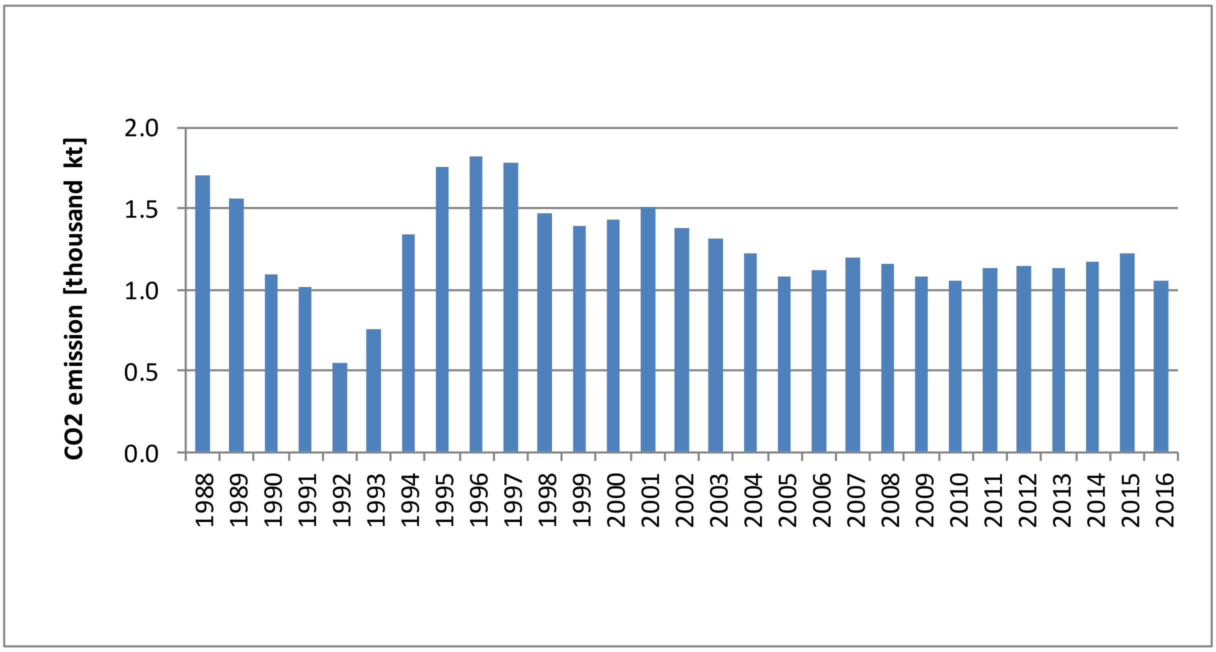

Figure 3.2.7.4. CO_2 emission for 1.A.2.b category in 1988-2016

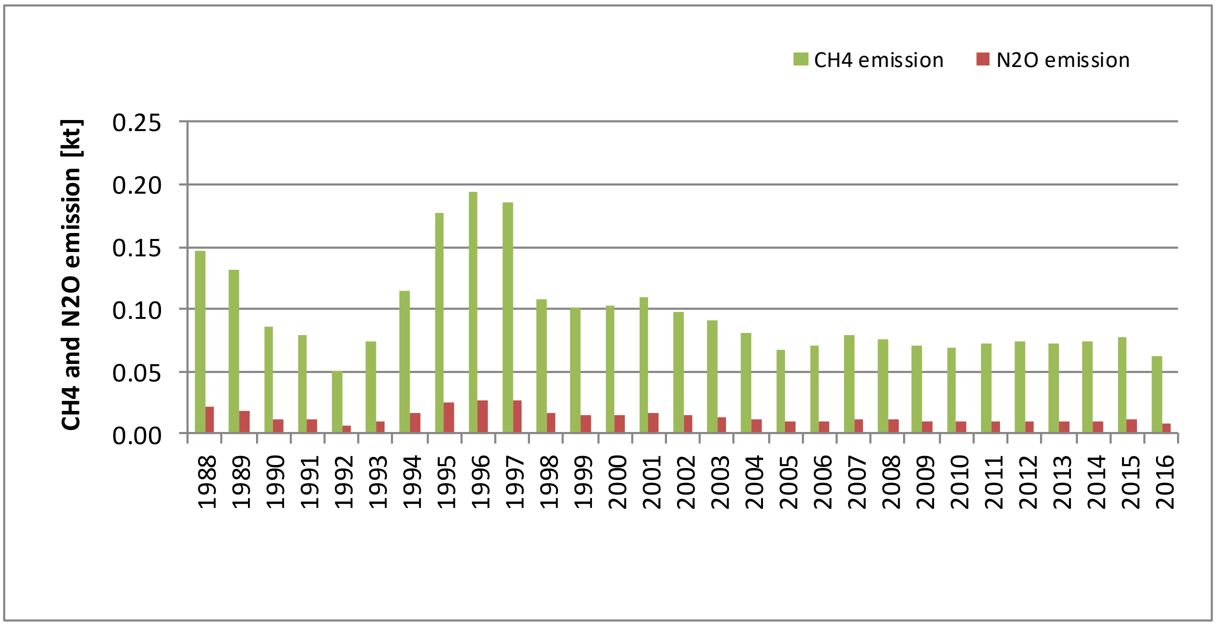

Figure 3.2.7.5. CH_4 and N_2O emissions for 1.A.2.b category in 1988-2016

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 1988-2016 was presented in Annex 2 (table 6).

The data on fuel type use in the sub-category 1.A.2.c *Chemicals* over the 1988-2016 period are presented in table 3.2.7.3.

Table 3.2.7.3. Fuel consumption in 1988-2016 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	33.608	25.961	29.290	29.765	23.485	26.741	22.114	16.816
Gaseous Fuels	7.494	8.061	9.009	8.754	7.950	9.707	11.807	13.887
Solid Fuels	29.171	29.514	28.909	29.376	45.603	43.378	48.757	49.660
Other Fuels	1.070	0.570	0.671	0.707	0.509	0.584	0.770	0.732
Biomass	0.094	0.153	0.000	0.121	0.000	0.058	0.058	0.053
TOTAL	**71.437**	**64.259**	**67.879**	**68.723**	**77.547**	**80.468**	**83.506**	**81.148**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	13.779	16.675	13.302	10.494	14.934			
Gaseous Fuels	13.568	14.696	14.500	14.860	12.068			
Solid Fuels	50.527	50.968	50.138	46.376	45.388			
Other Fuels	0.581	1.092	1.082	0.936	0.652			
Biomass	0.131	0.050	0.111	0.094	0.144			
TOTAL	**78.586**	**83.481**	**79.133**	**72.760**	**73.187**			

Figure 3.2.7.6 shows CO_2 emissions in the sub-category 1.A.2.c in the 1988-2016 period. Emissions of CH_4 and N_2O, in turn, are shown in figure 3.2.7.7.

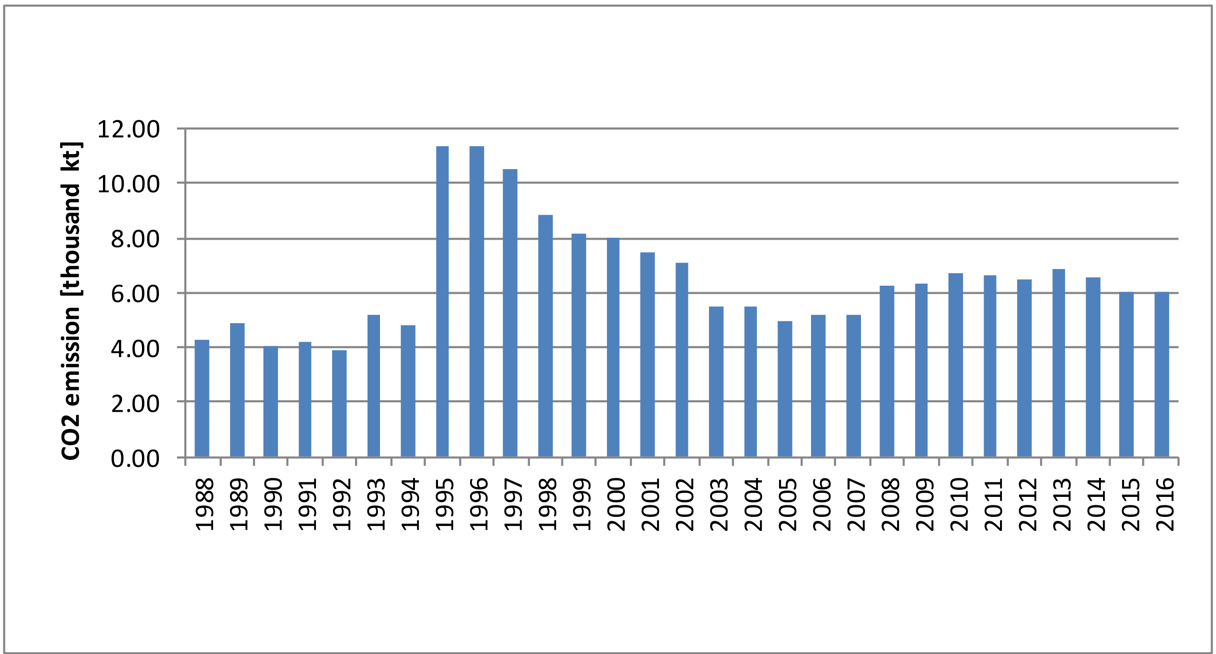

Figure 3.2.7.6. CO_2 emission for 1.A.2.c category in 1988-2016

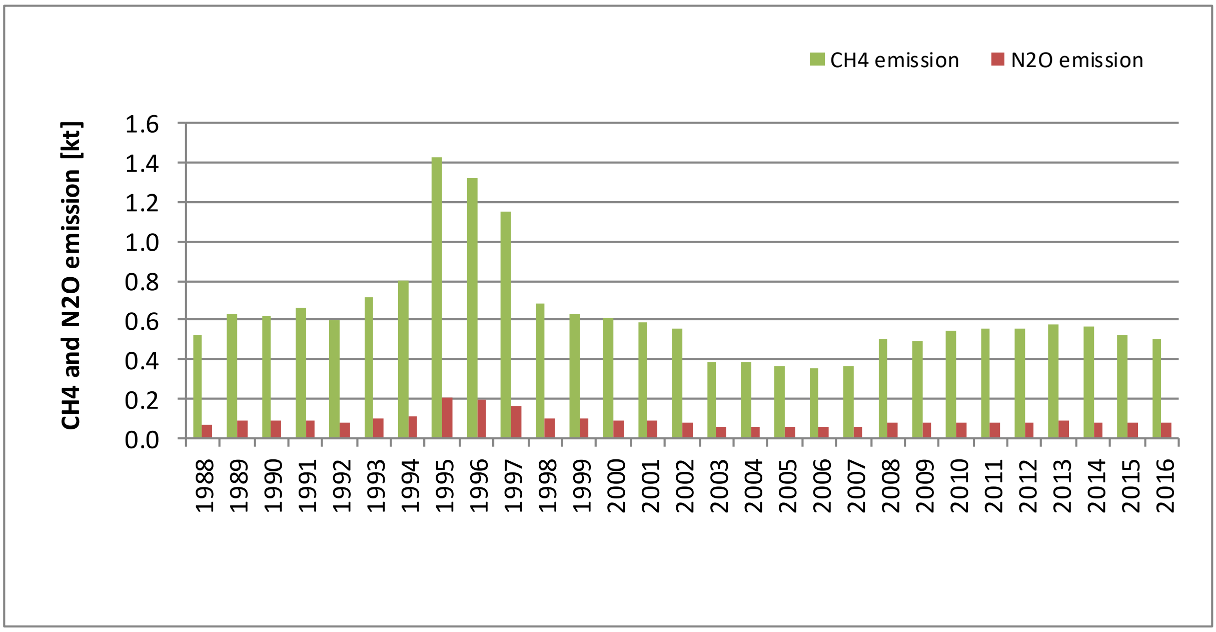

Figure 3.2.7.7. CH_4 and N_2O emissions for 1.A.2.c category in 1988-2016

Significant increase in fuel consumption between 1994 and 1995 in mentioned categories is the result of algorithm change in classification of fuel consumption for particular parts of national energy balance. For the years before 1995 all fuels consumed for energy and heat production in Autoproducer CHP Plants were included in *Transformation input in Autoproducer CHP Plants* and reported under 1.A.1.a subcategory. Starting from 1995 the fuel consumption for non-commercial heat production (heat not sold to third parties) was classified as part of final energy consumption in individual subsectors and reported in CRF in 1.A.2 category. This methodology change was described in *Energy Statistic of OECD Countries* (in Part I: *Methodology* as country notes for "Electricity and Heat"). Mentioned modification in national energy statistic is noticeable also in Eurostat database. In terms of GHG emission inventory analysed change resulted in reallocation of part of emission from 1.A.1.a into 1.A.2 IPCC category.

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 1988-2016 period are presented in table 3.2.7.4. 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 3.2.7.4. Fuel consumption in 1988-2016 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	4.972	5.134	4.587
Solid Fuels	13.825	13.458	11.620	9.480	7.878	8.515	10.114	11.301
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	19.630	19.475
TOTAL	**37.683**	**36.386**	**36.093**	**34.544**	**34.415**	**34.671**	**36.870**	**37.351**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	1.785	1.872	1.545	1.830	1.921			
Gaseous Fuels	5.535	6.271	6.994	7.166	7.991			
Solid Fuels	10.643	11.460	11.291	10.922	9.790			
Other Fuels	0.000	0.037	0.125	0.108	0.190			
Biomass	20.441	27.243	27.092	27.156	30.526			
TOTAL	**38.404**	**46.883**	**47.047**	**47.182**	**50.417**			

Figures 3.2.7.8 and 3.2.7.9 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.2.d in the period: 1988-2016.

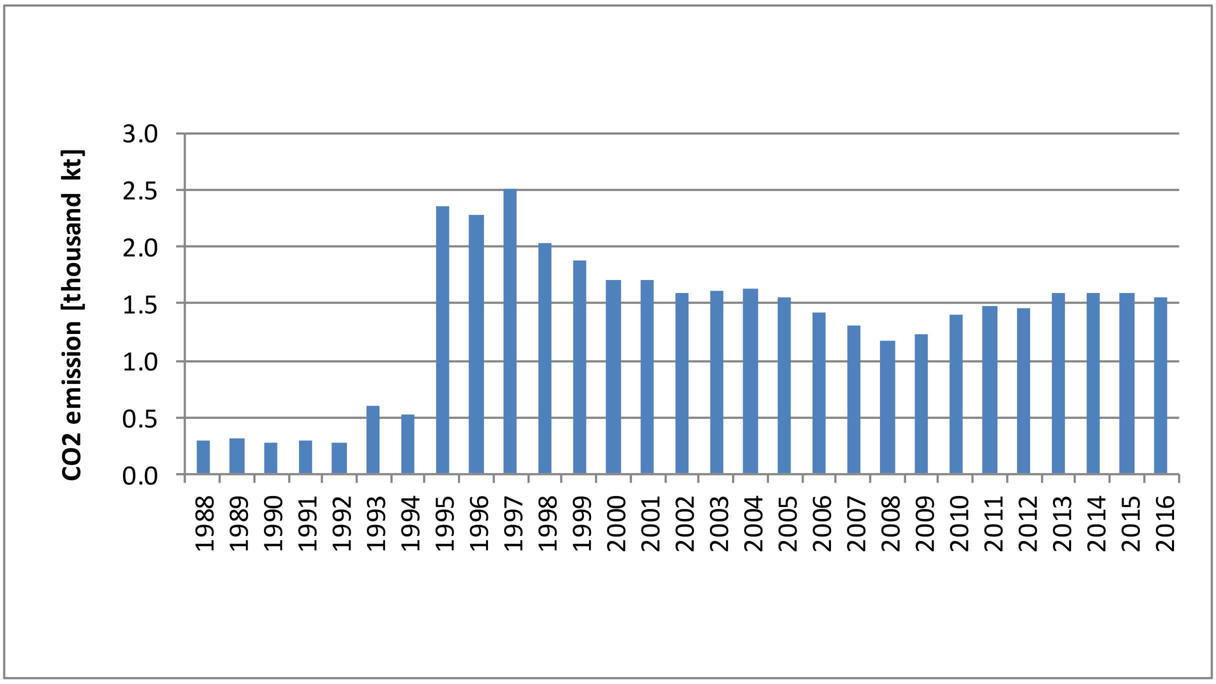

Figure 3.2.7.8. CO_2 emission for 1.A.2.d category in 1988-2016

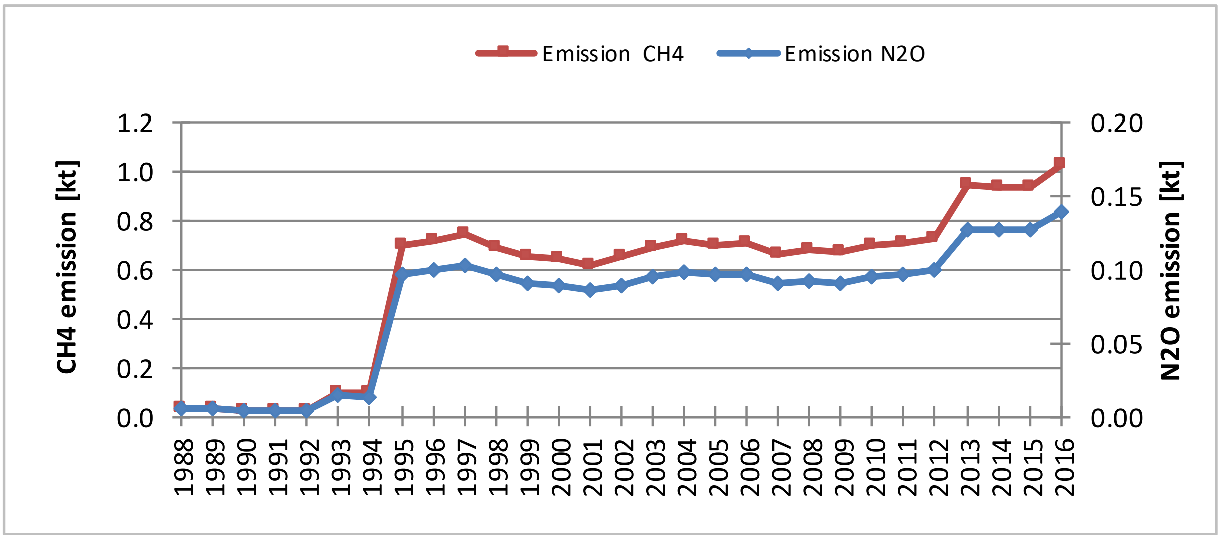

Figure 3.2.7.9. CH_4 and N_2O emissions for 1.A.2.d category in 1988-2016

Considerable increase of fuel consumption and GHG emission between 1994 and 1995 results from the methodology change concerning fuel classification in energy balance, which is described in subchapter above (3.2.7.2.3. Chemicals).

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 1988-2016 period are presented in table 3.2.7.5. Detailed data on fuel consumption was tabulated in Annex 2 (table 8).

Table 3.2.7.5. Fuel consumption in 1988-2016 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	26.530	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**	**53.696**	**53.487**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	4.994	3.900	3.482	2.856	3.279			
Gaseous Fuels	23.704	24.475	25.094	26.008	27.589			
Solid Fuels	26.486	25.094	24.884	22.638	23.869			
Other Fuels	0.000	0.000	0.000	0.000	0.000			
Biomass	0.635	0.866	1.097	1.479	1.790			
TOTAL	**55.819**	**54.335**	**54.557**	**52.981**	**56.527**			

Figures 3.2.7.10 and 3.2.7.11 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.2.e in the period: 1988-2016.

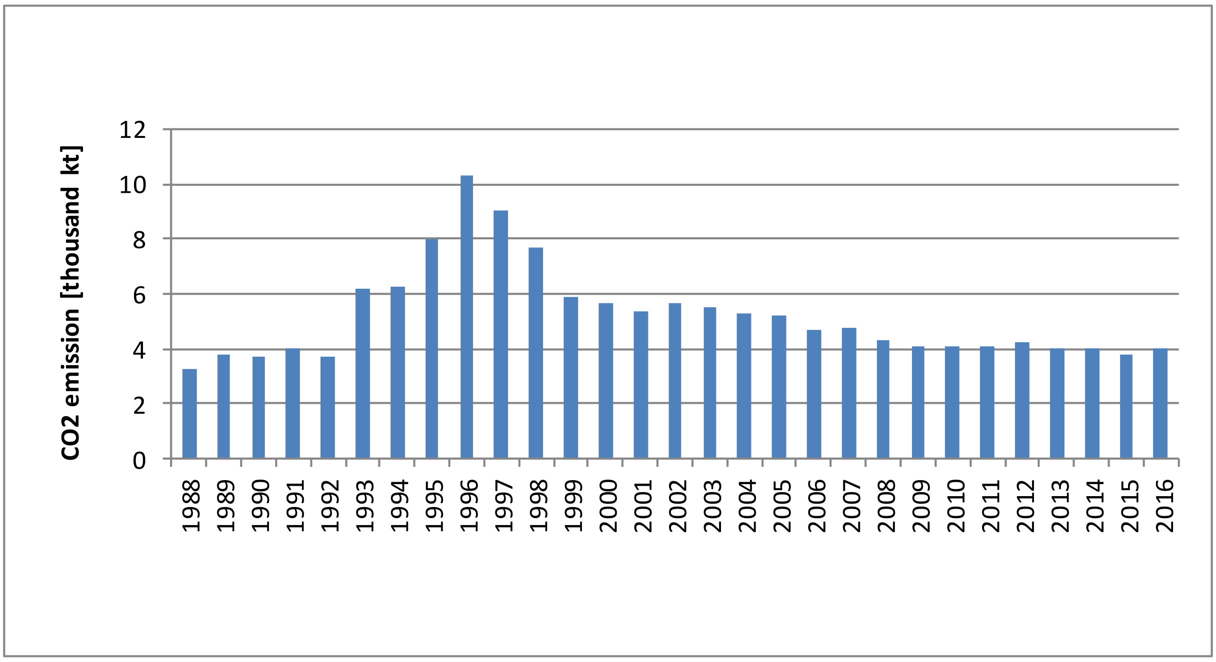

Figure 3.2.7.10. CO_2 emission for 1.A.2.e category in 1988-2016

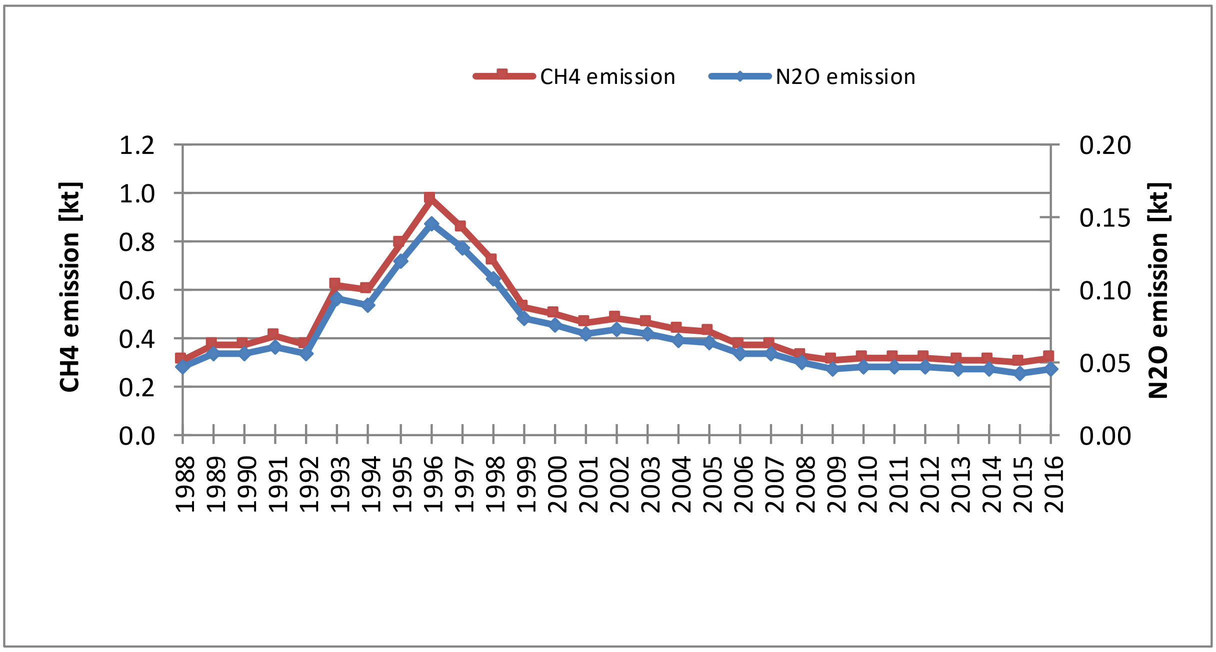

Figure 3.2.7.11. CH_4 and N_2O emissions for 1.A.2.e category in 1988-2016

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 1988-2016 period are presented in table 3.2.7.6. Detailed data concerning total fuel consumption in 1.A.2.f subcategory was tabulated in Annex 2 (table 9).

Table 3.2.7.6. Fuel consumption in 1988-2016 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	38.225	38.955	41.274	42.465	39.696	41.394	42.872	44.492
Solid Fuels	38.528	35.186	36.078	50.003	41.280	29.982	32.419	39.231
Other Fuels	1.831	3.418	6.663	7.737	7.778	12.134	14.966	16.746
Biomass	0.261	0.110	0.139	0.117	0.224	0.314	0.422	1.686
TOTAL	**91.001**	**91.883**	**92.874**	**106.177**	**95.086**	**91.033**	**96.717**	**106.565**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	3.556	3.274	2.425	1.981	2.917			
Gaseous Fuels	42.349	40.911	40.873	40.514	43.984			
Solid Fuels	31.510	27.253	27.959	26.089	27.074			
Other Fuels	16.083	16.515	19.231	19.079	25.428			
Biomass	1.767	1.893	2.296	2.327	2.642			
TOTAL	**95.265**	**89.846**	**92.784**	**89.990**	**102.045**			

Figures 3.2.7.12 and 3.2.7.13 show emissions of CO_2, CH_4 and N_2O, respectively, in the sub-category 1.A.2.f in the period: 1988-2016.

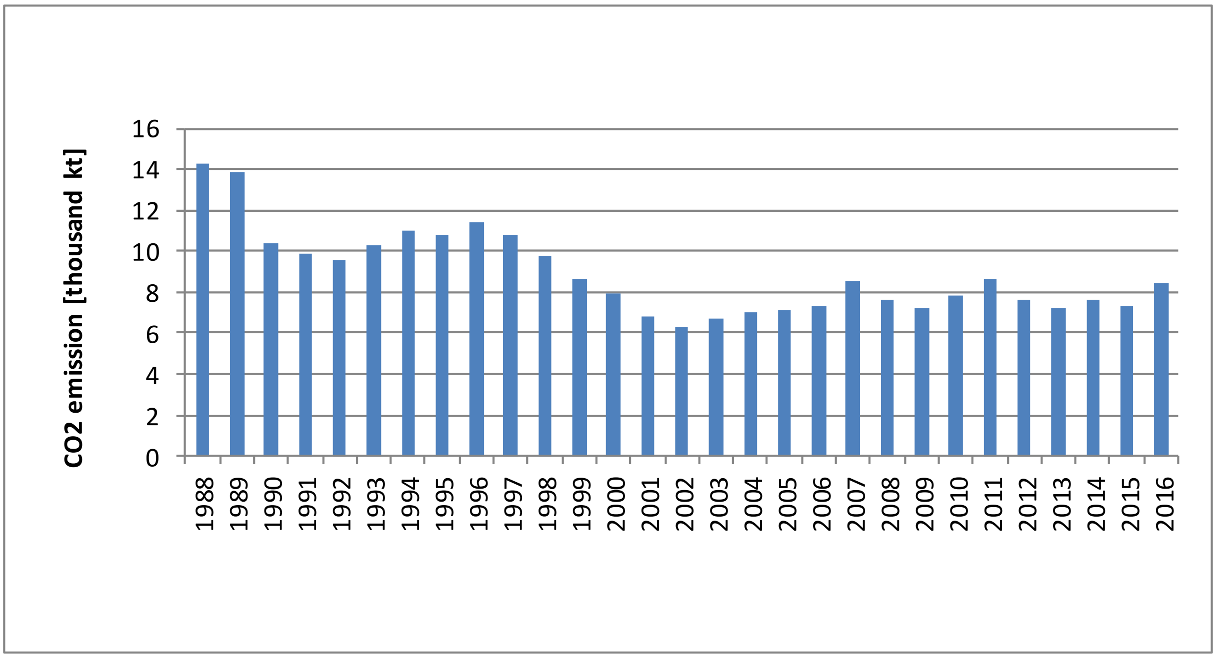

Figure 3.2.7.12. CO_2 emission from 1.A.2.f category in 1988-2016

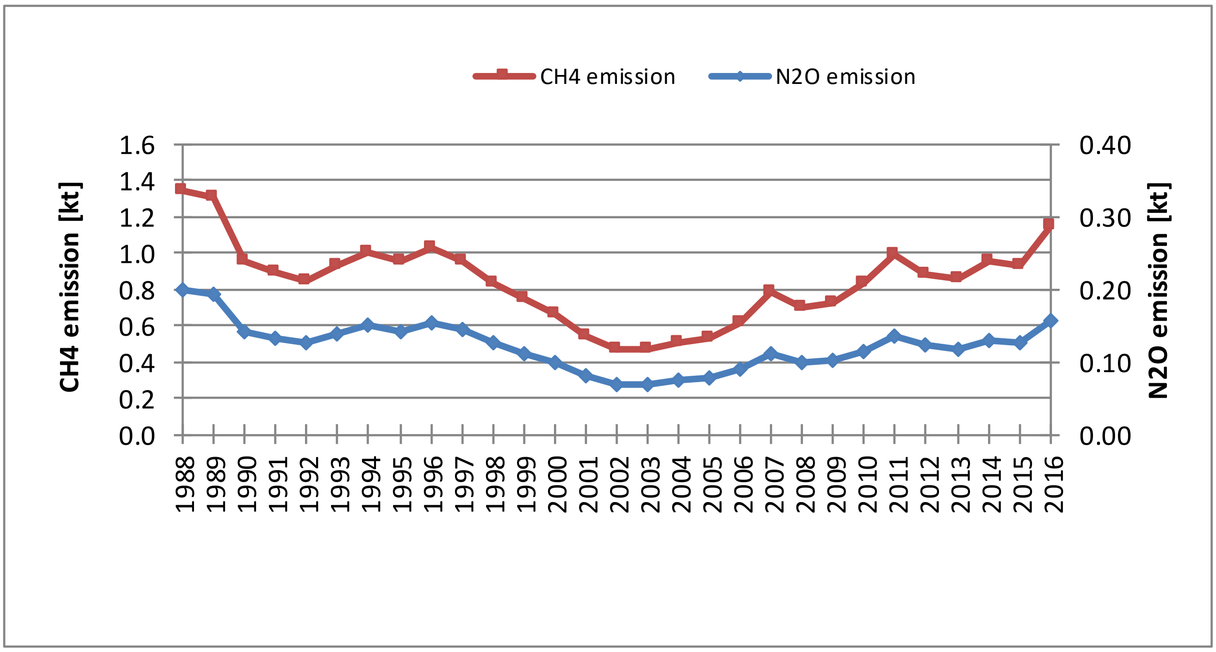

Figure 3.2.7.13. CH_4 and N_2O emissions from 1.A.2.f category in 1988-2016

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 1988-2016 period are presented in table 3.2.7.7. Detailed data concerning total fuel consumption in 1.A.2.g subcategory was tabulated in Annex 2 (table 10).

Table 3.2.7.7. Fuel consumption in 1988-2016 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	22.582	23.324	23.289	23.541	26.265	22.861	24.964	23.876
Solid Fuels	23.495	20.805	18.958	17.446	14.889	11.734	11.916	10.953
Other Fuels	1.661	1.700	3.789	0.938	1.154	1.392	0.070	0.052
Biomass	12.184	12.193	11.626	13.240	14.044	14.007	17.901	20.051
TOTAL	**74.088**	**73.047**	**73.042**	**68.048**	**68.163**	**61.539**	**66.545**	**66.579**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	9.626	8.669	9.613	8.271	9.080			
Gaseous Fuels	23.019	26.036	23.395	22.750	24.490			
Solid Fuels	8.173	7.973	7.022	7.911	7.147			
Other Fuels	0.069	0.098	0.064	0.045	0.037			
Biomass	20.854	24.842	25.929	27.981	30.076			
TOTAL	**61.741**	**67.618**	**66.023**	**66.958**	**70.830**			

Figures 3.2.7.14 and 3.2.7.15 show emissions of CO_2, CH_4 and N_2O, respectively in the 1.A.2.g category in the period: 1988-2016.

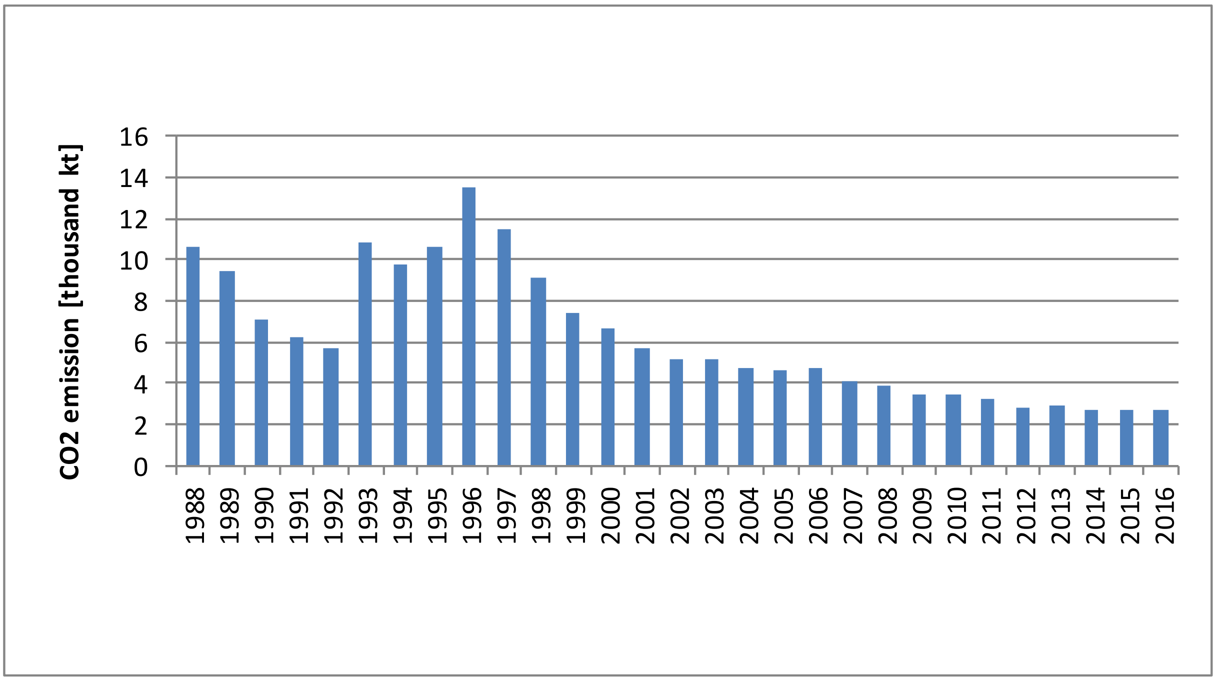

Figure 3.2.7.14. CO_2 emission from 1.A.2.g category in 1988-2016

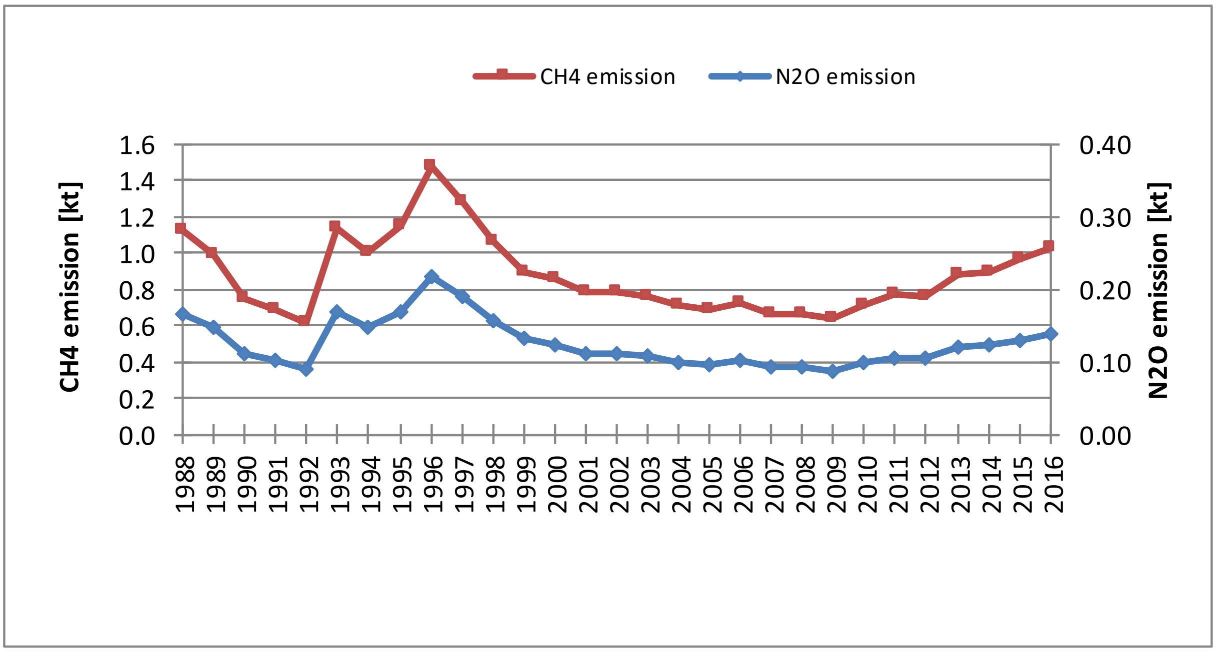

Figure 3.2.7.15. CH_4 and N_2O emissions from 1.A.2.g category in 1988-2016

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

The were no changes in 1.A.1 subsector in the years 1988-2016.

3.2.7.6. Source-specific planned improvements

Analysis of the possibility of country specific EF elaboration for the gaseous fuels.

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 2016 is about 13.3%. Road transport is by far the largest contributor to transport emissions (see figure 3.2.8.1) - in year 2016 about 97.6%.

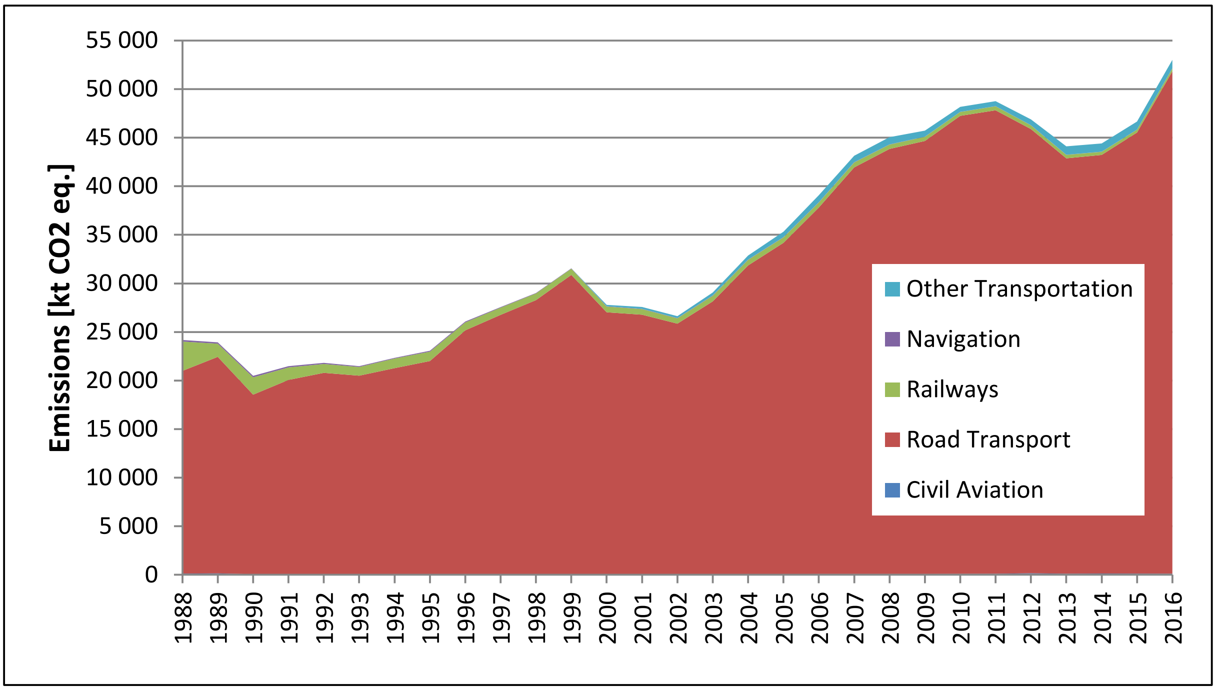

Figure 3.2.8.1. Emissions from transport in years 1988-2016

3.2.8.2. Methodological issues

The methodology used for estimation of GHG emissions in the national inventory for mobile non-road sources for the entire time series 1988-2016 is factor based – data on fuel used are multiplied by the corresponding emission factors. All emission factors for non-mobile sources were taken from IPCC 2006 guidelines and have constant values over the entire time series 1988-2016.

GHG emissions from sector 1.A.3.b *Road transport* has been calculated with the use of software COPERT 4. All emission factors are default values from COPERT 4.

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 1990-2016 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.

Jet kerosene given in Polish statistic is reported as International aviation although include whole amount of jet kerosene used for domestic and international purposes. To split jet kerosene Eurocontrol data were used. Each year, under contract with the European Commission's Directorate-General for Climate Action, EUROCONTROL calculates the mass of fuel burnt by civil aviation flights starting from and/or finishing at airports in the Member States of the European Union (EU). This work is done in support of both the European Environment Agency (EEA) and the Member States of the EU. The calculation are made with the split on domestic and international aviation. The total amount of jet kerosene used by Poland – calculated by Eurocontrol is similar to this reported by Poland to Eurostat. To stay in line with Eurostat database (and Polish statistic) only the share of domestic and international fuel use were used based on Eurocontrol data. Below in table are given Eurocontrol data of jet kerosene used in Poland and the share of domestic and international use.

Table 3.2.8.1. Eurocontrol data of jet kerosene used in Poland and the share of domestic and international use for years 2005-2016

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Eurocontrol													
Domestic	kt	22.93	25.89	28.18	27.64	25.38	29.48	32.55	46.86	34.84	38.89	34.65	34.57
International	kt	302.09	382.61	453.50	513.39	451.76	475.87	477.58	493.48	517.22	548.54	586.05	666.24
Total	kt	325.02	408.49	481.68	541.04	477.13	505.35	510.13	540.34	552.06	587.43	620.70	700.81
Share		*311.00*	*415.00*	*432.00*	*519.00*	*470.00*	*495.00*	*485.00*	*537.00*	*524.00*	*590.00*	*646.00*	*685.40*
Domestic	%	7.05	6.34	5.85	5.11	5.32	5.83	6.38	8.67	6.31	6.62	5.58	4.93
International	%	92.95	93.66	94.15	94.89	94.68	94.17	93.62	91.33	93.69	93.38	94.42	95.07
Total	%	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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. The 5-years average, taken from the nearest years to data lack period, was evaluated as the most representative in consultations with experts in the area of transport and energy. The share 5.93% was then accepted for the whole period before 2005. Such assumption seems to be reliable and not affecting accuracy of the inventory.

Emission factors for the estimation of GHG emissions from domestic aviation are default values from the IPCC 2006 guidelines (table 3.2.8.2)

Table 3.2.8.2. Emission factors for domestic aviation [kg/GJ]

EFs	CO_2	CH_4	N_2O
Aviation gasoline	70.00	0.005	0.002
Jet kerosene	71.50	0.005	0.002

Emissions from aviation come from the combustion of jet fuel and aviation gasoline. Data on fuel use in domestic aviation are shown in table 3.2.8.3 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 1988-2016.

Between 1988 and early 1990-ties dramatic decrease in fuel consumption and heavy industry production occurred triggered by significant economic changes related to political transformation from centralized to market economy. These changes affected all energy sectors and this is the main reason why Poland choose 1988 as a base year (as being more representative in trend than 1990 with collapsing industry).

Table 3.2.8.3. Fuel consumption and GHG emission in years 1988-2016

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Aviation gasoline	TJ	879.98	836.02	352.00	220.00	88.00	176.00	440.00	308.00	176.00	264.00
Jet fuel	TJ	890.50	1224.76	548.59	566.45	614.93	612.38	620.04	668.52	785.89	704.24
CO_2 emission	kt	125.27	146.09	63.86	55.90	50.13	56.11	75.13	69.36	68.51	68.83
CH_4 emission	kt	0.001	0.001	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
N_2O emission	kt	0.004	0.004	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.002
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Aviation gasoline	TJ	176.00	132.00	132.00	132.00	176.00	176.00	132.00	132.00	132.00	176.00
Jet fuel	TJ	717.00	640.45	681.27	671.07	658.31	711.89	699.13	943.36	1 130.81	1 086.85
CO_2 emission	kt	63.59	55.03	57.95	57.22	59.39	63.22	59.23	76.69	90.09	90.03
CH_4 emission	kt	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001
N_2O emission	kt	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003
		2008	2009	2010	2011	2012	2013	2014	2015	2016	
Aviation gasoline	TJ	132.00	176.00	176.00	220.00	220.00	176.00	220.00	176.00	129.43	
Jet fuel	TJ	1 140.26	1 074.83	1 241.80	1 330.71	2 002.35	1 422.02	1 679.66	1 550.85	1 453.82	
CO_2 emission	kt	90.77	89.17	101.11	110.55	158.57	113.99	135.50	123.21	113.01	
CH_4 emission	kt	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	
N_2O emission	kt	0.003	0.003	0.003	0.003	0.004	0.003	0.004	0.003	0.003	

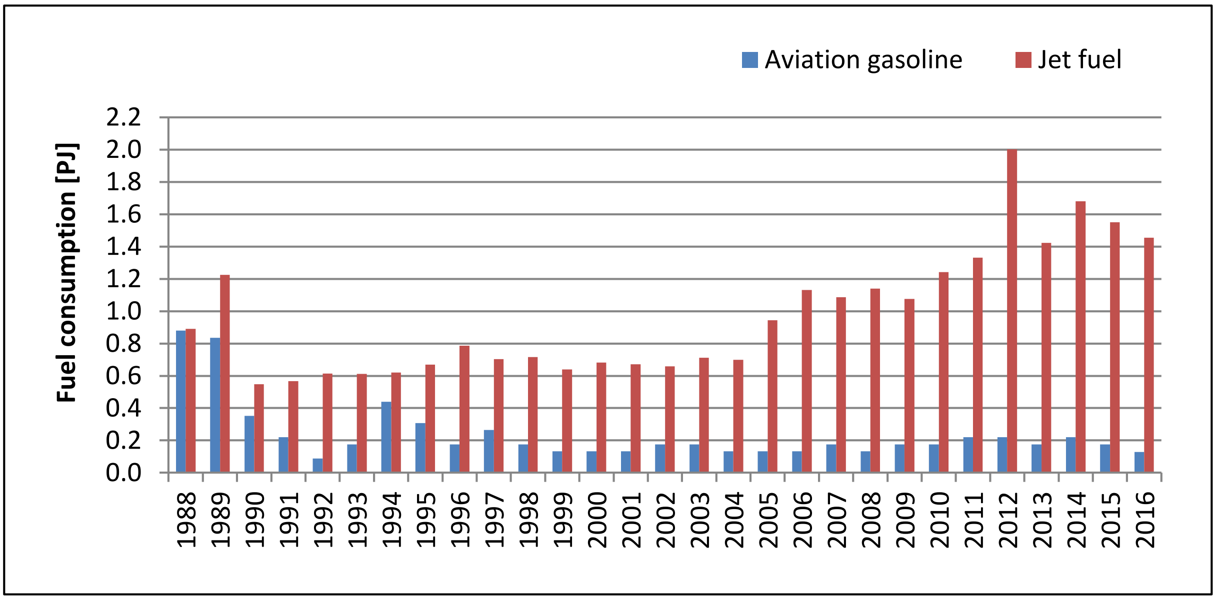

Figure 3.2.8.2. Fuel consumption in 1.A.3.a category for 1988-2016

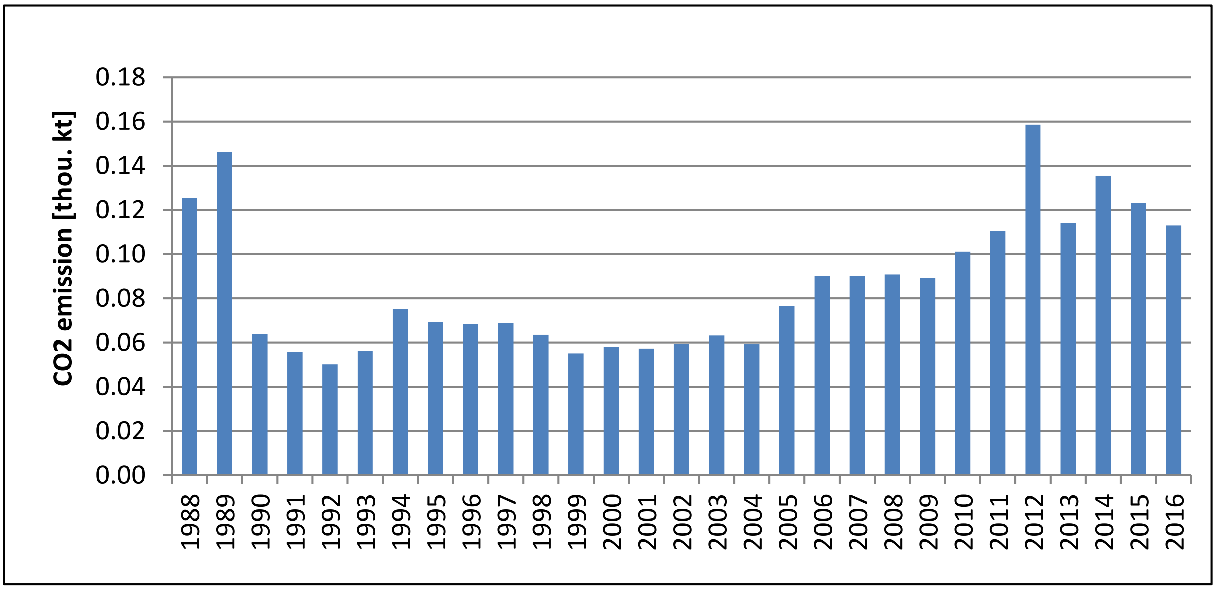

Figure 3.2.8.3. CO_2 emission for 1.A.3.a category in 1988-2016

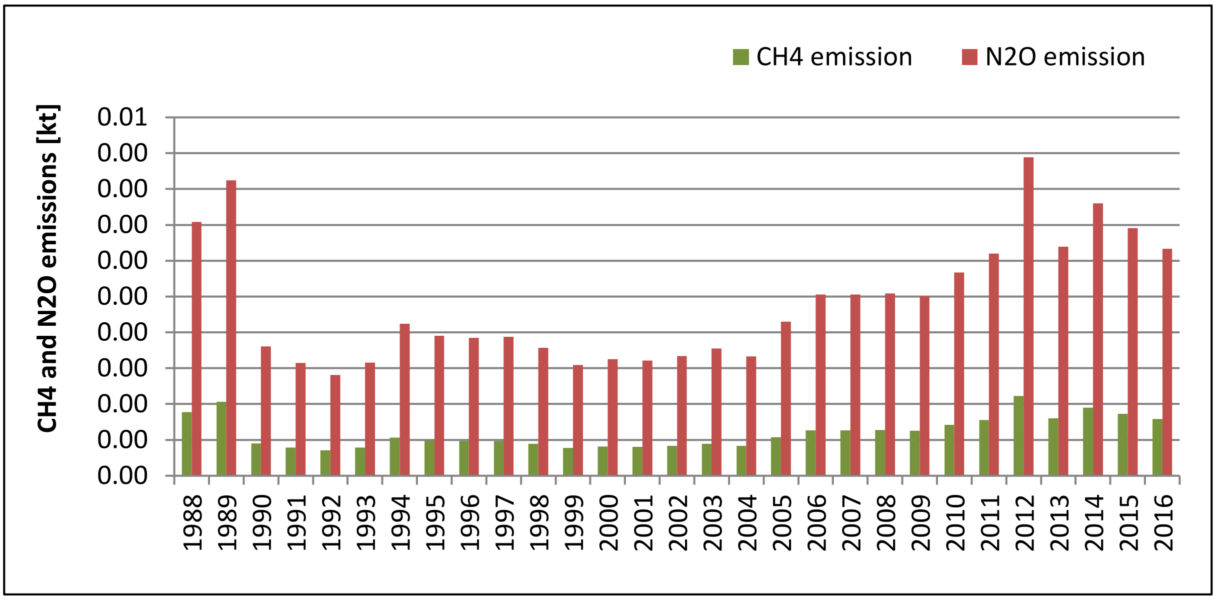

Figure 3.2.8.4. CH_4 and N_2O emissions for 1.A.3.a category in 1988-2016

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

Category includes emissions from all types of vehicles such as: passenger cars, light and heavy duty vehicles, buses, motorcycles and mopeds. Poland applied software COPERT to the official reporting of national emissions within the framework cooperation in the European Union. COPERT 4 is an program aiming at the calculation of air pollutant emissions from road transport and the methodology applied is part of the EMEP/CORINAIR Emission Inventory Guidebook. The use of COPERT allows for estimating emissions in accordance with the requirements of international conventions and protocols and EU legislation.

Calculations for the years 1988-2016 was made by model COPERT 4 version 11.4. All emission factors are default values from COPERT 4.

Emission estimates from this category are based on:

- fuel consumption,
- number of vehicles per vehicle category, engine size or vehicle weigh and emission control technology,
- the mileage per vehicle class and,
- mileage share per road class (urban, rural and highways),
- the average speed per vehicle type and per road class,
- monthly temperature (min and max),
- fuel characteristics.

Data on fuel consumption for years 1990-2016 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 COPERT 4 calculations – mass of statistical and calculated fuel consumption is equal. Table 3.2.8.4 shows fuel consumption, implied emission factors and GHG emissions in 2016 by main vehicle categories.

Table 3.2.8.4. Fuel consumption, emission factors and GHG emissions in 2016 by vehicle categories

Vehicle category by fuel type	Fuel consumption	Implied emission factors			Emissions		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	TJ	(t/TJ)	(kg/TJ)	(kg/TJ)	kt	kt	kt
Passenger cars	408 797.30				27 943.93	3.10	1.00
Gasoline	144 295.44	70.65	14.07	1.89	10 194.56	2.03	0.27
Diesel oil	179 093.08	71.63	0.70	2.87	12 828.00	0.12	0.51
Liquefied petroleum gases	76 154.12	64.62	12.01	2.67	4 921.38	0.91	0.20
Biomass	9 254.66	70.80	3.00	0.60	655.23	0.03	0.01
Light duty trucks	96 803.83				6 732.58	0.27	0.19
Gasoline	12 921.65	70.98	16.33	2.51	917.21	0.21	0.03
Diesel oil	81 188.95	71.63	0.61	1.95	5 815.36	0.05	0.16
Biomass	2 693.24	70.80	3.00	0.60	190.68	0.01	0.00
Heavy duty trucks and buses	231 161.56				16 089.69	0.80	0.58
Diesel oil	224 136.46	71.63	3.31	2.57	16 054.34	0.74	0.58
Gaseous fuels	610.82	57.86	68.15	NO	35.34	0.04	NO
Biomass	6 414.29	70.80	3.00	0.60	454.13	0.02	0.00
Motorcycles and mopeds	4 408.59				307.11	0.40	0.01
Gasoline	4 285.94	71.66	92.55	1.47	307.11	0.40	0.01
Biomass	122.65	70.80	3.00	0.60	8.68	0.00	0.00

The number of vehicles per vehicle category, engine size or weigh and emission control technology comes from Polish Central Vehicle and Driver Register system (CEPiK) and Central Statistical Office [GUS T]. The amount of vehicles according to categories and fuel type is shown in figure below.

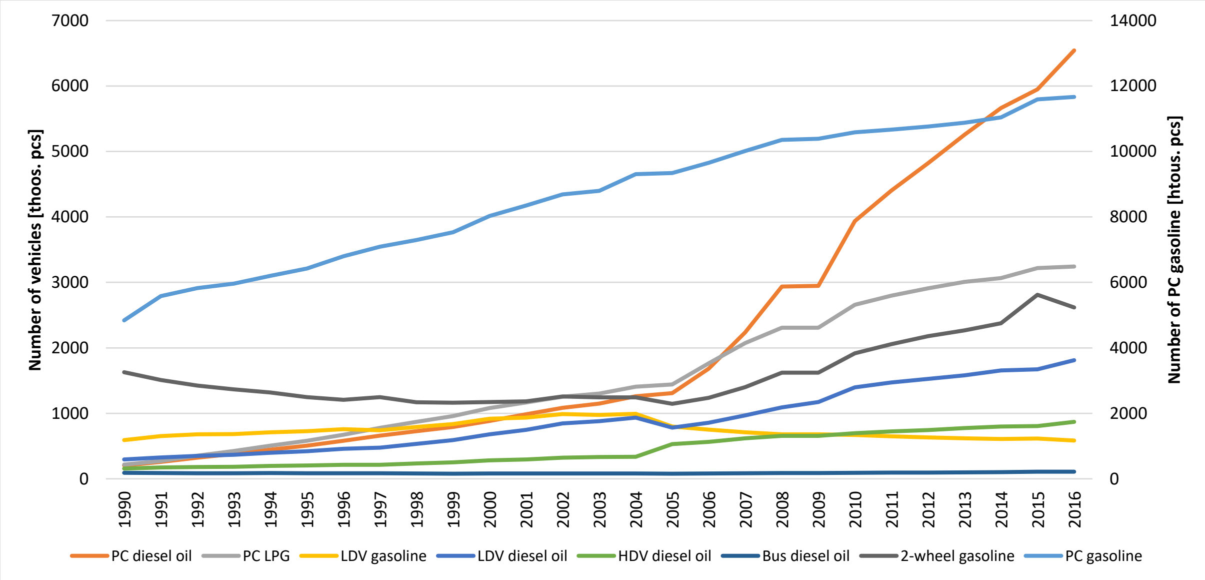

Figure 3.2.8.5. Number of vehicles in years 1988-2016

Annual mileage for main vehicle categories, speed and share in different travel conditions comes from literature and on the basis of own research. Estimations was based on the results of balancing the consumption of fuel in road transport as well as the results of data from surveys carried out on the vehicle inspection stations, tonne-kilometers, number of registered vehicles and the average value of technical and operational characterizing the work of motor transport (eg. average number of people in car, average utilization rate of the fleet, etc.). To determine the annual mileage of vehicle for elementary ecological categories a model of the intensity of use of vehicles was developed [Chłopek, 2017]. This model was created on the basis of functional similarity and on the structure of vehicles at the elementary categories. These data were determined using software INFRAS [INFRAS]. Average annual mileage for main vehicle categories in 2016 are presented in figure 3.2.8.6. Mileage share and speed per road class are shown in figures 3.2.8.7-8. Estimations were made using information from [Chlopek].

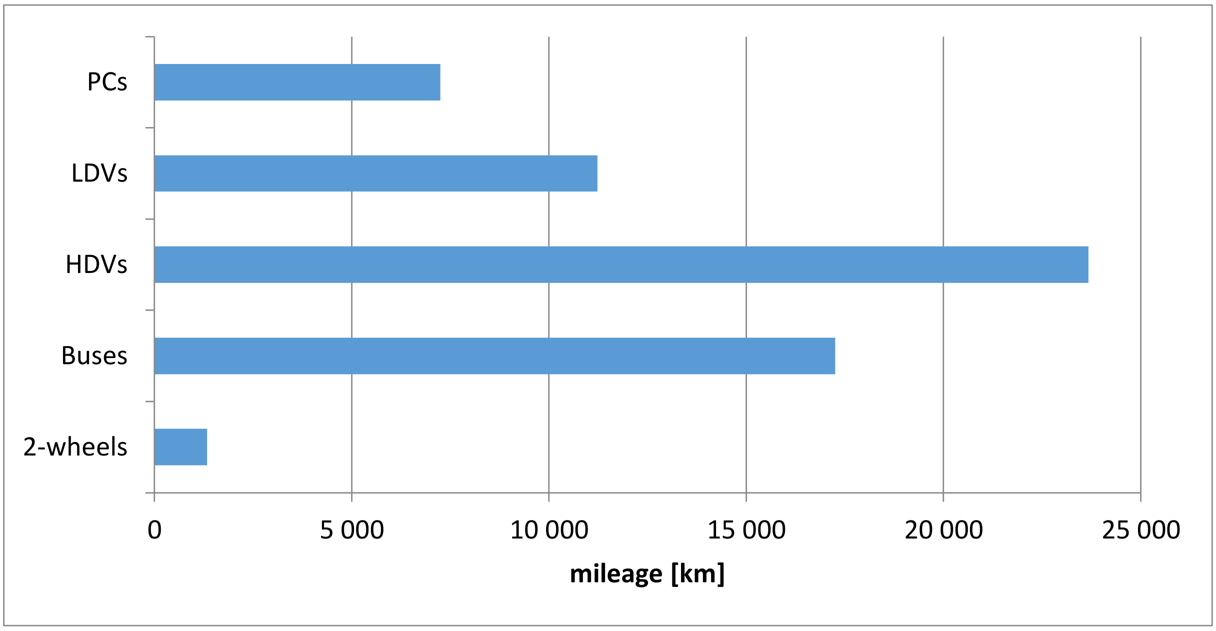

Figure 3.2.8.6. Average annual mileage driven by vehicles in 2016

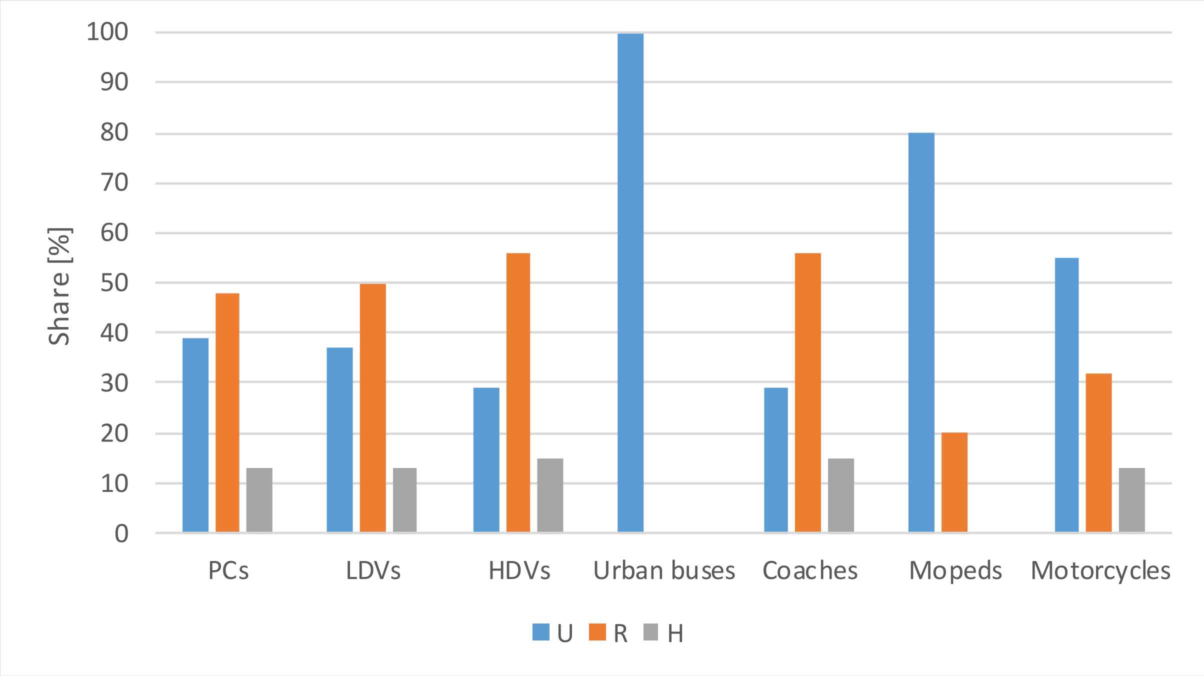

Figure 3.2.8.7. Mileage share per road class (urban, rural and highways) in 2016

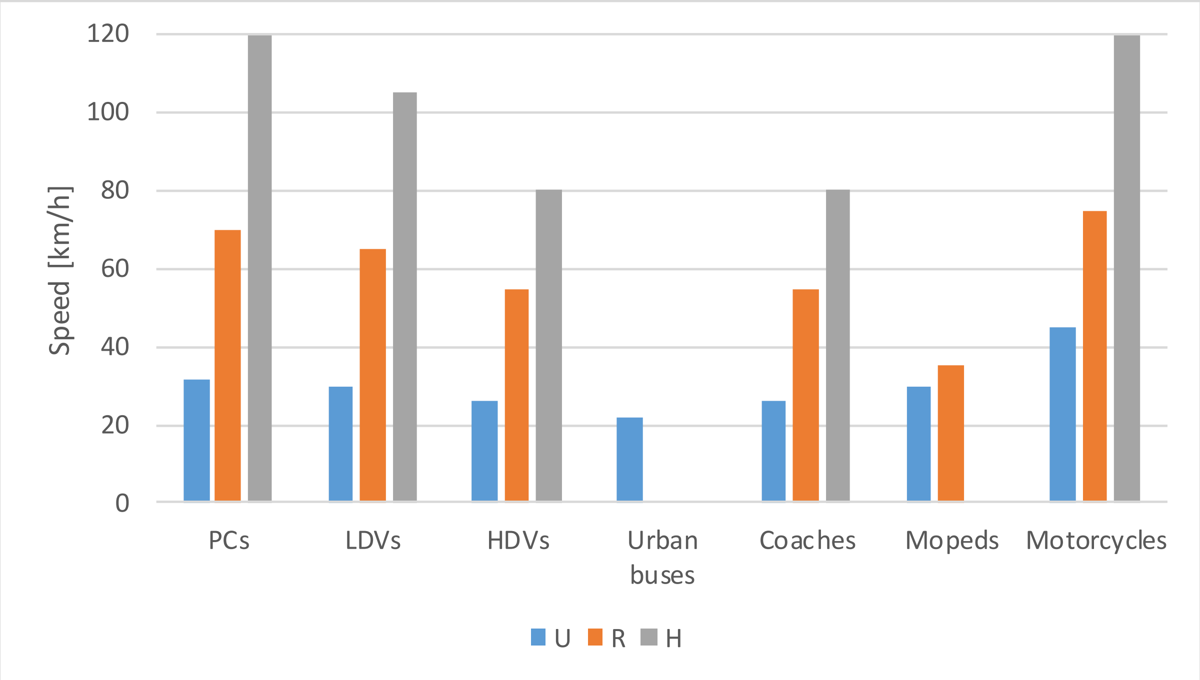

Figure 3.2.8.8. The average speed per road class (urban, rural and highways) in 2016

Consumption of main fuels in road transport (gasoline, diesel oil and LPG) and GHG emissions in 1988-2016 period is shown in table 3.2.8.5. Consumption of CNG/LNG by buses was published for the first time last year in national statistics (with data started from year 2015). Therefore GHG emissions from this new vehicle category was reported for the first time in previous submission. Taking into account that the number of CNG/LNG buses in Poland is still relatively small (399 buses in 2015 and 481 buses in 2016) therefore, it can be assumed that GHG emission in years before 2015 was rather insignificant.

Table 3.2.8.5. Fuel consumption and GHG emission in years 1988-2016

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Motor gasoline	PJ	130.33	144.36	136.14	158.81	168.42	172.06	190.42	193.03	201.78	217.90
Diesel oil	PJ	155.40	161.03	117.85	116.77	118.15	107.85	101.42	104.89	136.47	139.25
LPG	PJ	0.00	0.00	0.00	0.00	0.00	1.10	3.27	8.10	11.64	15.46
Biodiesel	PJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bioethanol	PJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO_2 emission	kt	20 508	21 905	18 150	19 640	20 356	20 302	20 786	21 509	24 627	26 191
CH_4 emission	kt	7.400	7.935	7.110	7.903	8.136	8.165	8.329	8.272	8.572	8.823
N_2O emission	kt	0.655	0.705	0.591	0.644	0.697	0.718	0.767	0.819	0.933	1.017
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Motor gasoline	PJ	222.17	247.13	222.70	206.59	189.16	180.68	183.42	177.04	181.62	181.35
Diesel oil	PJ	155.34	162.08	134.79	140.58	134.84	164.18	200.99	229.82	268.77	323.21
LPG	PJ	16.10	21.48	19.55	26.96	38.13	49.22	61.69	71.25	78.20	80.50
Biodiesel	PJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65	1.46	1.02
Bioethanol	PJ	0.00	0.00	0.00	0.00	0.00	1.18	0.56	1.42	2.30	3.00
CO_2 emission	kt	27 694	30 259	26 465	26 251	25 349	27 623	31 288	33 558	37 150	41 240
CH_4 emission	kt	8.619	8.842	8.057	6.772	6.153	6.038	6.238	6.432	6.656	6.687
N_2O emission	kt	1.086	1.200	1.072	1.057	1.019	1.082	1.197	1.310	1.383	1.503
		2008	2009	2010	2011	2012	2013	2014	2015	2016	
Motor gasoline	PJ	179.20	179.78	177.66	168.03	160.83	153.23	148.02	152.99	161.50	
Diesel oil	PJ	352.55	365.97	402.82	421.92	401.95	369.44	379.22	407.38	484.42	
LPG	PJ	79.07	76.04	76.36	73.97	73.88	73.28	73.00	70.98	76.15	
CNG/LNG	PJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	1.67	
Biodiesel	PJ	12.88	19.57	29.22	31.60	28.01	25.26	23.97	26.24	18.48	
Bioethanol	PJ	5.31	7.05	7.10	6.73	5.79	6.03	5.56	6.43	0.00	
CO_2 emission	kt	43 132	43 953	46 508	47 072	45 121	42 192	42 533	44 831	51 073	
CH_4 emission	kt	6.463	6.245	5.685	5.349	5.019	4.613	4.308	4.231	4.566	
N_2O emission	kt	1.551	1.563	1.665	1.683	1.607	1.513	1.500	1.564	1.775	

The decrease in fuel consumption of 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 2016 was about 3%. Amounts of biofuels used in years 1988-2016 are given in table 3.2.8.5. 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 below figure.

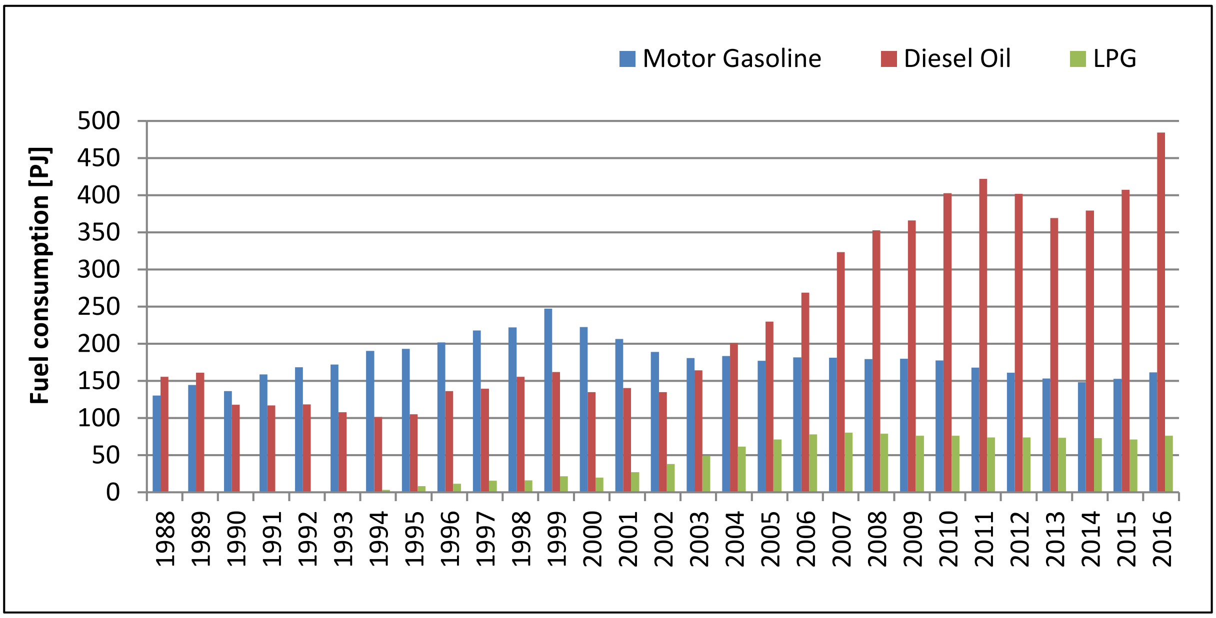

Figure 3.2.8.5. Fuel consumption in 1.A.3.b category for 1988-2016

Figure 3.2.8.6 shows CO_2 emissions in sub-category 1.A.3.b in period 1988-2016. Emissions of CH_4 and N_2O in the same sub-category are shown in figure 3.2.8.7.

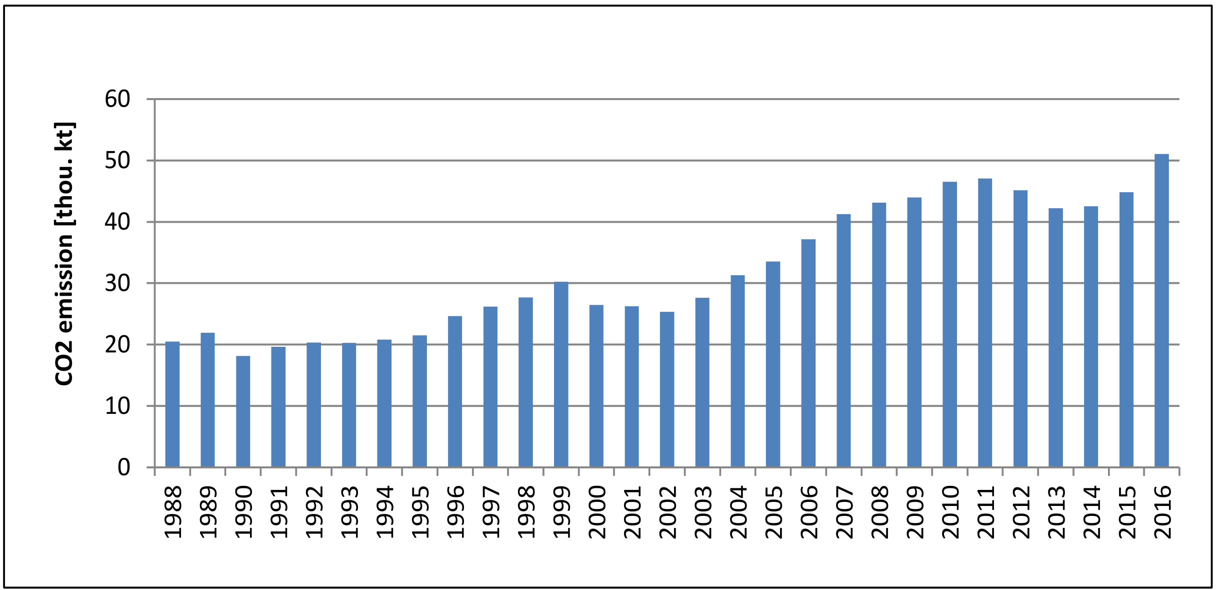

Figure 3.2.8.6. CO_2 emission for 1.A.3.b category in 1988-2016

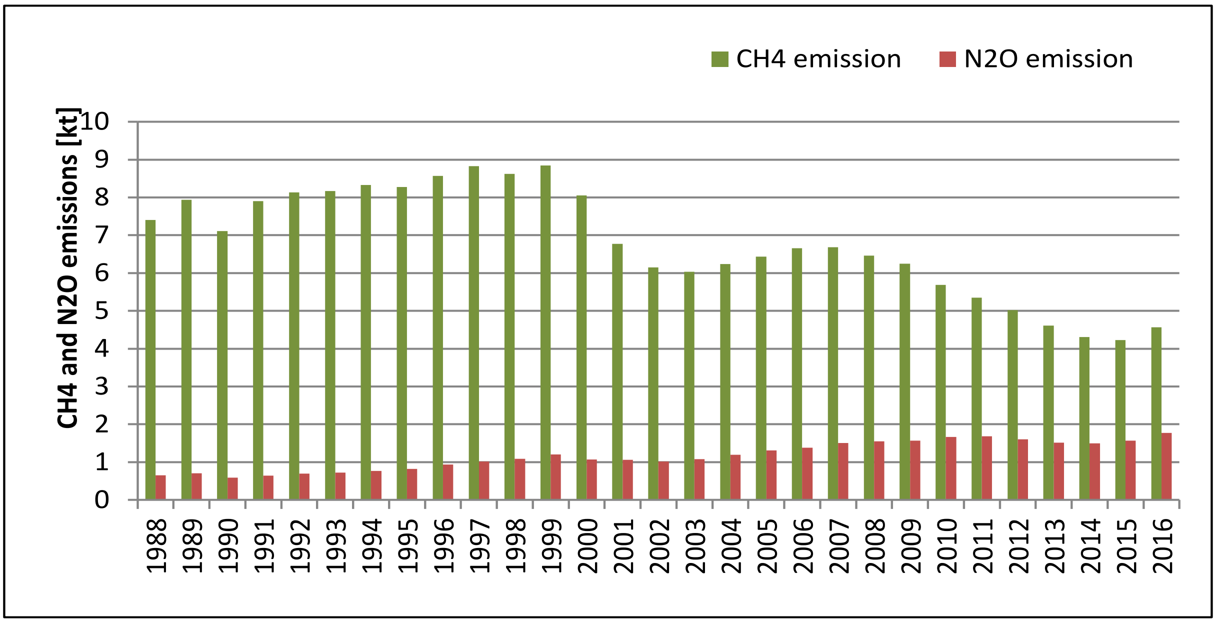

Figure 3.2.8.7. CH_4 and N_2O emissions for 1.A.3.b category in 1988-2016

<u>CO_2 emissions from urea based catalyst</u>

For estimating CO_2 emissions from urea-based catalyst additives in catalytic converters model COPERT 4 was used. Emissions are reported in sector 2.D.3 (chapter 4.5.2.3.2). The model assumed that consumption of urea is equal share of fuel consumption. For diesel passenger cars Euro VI the consumption of urea is equal 2% of fuel consumption, the selective catalytic reduction (SCR) ratio being equal to 10%; for diesel heavy duty trucks and buses, the consumption of urea is assumed to be equal 6% of fuel consumption at Euro V level (SCR ratio = 76.2%) and equal 3.5% at Euro VI level (SCR ratio = 100%). The purity (the mass fraction of urea in the urea-based additive), the default value of 32.5% has been used (IPCC 2006).

3.2.8.2.3. Railways (CRF sector 1.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. Emission factors for the estimation of GHG emissions from railways are default values from the IPCC 2006 guidelines (table 3.2.8.6).

Table 3.2.8.6. Emission factors for railways [kg/GJ]

EFs	CO_2	CH_4	N_2O
Hard coal	96.10	0.002	0.0015
Diesel oil	74.10	0.004	0.0286

The amounts of fuels used in railway transport in the 1988-2016 period are shown table 3.2.8.7 and in figure 3.2.8.8.

Table 3.2.8.7. Fuel consumption and GHG emission in years 1988-2016

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Hard coal	TJ	10 972	5 785	3 169	1 686	350	293	156	132	192	181
Diesel oil	TJ	23 600	9 585	17 761	13 556	10 596	10 425	11 798	11 497	9 652	8 666
CO_2 emission	kt	2 803	1 266	1 621	1 167	819	801	889	865	734	660
CH_4 emission	kt	0.120	0.051	0.080	0.060	0.045	0.044	0.049	0.048	0.040	0.036
N_2O emission	kt	0.691	0.283	0.513	0.390	0.304	0.299	0.338	0.329	0.276	0.248
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Hard coal	TJ	138	0	0	0	0	0	0	0	0	0
Diesel oil	TJ	8 151	7 722	7 078	6 907	6 564	6 907	6 907	6 778	6 220	6 135
CO_2 emission	kt	617	572	524	512	486	512	512	502	461	455
CH_4 emission	kt	0.034	0.032	0.029	0.029	0.027	0.029	0.029	0.028	0.026	0.025
N_2O emission	kt	0.233	0.221	0.202	0.198	0.188	0.198	0.198	0.194	0.178	0.175
		2008	2009	2010	2011	2012	2013	2014	2015	2016	
Hard coal	TJ	0	0	0	0	0	0	0	0	0	
Diesel oil	TJ	5 362	5 196	4 806	4 980	4 633	4 287	3 854	3 526	3 484	
CO_2 emission	kt	397	385	356	369	343	318	286	261	258	
CH_4 emission	kt	0.022	0.022	0.020	0.021	0.019	0.018	0.016	0.015	0.014	
N_2O emission	kt	0.153	0.149	0.137	0.142	0.133	0.123	0.110	0.101	0.100	

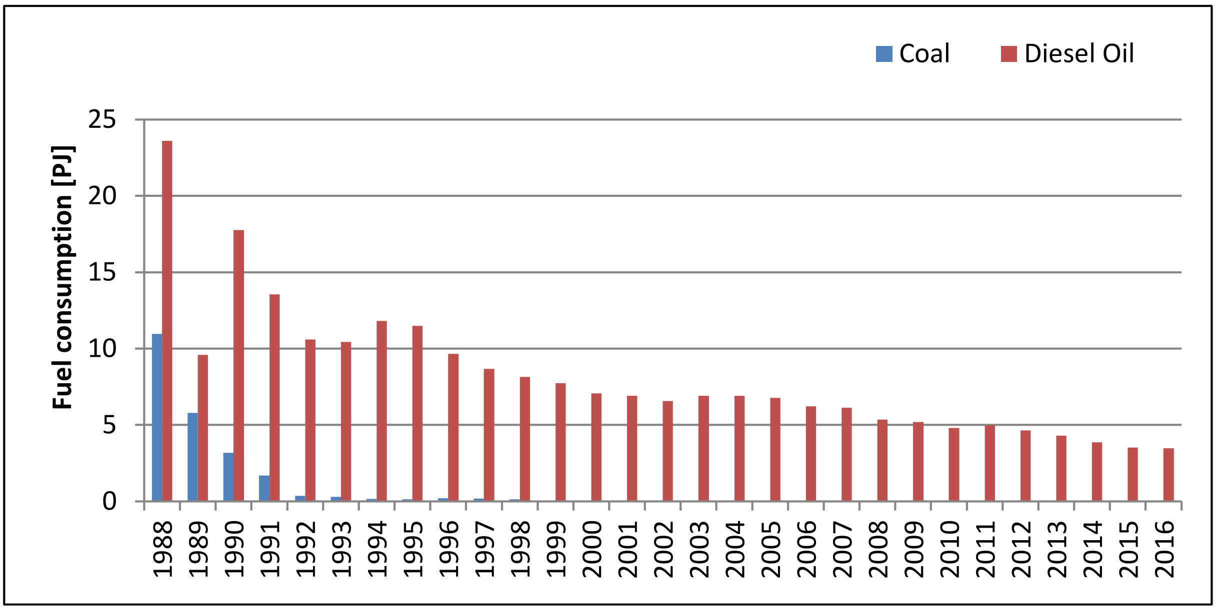

Figure 3.2.8.8. Fuel consumption in 1.A.3.c category for 1988-2016

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.

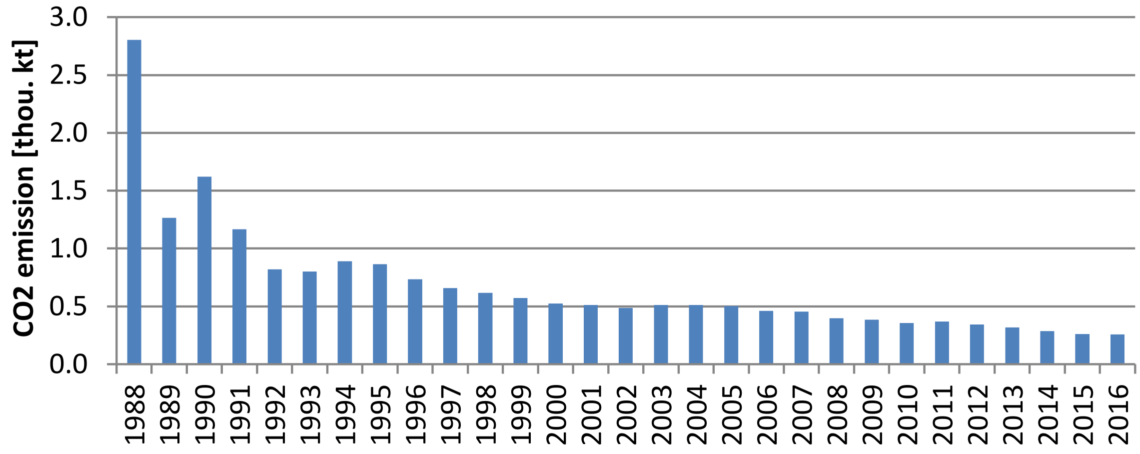

Figure 3.2.8.9. CO_2 emission for 1.A.3.c category in 1988-2016

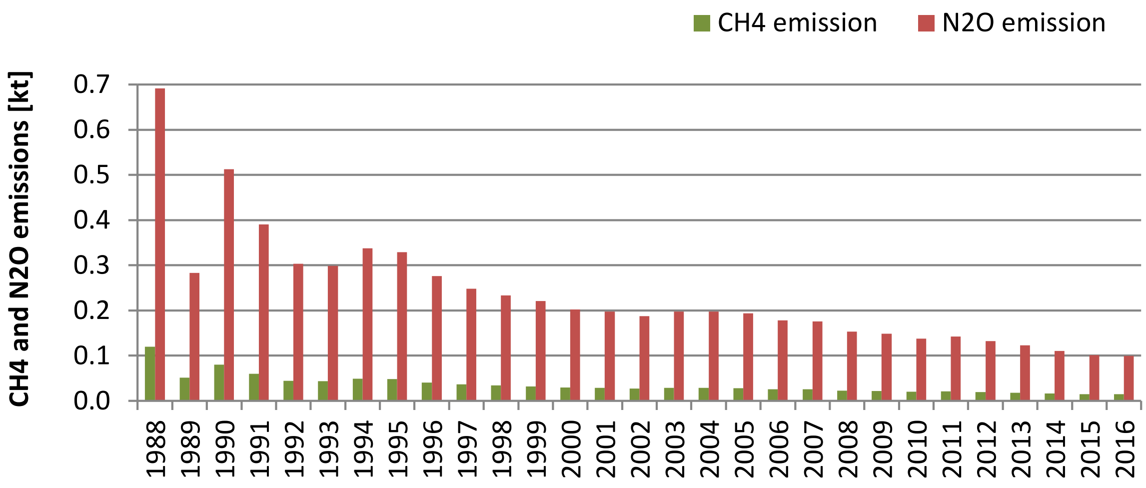

Figure 3.2.8.10. CH_4 and N_2O emissions for 1.A.3.c category in 1988-2016

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.

Emission factors for the estimation of GHG emissions from domestic navigation are default values from the IPCC 2006 guidelines (table 3.2.8.8).

Table 3.2.8.8. Emission factors for domestic navigation [kg/GJ]

		CO_2	CH_4	N_2O
Inland navigation	Diesel oil	74.10	0.007	0.002
Maritime	Diesel oil	74.10	0.007	0.002
Maritime	Fuel oil	74.40	0.007	0.002

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 (see table 3.2.8.9). The amounts of fuels (diesel and fuel oil) used in both inland water and maritime navigation in the 1988-2016 period are shown in table 3.2.8.10 and figure 3.2.8.11.

Table 3.2.8.9. Cargo traffic at Polish seaports

Cargo traffic		1990	1991	1992	1993	1994	1995	1996	1997	1998
International	kt	45 901	40 671	43 558	49 814	51 148	48 179	47 925	50 630	50 564
Domestic	kt	1 138	1 009	744	711	1 327	1 142	1 068	355	432
Share of domestic	%	2.4	2.4	1.7	1.4	2.5	2.3	2.2	0.7	0.8
		1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
International	kt	49 227	47 334	47 220	48 404	51 020	56 011	58 489	59 137	51 604
Domestic	kt	453	537	534	562	866	907	990	1 182	830
Share of domestic	%	0.9	1.1	1.1	1.1	1.7	1.6	1.7	2.0	1.6
		2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
International	kt	47 806	44 250	58 613	56 609	57 728	62 898	67 776	68 471	70 804
Domestic	kt	1 027	829	893	1 129	1 098	1 206	1 159	1 264	2 129
Share of domestic	%	2.1	1.8	1.5	2.0	1.9	1.9	1.7	1.8	2.9

Table 3.2.8.10. Fuel consumption and GHG emission in years 1988-2016

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Diesel oil-inland navigation	TJ	968.83	681.61	858.00	686.00	815.00	686.00	300.00	686.00	686.00	644.00
Marine diesel oil	TJ	239.59	236.54	232.96	183.59	119.30	82.08	97.98	93.40	72.68	27.93
Marine fuel oil	TJ	894.34	878.75	900.55	825.50	546.35	340.58	425.53	428.31	399.10	127.94
CO_2 emission	kt	158.77	136.05	150.54	128.33	111.52	83.28	62.43	90.90	87.11	59.69
CH_4 emission	kt	0.015	0.013	0.014	0.012	0.010	0.008	0.006	0.008	0.008	0.006
N_2O emission	kt	0.004	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002
		1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Diesel oil-inland navigation	TJ	386.00	300.00	257.00	257.00	214.00	300.00	257.00	214.00	257.00	214.00
Marine diesel oil	TJ	27.25	25.20	24.52	19.76	19.60	31.67	22.84	30.42	31.48	24.15
Marine fuel oil	TJ	156.91	142.74	138.76	133.80	133.37	182.04	85.41	60.55	80.26	65.28
CO_2 emission	kt	42.77	35.15	31.60	30.86	27.63	38.67	27.35	22.80	27.59	22.70
CH_4 emission	kt	0.004	0.003	0.003	0.003	0.003	0.004	0.003	0.002	0.003	0.002
N_2O emission	kt	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
		2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Diesel oil-inland navigation	TJ	214.00	130.00	130.00	130.00	130.00	130.00	130.00	86.00	82.13	
Marine diesel oil	TJ	26.70	16.49	9.22	10.46	10.14	13.39	7.18	68.63*	205.69	
Marine fuel oil	TJ	63.97	38.21	12.78	14.79	11.06	23.32	12.19	0.00*	0.00	
CO_2 emission	kt	22.79	13.81	11.31	11.55	11.24	12.43	11.11	11.46	21.33	
CH_4 emission	kt	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	
N_2O emission	kt	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	

*Due to changes in regulations regarding MARPOL Convention 1973/78/97 and implementation of Directive 2012/33/EU of the European parliament and of the council of 21 November 2012 amending Council Directive 1999/32/EC as regards the sulphur content of marine fuels, high sulphur fuel oil was withdraw from use. Instead low sulphur marine diesel oil (MDO) is used.

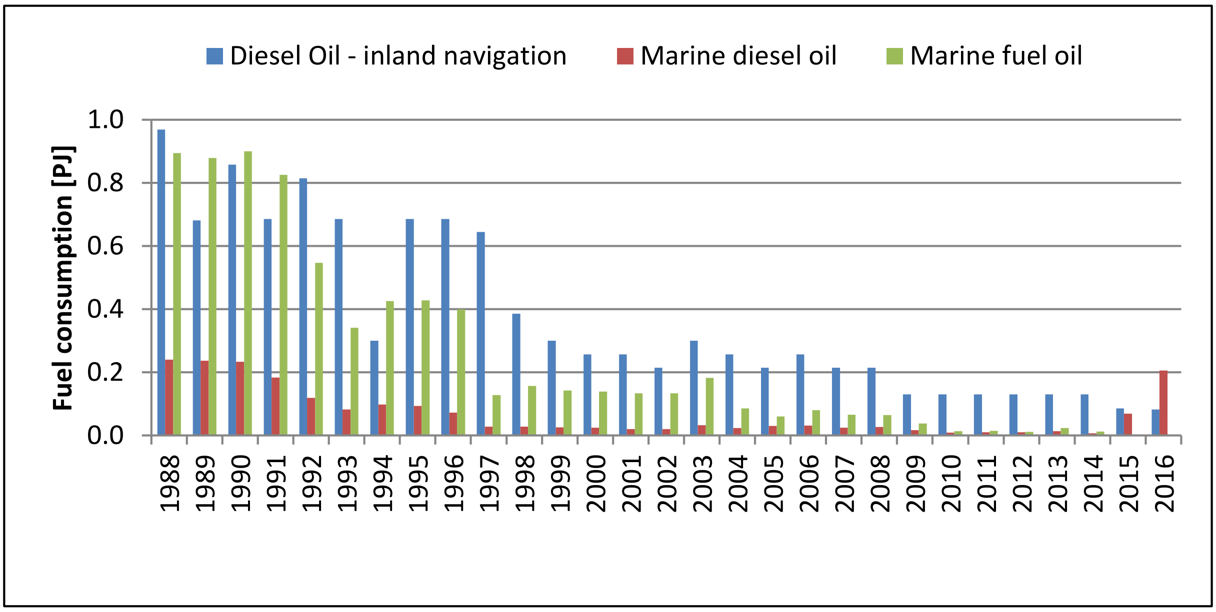

Figure 3.2.8.11. Fuel consumption in 1.A.3.d category for 1988-2016

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 1988-2016.

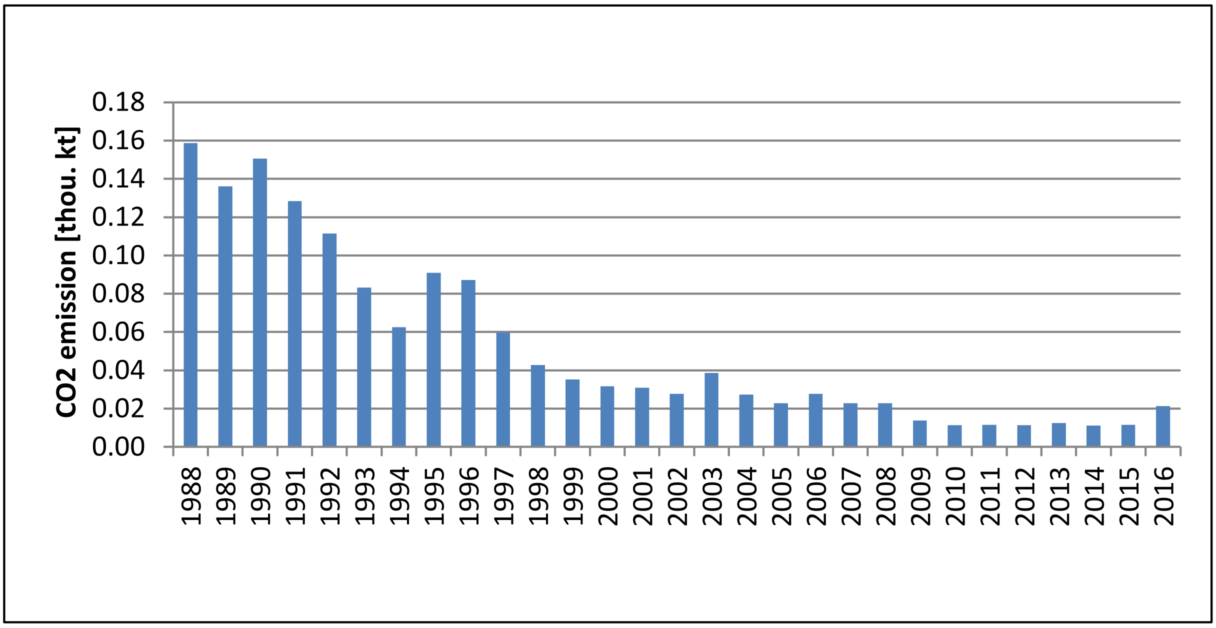

Figure 3.2.8.12. CO_2 emission for 1.A.3.d category in 1988-2016

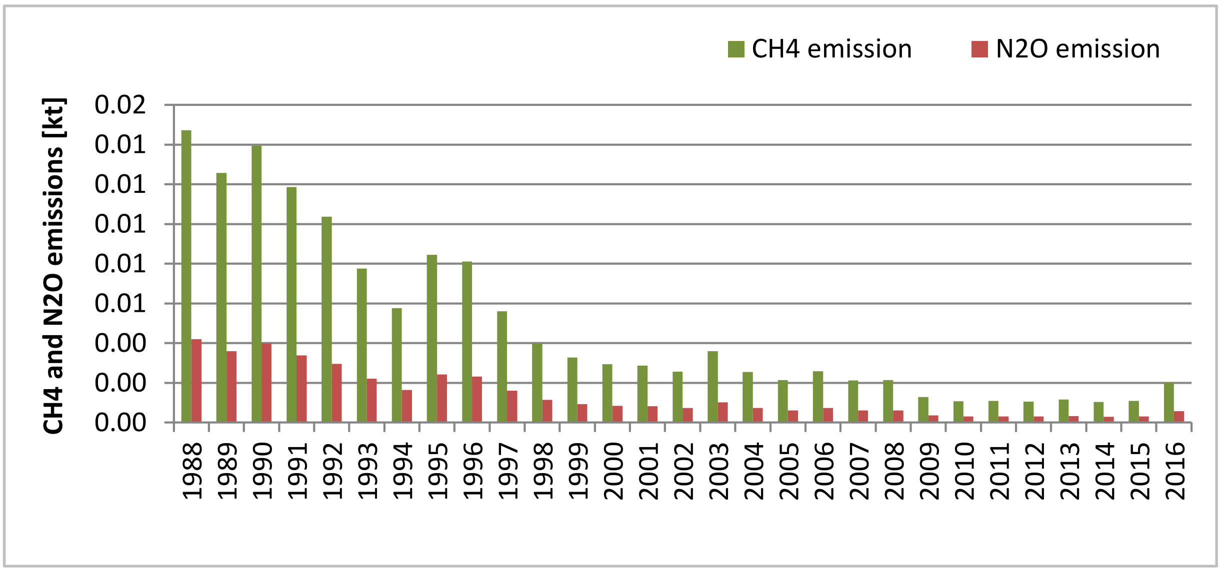

Figure 3.2.8.13. CH_4 and N_2O emissions for 1.A.3.d category in 1988-2016

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 1988-2016 period are shown in table 3.2.8.11 Natural gas consumption is shown on figure 3.2.8.14.

Table 3.2.8.11. Fuel consumption and GHG emission in years 1988-2016

		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
CO_2 emission	kt	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.39	1.34
CH_4 emission	kt	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000001	0.000007	0.000024
N_2O emission	kt	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	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	2498	3262	3502	5257	7381	9866
CO_2 emission	kt	1.45	1.28	1.17	142.62	188.39	198.60	299.75	418.31	557.02
CH_4 emission	kt	0.000026	0.000023	0.000021	0.002627	0.003526	0.003637	0.005521	0.007645	0.010130
N_2O 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	2014
Gasoline	TJ	0	45	0	45	0	0	0	0	0
Diesel oil	TJ	43	43	43	43	43	43	43	43	43
Natural gas	TJ	12912	11828	13442	11084	9269	9299	10806	15422	15143
CO_2 emission	kt	723.93	666.54	742.83	619.10	513.47	515.28	600.56	864.03	848.46
CH_4 emission	kt	0.013041	0.012092	0.013571	0.011348	0.009398	0.009428	0.010935	0.015551	0.015272
N_2O emission	kt	0.001317	0.001236	0.001370	0.001161	0.000953	0.000956	0.001106	0.001568	0.001540
		2015	2016							
Gasoline	TJ	0	0							
Diesel oil	TJ	43	52							
Natural gas	TJ	14378	15409							
CO_2 emission	kt	805.76	864.00							
CH_4 emission	kt	0.014507	0.015566							
N_2O emission	kt	0.001464	0.001572							

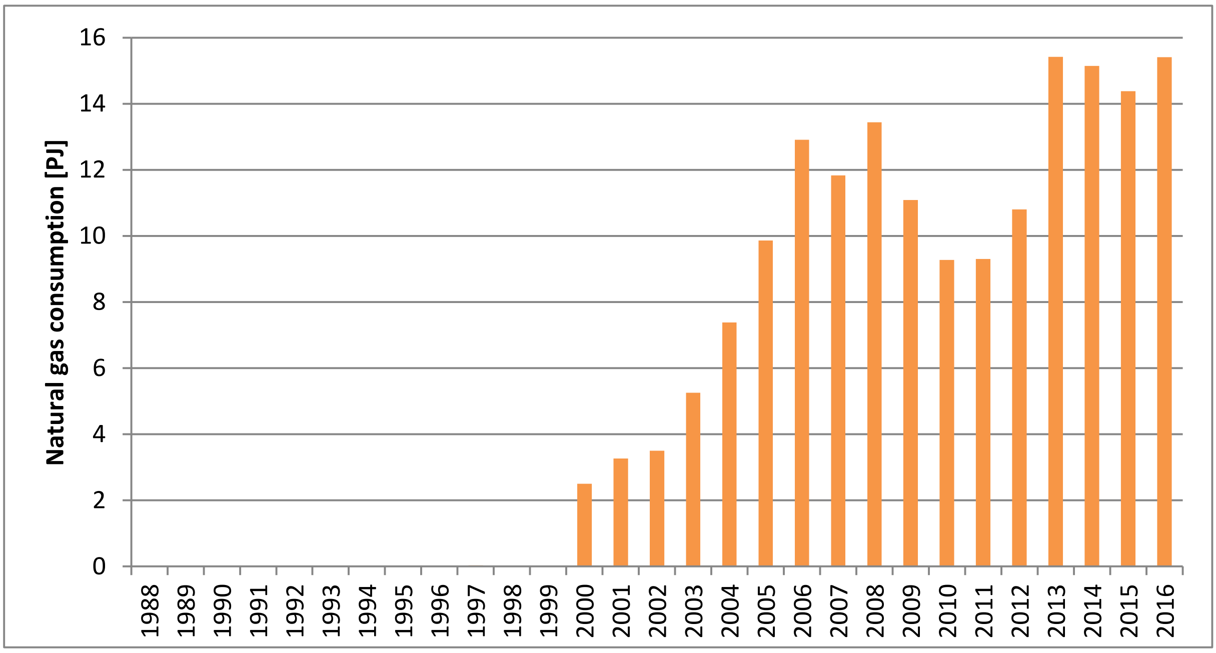

Figure 3.1.8.14. Natural gas consumption in *Pipelines transport* category for 1988-2016

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 1988-2016.

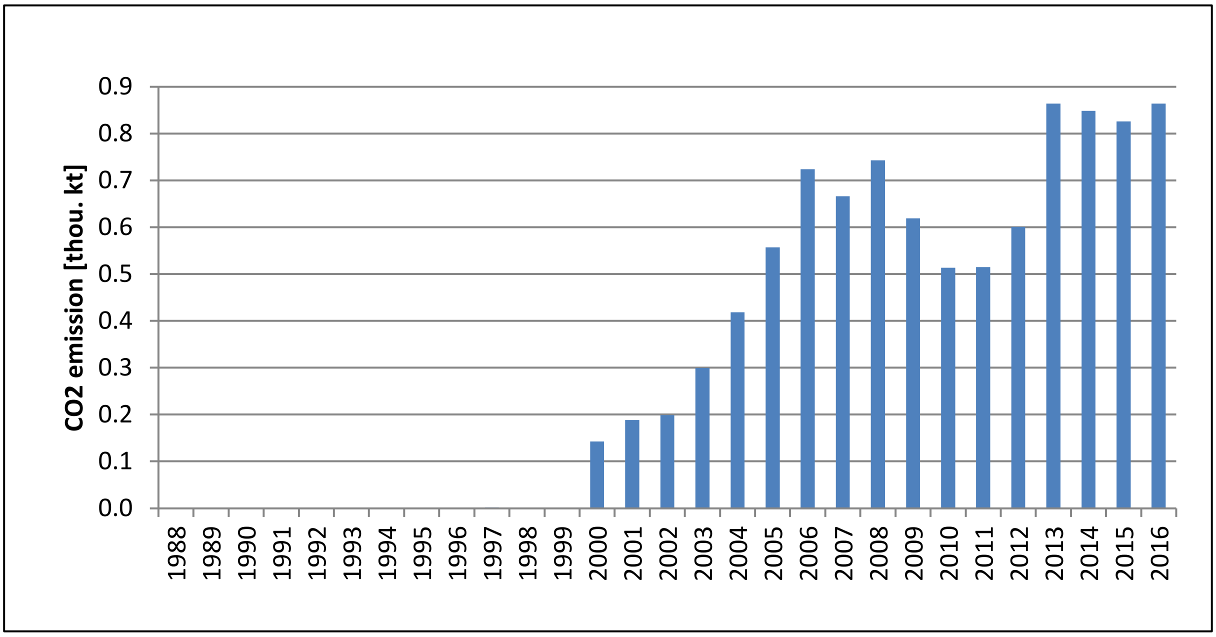

Figure 3.2.8.15. CO_2 emission from Pipelines category in 1988-2016

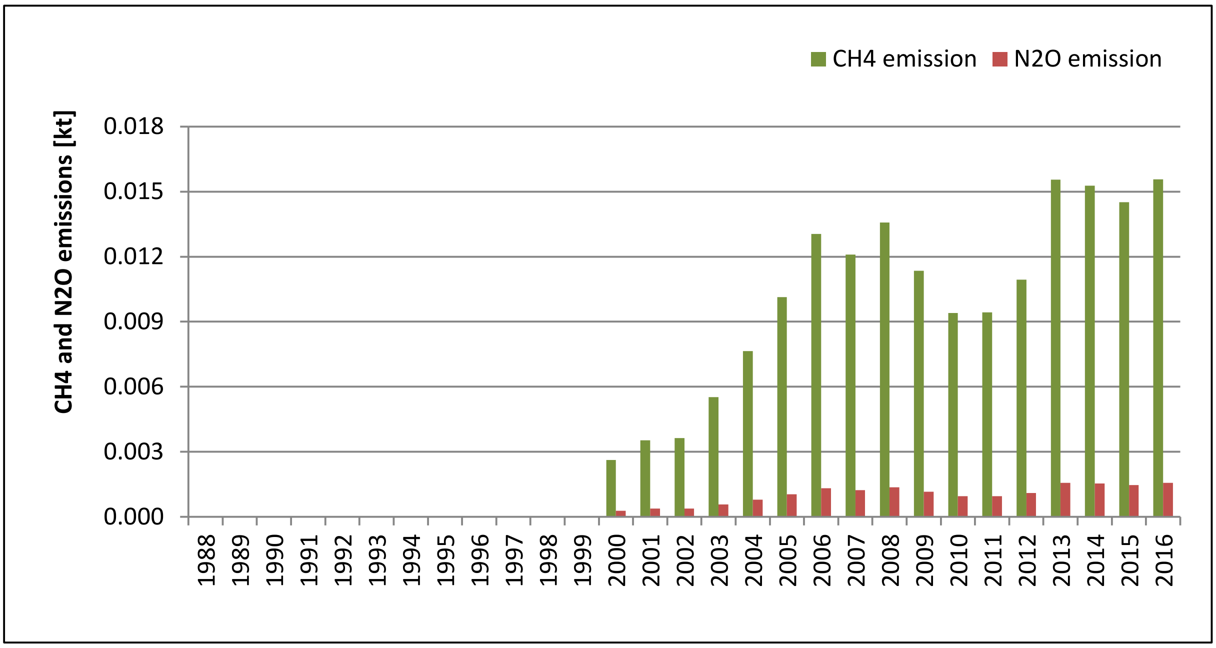

Figure 3.2.16. CH_4 and N_2O emissions from Pipelines category in 1988-2016

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 1988-2016 period are presented in table 3.2.8.12 and figure 3.2.8.17. The amounts of corresponding emissions of CO_2, CH_4 and N_2O are shown in tables 3.2.8.13–3.2.8.14 and figures 3.2.8.18 and 3.2.8.19.

Table 3.2.8.12. Fuel consumption in 1988-2016 in mobile sources in subcategories other than 1.A.3

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
ON-1.A.4.c.ii	PJ	49.42	47.82	50.53	48.68	57.21	72.16	78.15	82.28	91.81	106.80
ON-1.A.4.c.iii	PJ	4.55	4.15	3.44	3.31	3.45	2.83	3.24	3.18	2.57	2.68
OP-1.A.4.c.iii	PJ	7.54	6.87	5.62	5.41	5.64	4.62	5.28	5.18	4.20	4.37
		1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
ON-1.A.4.c.ii	PJ	97.17	99.52	110.25	102.78	102.47	103.68	105.60	108.03	80.22	73.74
ON-1.A.4.c.iii	PJ	1.93	1.94	1.72	1.81	1.77	1.43	1.61	1.37	1.29	1.33
OP-1.A.4.c.iii	PJ	3.15	3.16	2.80	2.95	2.90	2.33	2.62	2.23	2.10	2.18
		2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
ON-1.A.4.c.ii	PJ	73.79	71.69	71.91	72.49	73.03	71.40	68.96	68.13	72.15	
ON-1.A.4.c.iii	PJ	1.28	1.92	1.57	1.64	1.66	1.78	1.62	1.70	1.80	
OP-1.A.4.c.iii	PJ	2.09	3.11	2.53	2.65	2.68	2.88	2.62	2.77	2.94	

Table 3.2.8.13. GHG emission in 1988-2016 in subcategory 1.A.4.c.ii

1.A.4.c.ii		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
CO_2 emission	kt	3 662	3 544	3 744	3 607	4 239	5 347	5 791	6 097	6 803	7 914
CH_4 emission	kt	0.205	0.198	0.210	0.202	0.237	0.299	0.324	0.341	0.381	0.443
N_2O emission	kt	1.413	1.368	1.445	1.392	1.636	2.064	2.235	2.353	2.626	3.055
1.A.4.c.ii		**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
CO_2 emission	kt	7 200	7 374	8 170	7 616	7 593	7 682	7 825	8 005	5 944	5 464
CH_4 emission	kt	0.403	0.413	0.458	0.427	0.425	0.430	0.438	0.448	0.333	0.306
N_2O emission	kt	2.779	2.846	3.153	2.940	2.931	2.965	3.020	3.090	2.294	2.109
1.A.4.c.ii		**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
CO_2 emission	kt	5 468	5 312	5 329	5 372	5 412	5 291	5 110	5 048	5 346	
CH_4 emission	kt	0.306	0.297	0.298	0.301	0.303	0.296	0.286	0.283	0.299	
N_2O emission	kt	2.110	2.050	2.057	2.073	2.089	2.042	1.972	1.948	2.064	

Table 3.2.8.14. GHG emission in 1988-2016 in subcategory 1.A.4.c.iii

1.A.4.c.iii		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
CO_2 emission	kt	921	839	690	664	692	567	648	637	516	537
CH_4 emission	kt	0.085	0.077	0.063	0.061	0.064	0.052	0.060	0.059	0.047	0.049
N_2O emission	kt	0.024	0.022	0.018	0.017	0.018	0.015	0.017	0.017	0.014	0.014
1.A.4.c.iii		**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
CO_2 emission	kt	387	388	344	362	356	286	322	274	258	267
CH_4 emission	kt	0.036	0.036	0.032	0.033	0.033	0.026	0.030	0.025	0.024	0.025
N_2O emission	kt	0.010	0.010	0.009	0.010	0.009	0.008	0.008	0.007	0.007	0.007
1.A.4.c.iii		**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
CO_2 emission	kt	257	383	312	326	330	354	322	341	361	
CH_4 emission	kt	0.024	0.035	0.029	0.030	0.030	0.033	0.030	0.031	0.033	
N_2O emission	kt	0.007	0.010	0.008	0.009	0.009	0.009	0.008	0.009	0.009	

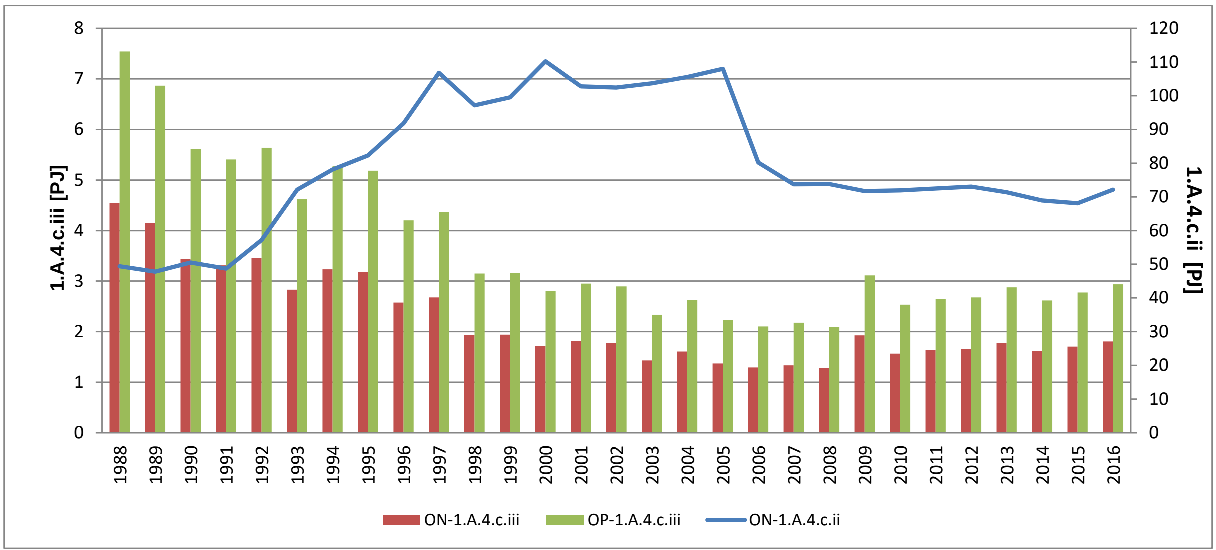

Figure 3.2.8.17. Fuel consumption in 1988-2016 in mobile sources in subcategories other than 1.A.3

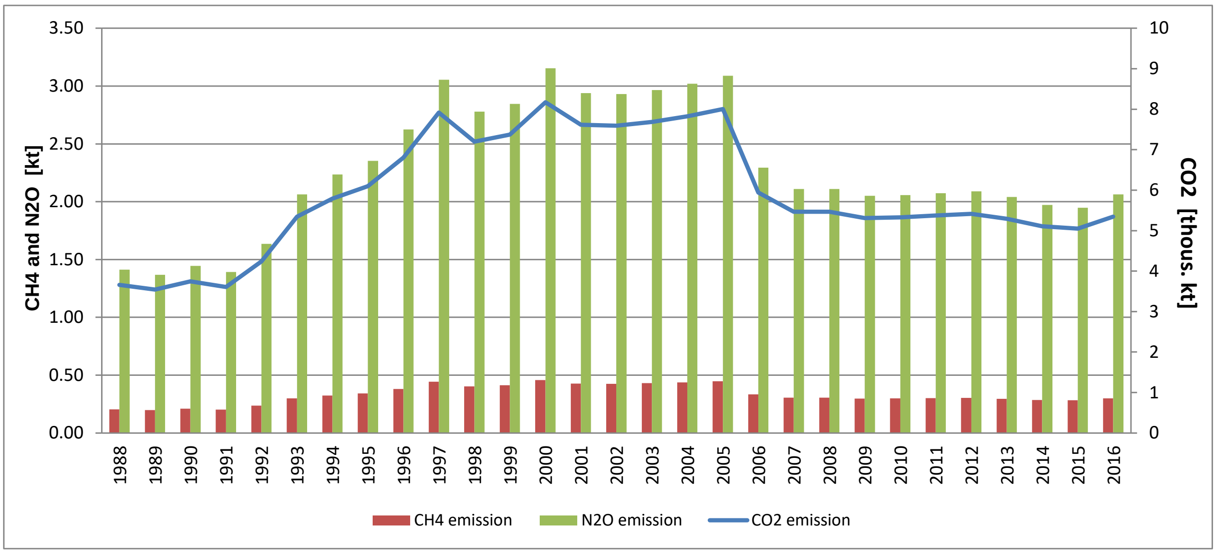

Figure 3.2.8.18. GHG emission in 1988-2016 in subcategory 1.A.4.c.ii

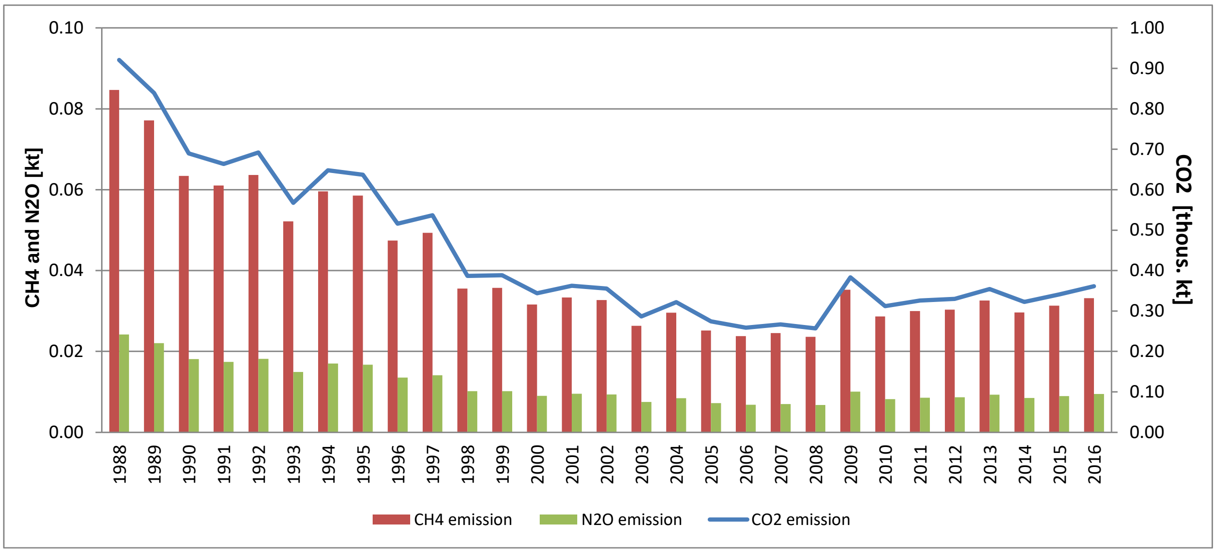

Figure 3.2.8.19. GHG emission in 1988-2016 in subcategory 1.A.4.c.iii

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

- in sector 1.A.3.a *Domestic aviation* share of domestic use of jet kerosene was updated based on actual Eurocontrol data;
- in sector 1.A.3.b *Road transport* in year 1993 estimations was corrected (difference is equal 0.99% of total CO_2 eq.);

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

Difference	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
kt CO_2 eq.	-1.76	-2.43	-1.09	-1.12	-1.22	-1.21	-1.23	-1.32	-1.56	-1.40
%	-1.47	-1.76	-1.81	-2.18	-2.72	-2.37	-1.73	-2.06	-2.51	-2.20
Difference	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
kt CO_2 eq.	-1.42	-1.27	-1.35	-1.33	-1.30	-1.41	-1.39	-1.80	-2.28	-2.16
%	-2.46	-2.56	-2.59	-2.58	-2.42	-2.46	-2.60	-3.04	-3.01	-2.64
Difference	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**		
kt CO_2 eq.	-2.34	-2.11	-1.73	-1.79	-2.13	-1.86	-1.45	1.24		
%	-2.54	-2.40	-1.89	-1.92	-3.71	-3.63	-2.83	2.43		

3.2.8.6. Source-specific planned improvements

- developing a methodology to split domestic and international aviation bunker fuels and estimating emissions from aviation;
- developing a methodology to estimate fuel structure in domestic navigation.

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 66.51% in 2016.

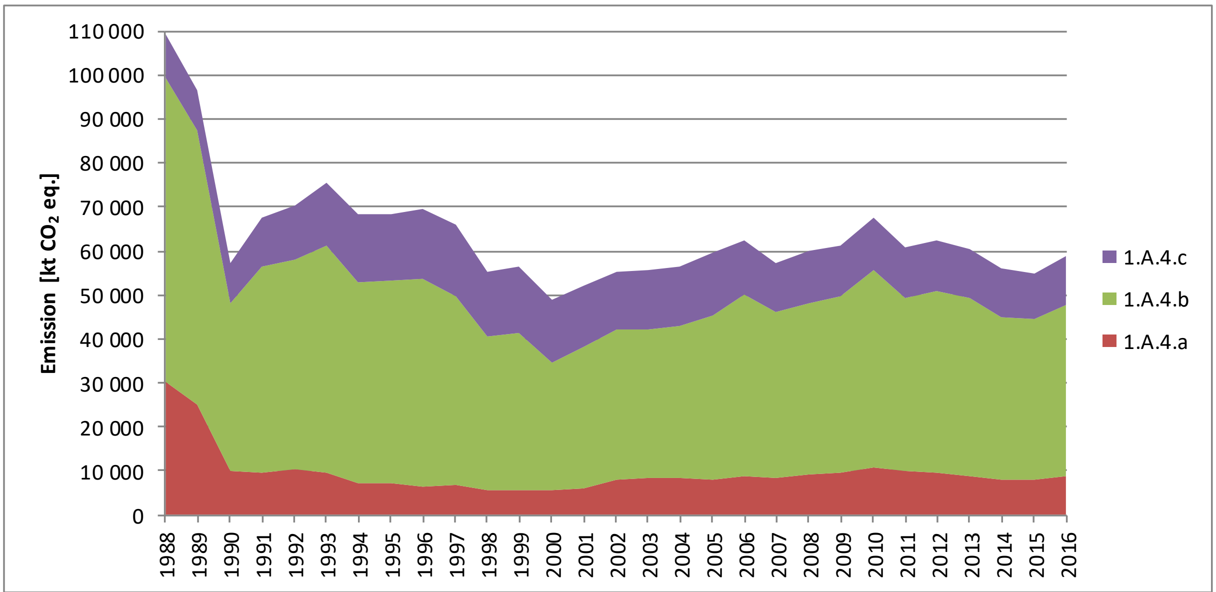

Figure 3.2.9.1. GHG emissions from 1.A.4 *Other sectors* in years 1988-2016 according to subcategories

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 1988-2016 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 3.2.9.1. Fuel consumption in 1988-2016 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	9.192	6.596	6.430	6.452
TOTAL	**83.431**	**88.087**	**79.490**	**85.126**	**86.309**	**95.222**	**120.162**	**127.317**
	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	69.564	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	38.105	33.664
Other Fuels	0.002	0.022	0.000	0.000	0.037	0.123	0.026	0.046
Biomass	7.353	7.773	6.162	6.920	6.815	8.779	9.859	9.781
TOTAL	**126.652**	**122.105**	**130.377**	**128.096**	**136.292**	**143.880**	**162.376**	**150.755**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	22.450	18.007	18.448	17.438	18.099			
Gaseous Fuels	80.888	76.501	67.429	71.823	80.972			
Solid Fuels	34.142	31.724	28.043	27.111	28.204			
Other Fuels	0.037	0.421	0.231	0.195	0.355			
Biomass	9.113	9.556	8.674	8.891	11.225			
TOTAL	**146.630**	**136.209**	**122.825**	**125.458**	**138.854**			

Figures 3.2.9.2 and 3.2.9.3 show emissions of CO_2, CH_4 and N_2O, respectively in the sub-category 1.A.4.a in the period 1988-2016.

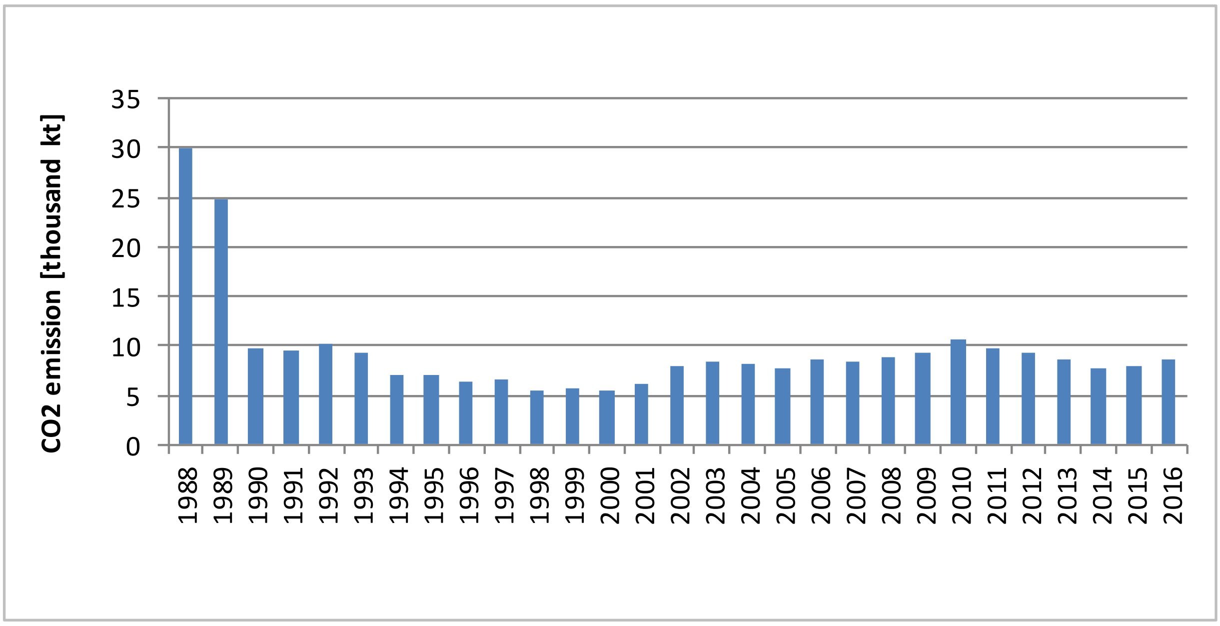

Figure 3.2.9.2. CO_2 emission for 1.A.4.a category in 1988-2016

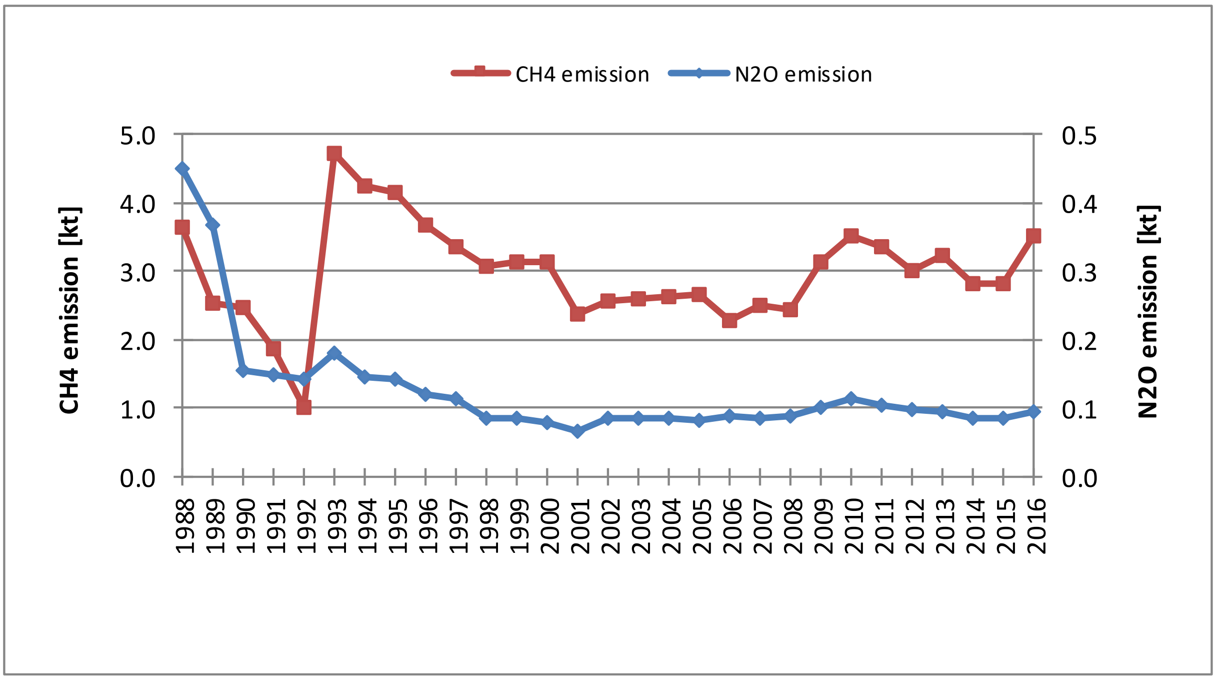

Figure 3.2.9.3. CH_4 and N_2O emissions for 1.A.4.a category in 1988-2016

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 1988-2016 period are presented in table 3.2.9.2 Detailed information on fuel consumption for 1.A.4.b subcategory is presented in Annex 2 (table 12).

Table 3.2.9.2. Fuel consumption in 1988-2016 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	330.381	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**	**620.940**	**563.403**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	26.767	25.084	25.571	24.400	25.556			
Gaseous Fuels	141.397	143.187	131.598	132.202	145.148			
Solid Fuels	301.038	289.864	265.515	260.220	276.510			
Other Fuels	0.000	0.000	0.000	0.000	0.000			
Biomass	116.850	116.850	105.450	105.450	111.435			
TOTAL	**586.052**	**574.985**	**528.134**	**522.272**	**558.649**			

Figure 3.2.9.4 show emissions of CO_2 in 1.A.4.b in the 1988-2016 period while CH_4 and N_2O, emissions in the same sub-category are shown in figure 3.2.9.5.

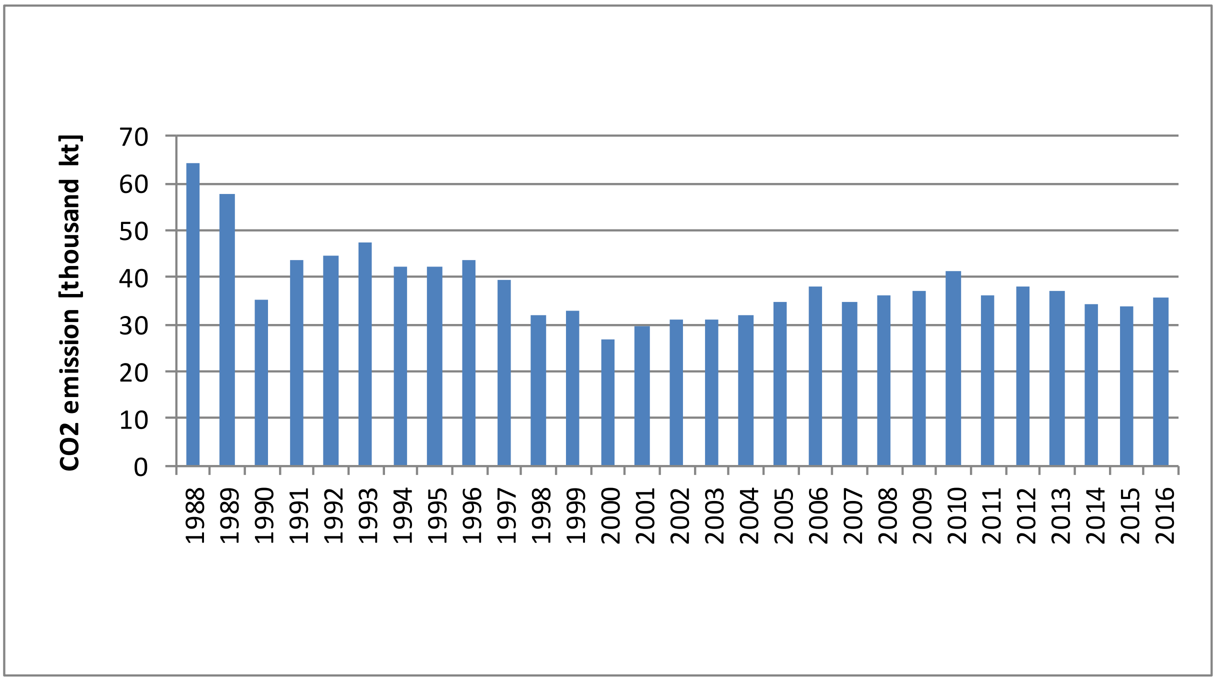

Figure 3.2.9.4. CO_2 emission for 1.A.4.b category in 1988-2016

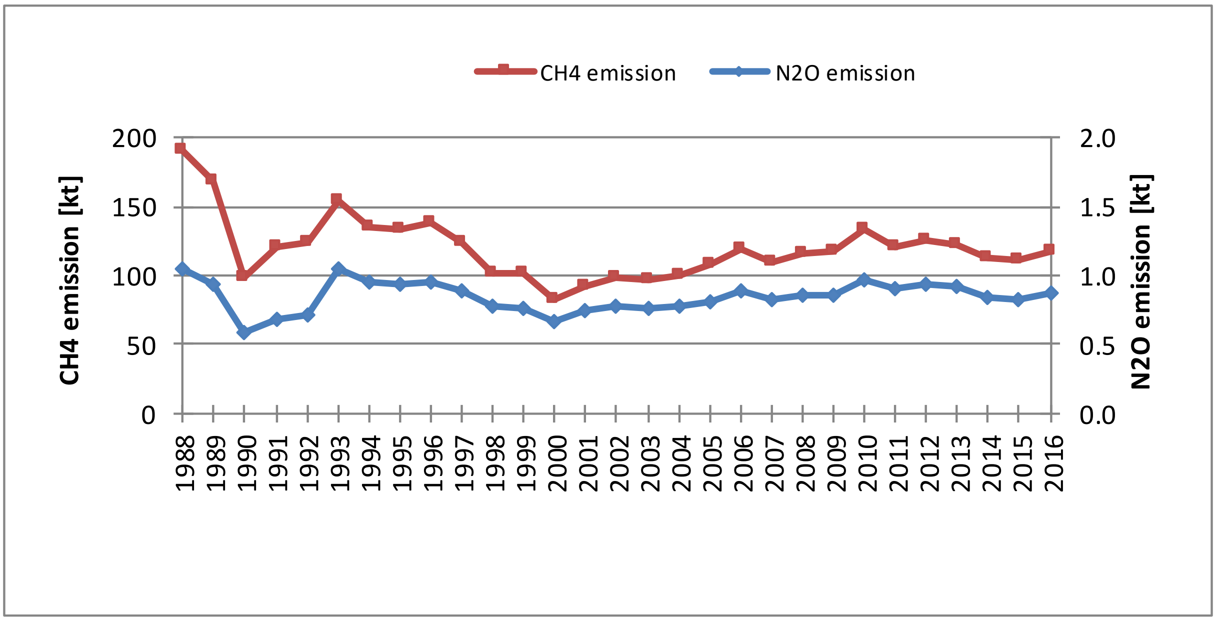

Figure 3.2.9.5. CH_4 and N_2O emissions for 1.A.4.b category in 1988-2016

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 1988-2016 period are presented in table 3.2.9.3. 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 3.2.9.3. Fuel consumption in stationary sources in 1.A.4.c subcategory for years 1988-2016 [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	17.100	17.100	19.043	19.010	19.017
TOTAL	**92.281**	**85.628**	**79.320**	**81.408**	**64.070**	**70.230**	**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	49.927	43.882
Other Fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	19.878	19.047	19.978	19.062	19.118	19.127	21.127	24.154
TOTAL	**66.302**	**69.821**	**71.832**	**65.354**	**70.283**	**69.146**	**75.805**	**73.238**
	2012	**2013**	**2014**	**2015**	**2016**			
Liquid Fuels	3.705	2.905	3.284	3.065	3.351			
Gaseous Fuels	1.796	1.501	1.438	1.144	1.305			
Solid Fuels	45.552	44.603	42.540	38.551	40.940			
Other Fuels	0.000	0.000	0.000	0.000	0.000			
Biomass	21.200	21.223	19.638	19.501	21.815			
TOTAL	**72.253**	**70.232**	**66.900**	**62.261**	**67.411**			

Figures 3.2.9.6 and 3.2.9.7 show emissions of CO_2, and CH_4 and N_2O, respectively in the sub-category 1.A.4.c.i in the period: 1988-2016.

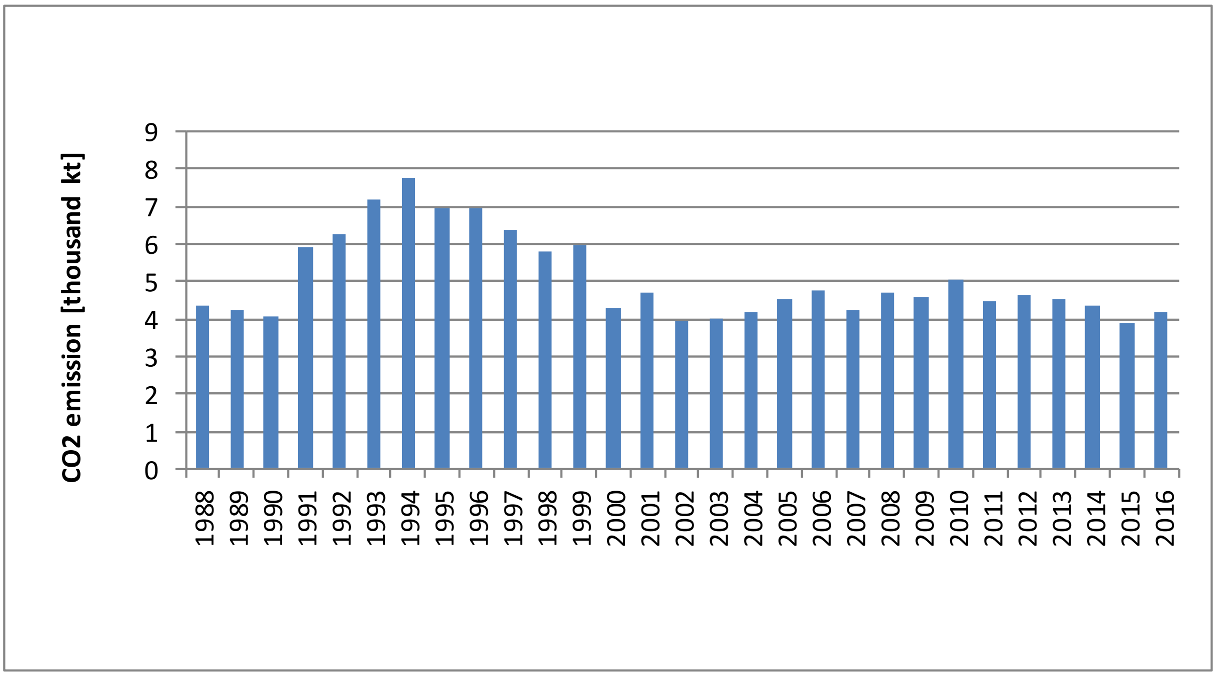

Figure 3.2.9.6. CO_2 emission for stationary sources in 1.A.4.c category in 1988-2016

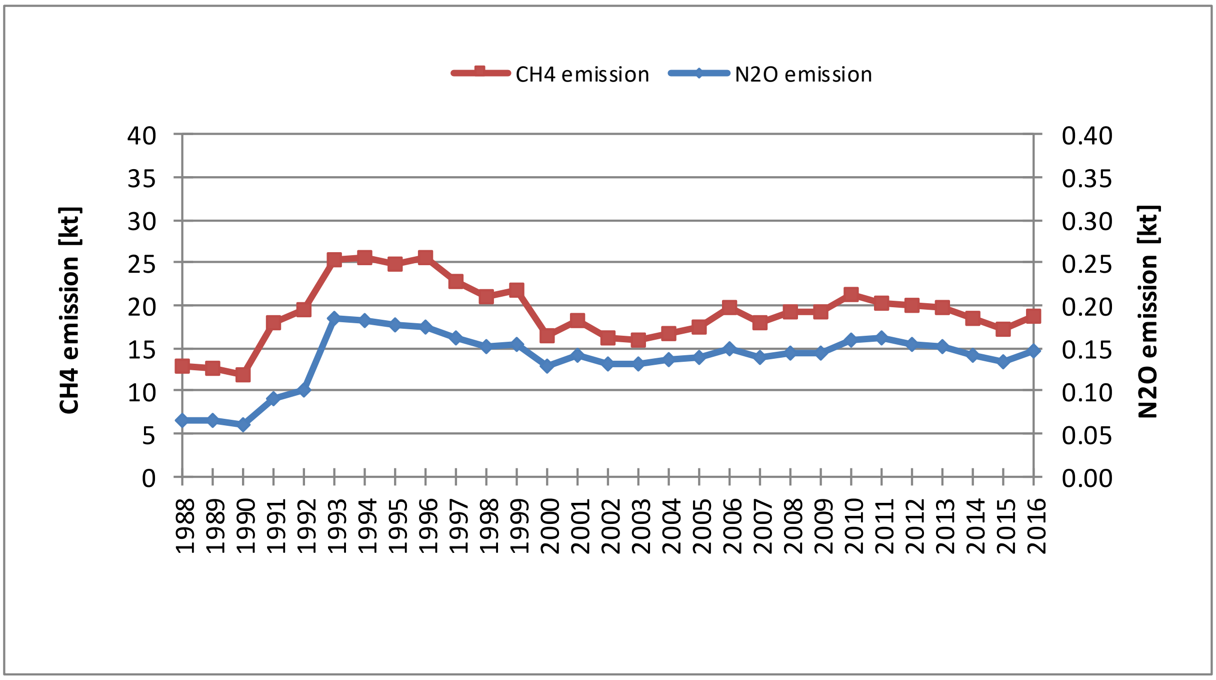

Figure 3.2.9.7. CH_4 and N_2O emissions for stationary sources in 1.A.4.c category in 1988-2016

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 for combustion of municipal waste – biogenic fraction in 1.A.4.a and 1.A.4.c categories for the years 1999-2008 was slightly corrected, so CH_4 and N_2O emissions were amended as well.

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
				CO_2				
kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				CH_4				
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
				N_2O				
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**
				CO_2				
kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				CH_4				
kt	0.000	0.000	0.000	0.002	0.010	0.003	0.003	0.004
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				N_2O				
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	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
				CO_2				
kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				CH_4				
kt	0.004	0.009	0.008	0.009	0.002	0.000	0.000	0.000
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				N_2O				
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	**2012**	**2013**	**2014**	**2015**				
kt	0.00	0.00	0.00	0.00				
%	0.0	0.0	0.0	0.0				
kt	0.000	0.000	0.000	0.000				
%	0.0	0.0	0.0	0.0				
kt	0.000	0.000	0.000	0.000				
%	0.0	0.0	0.0	0.0				

3.2.9.6. Source-specific planned improvements

Analysis of the possibility of country specific EF elaboration for the gaseous fuels.

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.

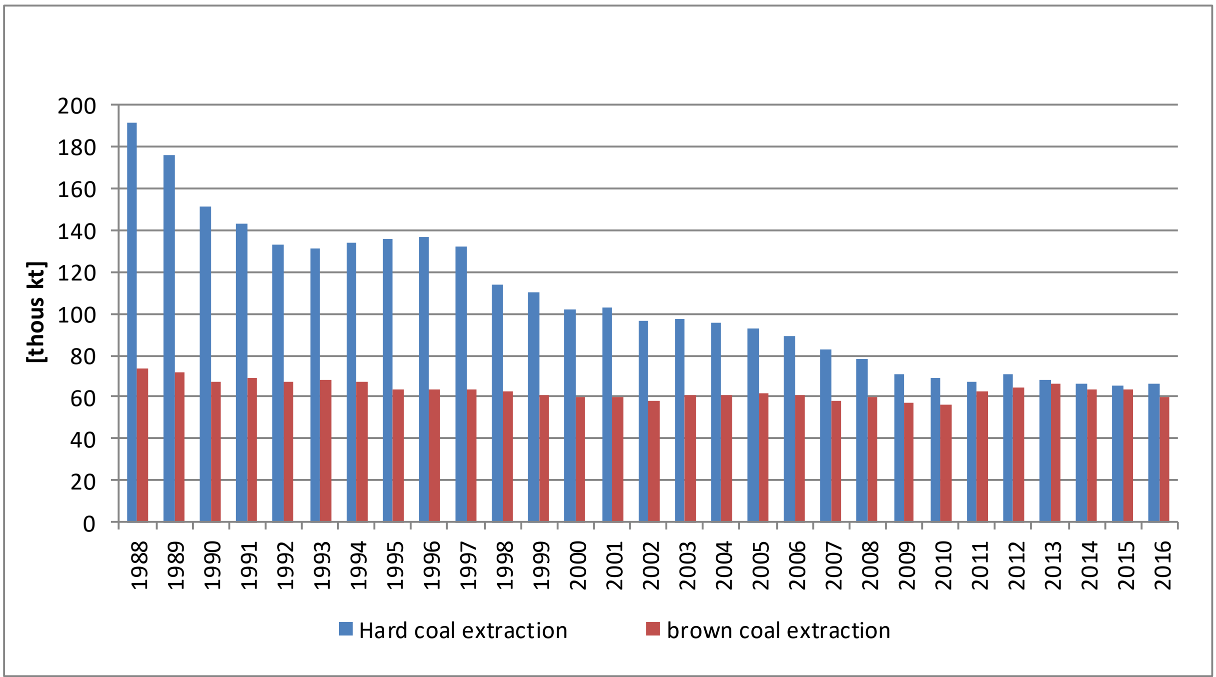

Figure 3.3.1. Hard coal and lignite extraction in 1988-2016

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>

The case study has been developed for estimating methane emission from coal mining "The national methodology for estimating methane emissions from coal mining for reporting to the national inventory of greenhouse gases emissions and removals" (National Centre for Emission Management 2016, in Polish). The results of the study were implemented in the last submission.

Data published by the State Mining Authority, on an annual basis, are used to calculate the amount of methane emitted during coal mining in each year. For 2016, data published in the report "Evaluation of work safety, mine rescue and public safety in connection with the activities of mining and geology in 2016" (http://www.wug.gov.pl/bhp/stan_bhp_w_gornictwie), on methane emission intensity and use (table 9, page 17) were applied to calculate the actual total emissions of methane from coal mines.

Table 3.3.1. Shows data on methane emissions and accompanying data related to coal mining, including the CH_4 implied emission factors for each year, in relation to hard coal extraction, for comparison purposes.

Table 3.3.1. Activity data used to calculate the CH_4 emissions from coal mining

Year	Methane content [mln m³]	Methane use for energy production [mln m³]	CH_4 emmision from underground mining - country specific data base published by State Mining Authority [kt]	Underground coal production [Mg]	Annual CH_4 emision factor [kg/t]	Conversion factor [Gg/10⁶m³]	Implied CH_4 emision factor [m³/t]
	a	b	a-b				
1988	1037.2	207.90	**555.63**	191 624 000	2.90	0.67	**4.33**
1989	1045.73	208.43	**560.99**	175 947 000	3.19	0.67	**4.76**
1990	988.92	188.53	**536.26**	151 321 000	3.54	0.67	**5.29**
1991	829.24	185.10	**431.57**	143 131 000	3.02	0.67	**4.50**
1992	848.09	174.06	**451.60**	132 730 000	3.40	0.67	**5.08**
1993	779.96	167.60	**410.28**	131 400 000	3.12	0.67	**4.66**
1994	764.53	136.30	**420.91**	134 078 000	3.14	0.67	**4.69**
1995	745.31	137.10	**407.50**	135 523 000	3.01	0.67	**4.49**
1996	748.4	147.50	**402.60**	136 272 000	2.95	0.67	**4.41**
1997	748.4	134.40	**411.38**	132 576 000	3.10	0.67	**4.63**
1998	763.3	152.70	**409.10**	113 859 000	3.59	0.67	**5.36**
1999	744.5	136.90	**407.09**	109 986 000	3.70	0.67	**5.52**
2000	746.9	124.00	**417.34**	102 081 000	4.09	0.67	**6.10**
2001	743.7	131.50	**410.17**	102 477 000	4.00	0.67	**5.97**
2002	752.6	122.40	**422.23**	96 160 000	4.39	0.67	**6.55**
2003	798.1	127.80	**449.10**	97 274 000	4.62	0.67	**6.89**
2004	825.9	144.20	**456.74**	95 623 000	4.78	0.67	**7.13**
2005	851.1	144.80	**473.22**	93 006 000	5.09	0.67	**7.59**
2006	870.3	158.30	**477.04**	89 342 000	5.34	0.67	**7.97**
2007	878.9	165.70	**477.84**	82 779 000	5.77	0.67	**8.62**
2008	880.9	156.50	**485.35**	77 989 000	6.22	0.67	**9.29**
2009	855.7	159.50	**466.45**	70 500 000	6.62	0.67	**9.88**
2010	836.4	161.10	**452.45**	69 189 000	6.54	0.67	**9.76**
2011	828.8	166.30	**443.88**	67 637 000	6.56	0.67	**9.79**
2012	828.2	178.60	**435.23**	71 339 000	6.10	0.67	**9.11**
2013	847.8	187.70	**442.27**	68 399 000	6.47	0.67	**9.65**
2014	891.1	211.40	**455.40**	65 969 000	6.90	0.67	**10.30**
2015	933.00	197.10	**493.05**	65 070 000	7.58	0.67	**11.31**
2016	933.80	195.00	**495.00**	66 484 000	7.45	0.67	**11.11**

It should be stressed that the data on emissions are collected and analyzed in a systematic way and they are published according with the law. These data therefore meet the requirements of data quality (QA/QC) arising from IPCC Guidelines in terms of durability and consistency of methodology.

This methodology is in line with Tier 3 approach (Tier 3 approach) of the IPCC Guidelines (2006), because it is based on direct measurements and calculations fugitive emissions from coal mines. Fugitive emission of CH_4 from post-mining was estimated based on the activity data concerning hard coal extraction amount from the study published by Polish Geological Institute [PIG] and emission factors presented in table 3.3.2. have been taken from IPCC 2006.

Table 3.3.2. CH_4 Emission factor for calculation post-mining emission from coal mines

CH_4 emission factor	
Post - Mining	2.50 [m^3CH_4/t; IPCC 2006, page 4.12]

Tier 1 method was used for calculation of fugitive emissions from abandoned underground mines (1.B.1.iii.) [IPCC 2006, page 4.21 equation 4.1.9.] Fugitive emission of CH_4 from mine closure was estimated based on number of abandoned underground mines provided by State Mining Authority [SMA] and emission factors from IPCC 2006 – table 4.1.5. 4.1.6. and 4.1.7.

Table 3.3.3 shows data on number of closed coal mines, emission factor used and total emission from abandoned underground mines, in 1988-2016.

Table 3.3.3. Activity data on number of closed coal mines. emission factors and total emission from abandoned underground mines, in 1988-2016

Inventory year	Number of closed mines per time brand 1976-2000	Emission factor - for interval of mine closure [mln m³/ mine]	Number of closed mines per time brand 2001 presend	Emission factor - for interval of mine closure [mln m³/ mine]	Fraction of gassy mines	Conversion factor	Total emission from closed mines [Gg CH_4]
1988	0	1.561	0	NA	1.00	0.67	0
1989	0	1.561	0	NA	1.00	0.67	0
1990	0	1.561	0	NA	1.00	0.67	0
1991	0	1.334	0	NA	1.00	0.67	0
1992	0	1.83	0	NA	1.00	0.67	0
1993	0	1.072	0	NA	1.00	0.67	0
1994	0	0.988	0	NA	1.00	0.67	0
1995	1	0.921	0	NA	1.00	0.67	0.62
1996	2	0.865	0	NA	1.00	0.67	1.16
1997	3	0.818	0	NA	1.00	0.67	1.64
1998	4	0.778	0	NA	1.00	0.67	2.09
1999	4	0.743	0	NA	1.00	0.67	1.99
2000	10	0.713	0	NA	1.00	0.67	4.78
2001	10	0.686	17	5.735	1.00	0.67	103.75
2002	10	0.661	22	2.397	1.00	0.67	51.39
2003	10	0.639	22	1.762	1.00	0.67	37.78
2004	10	0.620	23	1.454	1.00	0.67	32.15
2005	10	0.601	23	1.265	1.00	0.67	27.97
2006	10	0.585	23	1.133	1.00	0.67	25.05
2007	10	0.569	23	1.035	1.00	0.67	22.88
2008	10	0.555	23	0.959	1.00	0.67	21.20
2009	10	0.542	23	0.896	1.00	0.67	19.81
2010	10	0.529	23	0.845	1.00	0.67	18.68
2011	10	0.518	23	0.801	1.00	0.67	17.71
2012	10	0.507	23	0.763	1.00	0.67	16.87
2013	10	0.496	23	0.73	1.00	0.67	16.14
2014	10	0.487	23	0.701	1.00	0.67	15.50
2015	10	0.478	23	0.675	1.00	0.67	14.92
2016	10	0.469	23	0.652	1.00	0.67	14.42

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

Tier 1 method was used for calculation of fugitive emissions from surface mining and post-mining [IPCC 2006, page 4.18-4.19]. Fugitive emission of CH_4 from surface mining and post-mining was estimated based on the activity data concerning lignite extraction amount from the study published by Polish Geological Institute [PIG (2016)] and emission factors from IPCC 2006 (table 3.3.4.).

Table 3.3.4. CH_4 Emission factor for calculation mining and post-mining emission from surface coal mining

CH_4 emission factor	
Mining	1.20 [m^3CH_4/t; IPCC 2006, page 4.18]
Post - Mining	0.1 [m^3CH_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 3.3.5 data is shown on lignite extraction and total related methane emissions in 1988-2016.

Table 3.3.5. Lignite extraction and total methane emissions from lignite mines in 1988-2016

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
2014	64 002 000	55.75
2015	63 135 000	54.99
2016	60 273 000	52.50

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 1990-2016 was estimated based on carbon budgets in the coking plants (tab. 3.3.6). Data concerning input and output are based on [Eurostat] and [GUS 1991a-2016a]. Coke productions for 1990-2016 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. 3.3.6) 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.

Table 3.3.6. Carbon balance for coke production in years 1988-2016

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
INPUT [TJ]														
Coking coal	**656 592**	**637 742**	**535 538**	**448 105**	**437 665**	**405 168**	**436 596**	**451 761**	**403 902**	**423 800**	**377 787**	**338 208**	**366 814**	362 343
High Methane Natural Gas	0	1239	0	0	0	0	0	0	0	0	0	0	0	0
Coke			969	542	1767	1568	2394	2337	1824	1682	2109	1482	2024	1 054
Blast furnace gas	0	152	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
Industrial waste	7	0	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	29.53
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	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	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	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	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	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	39.0
INPUT – Carbon contents in charge components [kt]														
Coking coal	17 087.6	16 597.0	13 937.2	11 661.8	11 390.1	10 544.3	11 378.1	11 757.8	10 512.1	11 028.5	9 829.9	8 800.9	9 543.2	9 428.2
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	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	31.1
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	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	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	0.0
Carbon contents in charge – SUM [kt]	**17 087.8**	**16 626.0**	**13 965.7**	**11 677.7**	**11 442.2**	**10 590.6**	**11 448.7**	**11 826.7**	**10 565.9**	**11 078.2**	**9 892.1**	**8 844.6**	**9 602.9**	**9 459.3**
OUTPUT [TJ]														
Coke	**471 501.8**	**455 831.8**	385 206.0	323 646.0	315 381.0	292 838.0	326 468.0	329 973.0	294 662.0	300 248.0	277 761.0	238 488.0	255 702.0	254 961.0
Coke-Oven Gas	**118 914.6**	**117 040.4**	9 6832.0	84 743.0	82 307.0	75 753.0	84 002.0	84 767.0	76 036.0	79 286.0	73 457.0	62 989.0	68 849.0	69 008.0
Tar	27 580.0	27 429.3	22 885.3	20 268.2	20 648.1	19 071.4	21 146.6	21 265.0	19 831.9	19 600.4	17 949.6	16 264.8	17 003.0	17 232.6
Benzol	7 701.5	7 230.9	6 166.9	5 150.7	5 646.2	5 159.1	6 010.6	6 056.5	5 446.7	5 428.6	4 856.9	4 524.7	2 498.5	4 788.6
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	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	13.0
Tar	22	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	23
OUTPUT – Carbon content in products [kt]														
Coke	13 909.3	13 447.0	11 363.6	9 547.6	9 303.7	8 638.7	9 630.8	9 734.2	8 692.5	8 857.3	8 193.9	7 035.4	7 543.2	7 521.3
Coke-Oven Gas	1 545.9	1 521.5	1 258.8	1 101.7	1 070.0	984.8	1 092.0	1 102.0	988.5	1030.7	954.9	818.9	895.0	897.1
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	379.1
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	110.1
Carbon content in products – SUM [kt]	**16 239.1**	**15 738.3**	**13 267.7**	**11 213.6**	**10 957.9**	**10 161.7**	**11 326.3**	**11 443.3**	**10242.6**	**10444.1**	**9 655.5**	**8 316.1**	**8 869.8**	**8 907.7**
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**	**551.6**
CO_2 process emission[kt]	**3 112.1**	**3 254.8**	**2 559.5**	**1 701.9**	**1 775.9**	**1 572.4**	**448.8**	**1 405.9**	**1 185.5**	**2324.9**	**867.5**	**1 937.6**	**2 688.3**	**2 022.5**
Coke output [kt]	17 007	16 499	13 516	11 356	11 066	10 275	11 455	11 578	10 339	10 535	9 746	8 368	8 972	8 946
EF [kg CO_2/Mg of coke]	**183**	**197**	**189**	**150**	**160**	**153**	**39**	**121**	**115**	**221**	**89**	**232**	**300**	**226**

Table 3.3.6. (cont.) Carbon balance for coke production in years 1988-2016

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
INPUT [TJ]														
Coking coal	353 752	410 854	400 604	332 566	380 135	402 391	389 792	274 662	381 938	364 348	350 150	371 333	375 885	382 750
High Methane Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coke	1 710	1 568	1 710	2 138	2 366	2 650	3 050	1 938	3 021	2 964	2 366	1 710	1 938	2 622
Blast furnace gas	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
Industrial waste	0	0	0	0	0	0	0	0	3.5	0	0	0	0	0
NCV [MJ/kg]														
Coking coal	29.53	29.56	29.18	29.23	29.37	29.50	29.57	29.56	29.49	29.52	29.60	29.59	29.55	29.54
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	26.0	26.0	26.0	26.0	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	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	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	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	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	39.0
INPUT – Carbon contents in charge components [kt]														
Coking coal	9 204.6	10 689.9	10 429.2	8 657.1	9 893.5	10 470.6	10 141.8	7 146.4	9 938.6	9 480.5	9 110.0	9 661.2	9 779.6	9 958.2
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	0.0
Coke	50.4	46.3	50.4	63.1	69.8	78.2	90.0	57.2	89.1	87.4	69.8	50.4	57.2	77.3
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	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	0.0
Industrial waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Carbon contents in charge – SUM [kt]	**9 255.1**	**10 736.2**	10 479.6	8 720.2	9 963.3	10 548.8	10 231.8	7 203.6	10 027.8	9 567.9	9 179.8	9 711.6	9 836.8	10 035.6
OUTPUT [TJ]														
Coke	248 606.0	288 192.0	287 764.0	239 514.0	273 970.0	289 788.0	287 138.0	202 094.0	280 554.0	267 244.0	253 450.0	266 760.0	272 688.0	279 072.0
Coke-Oven Gas	65 570.0	75 091.0	72 947.0	61 947.0	71 712.0	76 950.0	73 935.0	53 376.0	73 008.0	69 440.0	65 321.0	68 844.0	69 754.0	71 337.0
Tar	16 462.6	18 188.1	17 417.0	14 590.0	16 211.0	17 342.0	15 721.0	11 838.0	16 475.0	15 268.0	14 175.0	14 854.0	14 477.0	14 251.0
Benzol	4 474.8	5 253.3	5 358.3	4 403.2	3 803.7	5 315.6	4 711.9	3 373.4	4 892.6	4 518.8	4 125.1	4 465.4	4 455.9	4 548.2
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	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	13.0
Tar	22	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	23
OUTPUT – Carbon content in products [kt]														
Coke	7 333.88	8 501.66	8 489.04	7 065.66	8 082.12	8 548.75	8 470.57	5 961.77	8 276.34	7 883.70	7 476.78	7 869.42	8 044.30	8 232.62
Coke-Oven Gas	852.41	976.18	948.31	805.31	932.26	1 000.35	961.16	693.89	949.10	902.72	849.17	894.97	906.80	927.38
Tar	362.18	400.14	383.17	320.98	356.64	381.52	345.86	260.44	362.45	335.90	311.85	326.79	318.49	313.52
Benzol	102.92	120.83	123.24	101.27	87.49	122.26	108.37	77.59	112.53	103.93	94.88	102.70	102.49	104.61
Carbon content in products – SUM [kt]	8 651.38	9 998.81	9 943.76	8 293.23	9 458.50	10 052.88	9 885.96	6 993.69	9 700.43	9 226.25	8 732.68	9 193.88	9 372.08	9 578.14
C process emission[kt]	603.67	737.39	535.86	426.98	504.79	495.91	345.80	209.88	327.41	341.64	447.07	517.75	464.71	457.45
CO_2 process emission[kt]	2 213.44	2 703.76	1 964.80	1 565.60	1 850.91	1 818.35	1 267.93	769.57	1 200.52	1 252.69	1 639.27	1 898.42	1 703.95	1 677.30
Coke output [kt]	8 723.00	10 112.00	10 097.00	8 404.00	9 613.00	10 168.00	10 075.00	7 091.00	9 844.00	9 377.00	8 893.00	9 360.00	9 568.00	9 792.00
EF [kg CO_2/Mg of coke]	254	267	195	186	193	179	126	109	122	134	184	203	178	171

Table 3.3.6. (cont.) Carbon balance for coke production in years 1988-2016

	2016
INPUT [TJ]	
Coking coal	378 568
High Methane Natural Gas	0
Coke	2 337
Blast furnace gas	0
Tar	0
Industrial waste	0
NCV [MJ/kg]	
Coking coal	29.54
INPUT – Material-specific carbon content [kg C/GJ]	
Coking coal	26.02
High Methane Natural Gas	15.3
Coke	29.5
Blast furnace gas	66.0
Tar	22.0
Industrial waste	39.0
INPUT – Carbon contents in charge components [kt]	
Coking coal	9 849.4
High Methane Natural Gas	0.0
Coke	77.35
Blast furnace gas	0.0
Tar	0.0
Industrial waste	0.0
Carbon contents in charge – SUM [kt]	9 918.36
OUTPUT [TJ]	
Coke	272 090.8
Coke-Oven Gas	70 472.6
Tar	14 439.8
Benzol	4 334.2
OUTPUT – Material-specific carbon content [kg C/GJ]	
Coke	29.5
Coke-Oven Gas	13.0
Tar	22
Benzol	23
OUTPUT – Carbon content in products [kt]	
Coke	8 026.68
Coke-Oven Gas	916.14
Tar	317.68
Benzol	99.69
Carbon content in products – SUM [kt]	9 360.18
C process emission[kt]	558.17
CO_2 process emission[kt]	2 046.64
Coke output [kt]	9 717.53
EF [kg CO_2/Mg of coke]	210

CH_4 emission in the period 1990-2016 was estimated based on coke production volume from [Eurostat] while for 1988 and 1989 from [IEA]. For the entire period emission factor is as 0.1 g CH_4/Mg coke produced [IPCC 2006 chapter 4, table 4.2. page 4.26] was applied.

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 3.3.7. have been taken from domestic case study [Steczko 1994]. Activity data for 1990-2016 come from [EUROSTAT]. For years: 1988-1989 the activity data come from [IEA] database.

Table 3.3.7. Emission factors for CO_2 and CH_4 from coke oven gas system (country specific EF)

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

Not done.

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]. For years: 1988-1989 the activity data come from [IEA] database, for 1990-2016 come from Eurostat (table 3.3.9).

Table 3.3.9. Activity data for emission from oil system

Year	Production [kJ]	Production [kt]	Transport [kt]	Import [kt]	Input to oil refineries [PJ]
1988	6.58	155.5	14 781.4	14 625.9	618.7
1989	6.48	153.2	14 521.0	14 367.8	628.4
1990	6.59	178.0	13 307.0	13 129.0	528.8
1991	6.45	173.0	11 721.0	11 548.0	478.3
1992	7.98	218.0	13 396.0	13 178.0	524.7
1993	9.49	256.0	14 196.0	13 940.0	540.0
1994	10.97	326.0	13 739.0	13 413.0	519.3
1995	11.28	365.0	14 424.0	14 059.0	519.1
1996	12.70	394.0	15 379.0	14 985.0	585.0
1997	11.92	370.0	15 485.0	15 115.0	613.7
1998	14.88	422.0	16 164.0	15 742.0	662.3
1999	18.03	519.0	17 146.0	16 627.0	694.7
2000	26.55	711.0	18 971.0	18 260.0	743.0
2001	31.64	829.0	18 736.0	17 907.0	740.9
2002	29.72	784.0	18 861.0	18 077.0	726.1
2003	32.60	776.0	18 433.0	17 657.0	743.9
2004	37.34	916.0	18 595.0	17 679.0	763.5
2005	35.18	899.0	19 182.0	18 283.0	753.7
2006	32.86	799.0	21 492.0	20 693.0	827.5
2007	30.30	724.0	22 698.0	21 974.0	845.2
2008	31.16	776.0	22 557.0	21 781.0	858.7
2009	28.79	692.0	22 161.0	21 469.0	850.9
2010	28.51	739.0	24 083.0	23 344.0	948.1
2011	25.26	674.0	25 035.0	24 361.0	982.7
2012	27.79	691.0	25 526.0	24 835.0	1 026.4
2013	39.74	963.0	24 435.0	23 472.0	1 004.0
2014	39.03	951.0	24 819.0	23 868.0	993.0
2015	38.28	929.0	27 558.0	26 629.0	1 078.3
2016	42.55	1001.1	25 574.2	24 573.0	1 096.0

CO_2 and CH_4 factors used for estimation of emissions from oil production have been taken from from IPCC 2006.

Table 3.3.10. Emission factors for CO_2 and CH_4 from oil production

Oil system	Emission factors	Source
CO_2		
Oil production - offshore [kt/m^3]	0.000043	IPCC 2006 page 4.50 table 4.2.4.
Oil production - onshore [kt/ m^3]	0.26	IPCC 2006 page 4.50 table 4.2.4.
Oil transmission [kt/m^3]	0.00049	IPCC 2006 page 4.52 table 4.2.4.
CH_4		
Oil production - offshore [kt/m^3]	0.00059	IPCC 2006 page 4.50 table 4.2.4.
Oil production - onshore [kt/m^3]	3.6	IPCC 2006 page 4.50 table 4.2.4.
Transmission [kt/m^3]	0.0054	IPCC 2006 page 4.52 table 4.2.4.
Refining [kt/m^3]	0.0410	IPCC 2006 page 4.53 table 4.2.4.

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 1990-2016 come from [EUROSTAT]. For years 1988-1989 activity data come from [IEA] database. Activity data are given in table 3.3.11.

Table 3.3.11. Activities for natural gas system [TJ]

Year	Production [TJ]	Total consumption [TJ]
1988	156.6	350.7
1989	145.0	343.0
1990	99.6	374.2
1991	111.3	348.9
1992	107.2	325.0
1993	136.9	341.4
1994	129.8	344.0
1995	132.7	376.6
1996	131.5	395.5
1997	134.2	394.3
1998	136.0	398.3
1999	129.9	387.8
2000	138.7	417.0
2001	146.2	434.4
2002	149.4	423.4
2003	151.2	471.5
2004	164.4	497.4
2005	162.6	512.2
2006	162.5	526.8
2007	163.1	523.1
2008	154.5	526.1
2009	154.0	505.0
2010	154.6	536.1
2011	161.2	537.4
2012	163.6	572.8
2013	160.1	575.1
2014	156.0	561.2
2015	154.2	576.8
2016	148.7	612.7

Emission factors gas system for production, processing, transmission, underground storage and distribution was taken from IPCC 2006. Emission factor listed in table 3.3.12.

Table 3.3.12. Emission factors for CO_2 and CH_4 from natural gas system [IPCC 2006, table 4.2.4]

Emission factors [kt/10⁶m³]	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

* Other Leakage - are included to underground storage of gas

Emissions associated with the exploitation of the gas storage.

Polish gas system (high-methane gas system) has four underground gas storage tanks gas with a total capacity of 0.6 billion m^3. The emission includes:

- Emissions from leaks from heads exploiting operating holes
- Emissions from pneumatic devices
- Emissions from gas compressor station
- Emissions from repair and maintenance
- Emissions from breakdown [country study: Steczko 2003]

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 page 4.51. table 4.2.4.].

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 2017]. These values amounted to: 1 771.43 kt for 2016, 1789.1 kt for 2015, 1545.68 kt for 2014, 1701.7 kt 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 page 4.48. table 4.2.4.].

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 EF from 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

Not done.

3.3.2.6. Source-specific planned improvements

No improvements are planned at the moment.

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

4.1. Source category description

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

IPCC Source Categories	GHG	Identification criteria (Level, Trend, Qualitative)		
2.A.1 Cement Production	CO_2	L	T	
2.A.2 Lime Production	CO_2		T	
2.A.4 Other Process Uses of Carbonates	CO_2	L	T	
2.B.1 Ammonia Production	CO_2	L	T	
2.B.2 Nitric Acid Production	N_2O		T	
2.C.1 Iron and Steel Production	CO_2	L	T	
2.F.1 Refrigeration and Air conditioning	F-gases	L	T	

Share of these subcategories in total Poland's GHG emissions amounts ca. 6.24%.

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

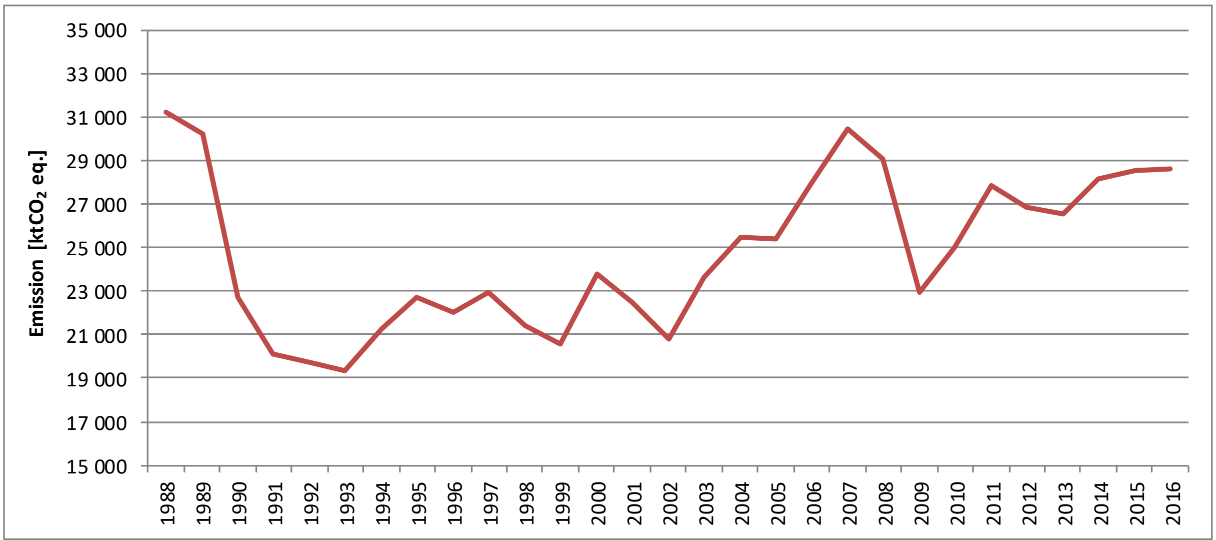

Figure 4.1.1. Emission trend in *Industrial processes and product use* sector in period 1988-2016

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

- 2.A *Mineral industry,*
- 2.B *Chemical industry,*
- 2.C *Metal industry,*
- 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 2016 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 industry*: 2.A.1 *Cement Production*, 2.A.4.a *Other process uses of carbonates – ceramics,*
- 2.C *Metal industry*: 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 1988-2016 are shown in figure 4.1.2

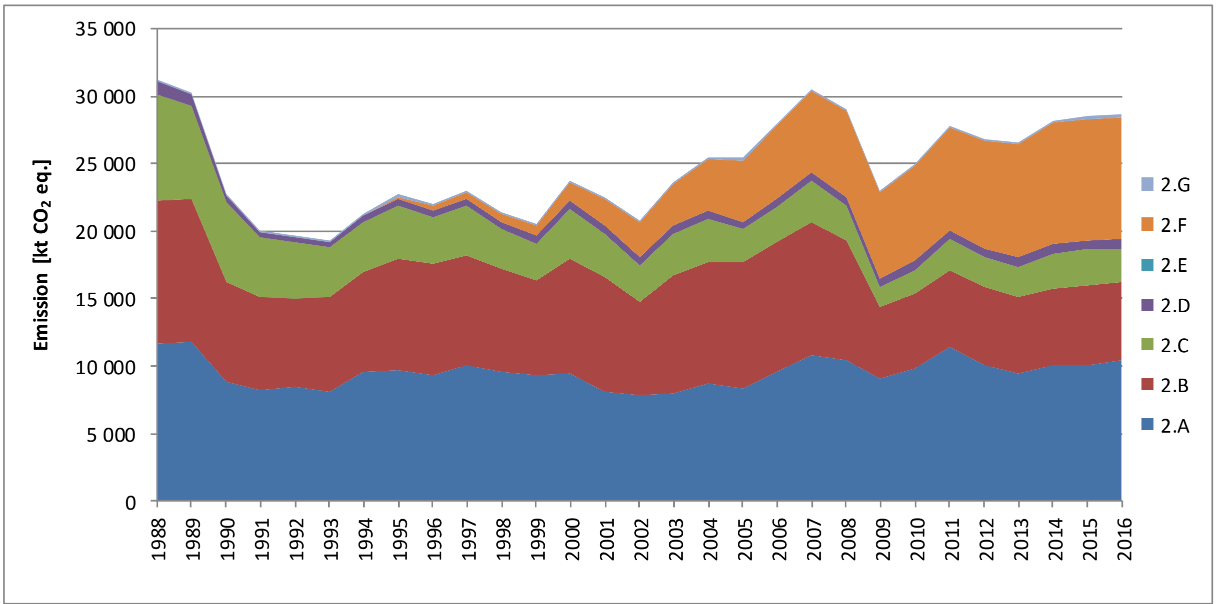

Figure 4.1.2. GHG emissions from *Industrial processes and product use* in 1988-2016 according to subcategories

4.2. Mineral industry (CRF sector 2.A)

4.2.1. Source category description

Estimation of emissions in 2.A *Mineral industry* 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) – 62.82% in 2016.

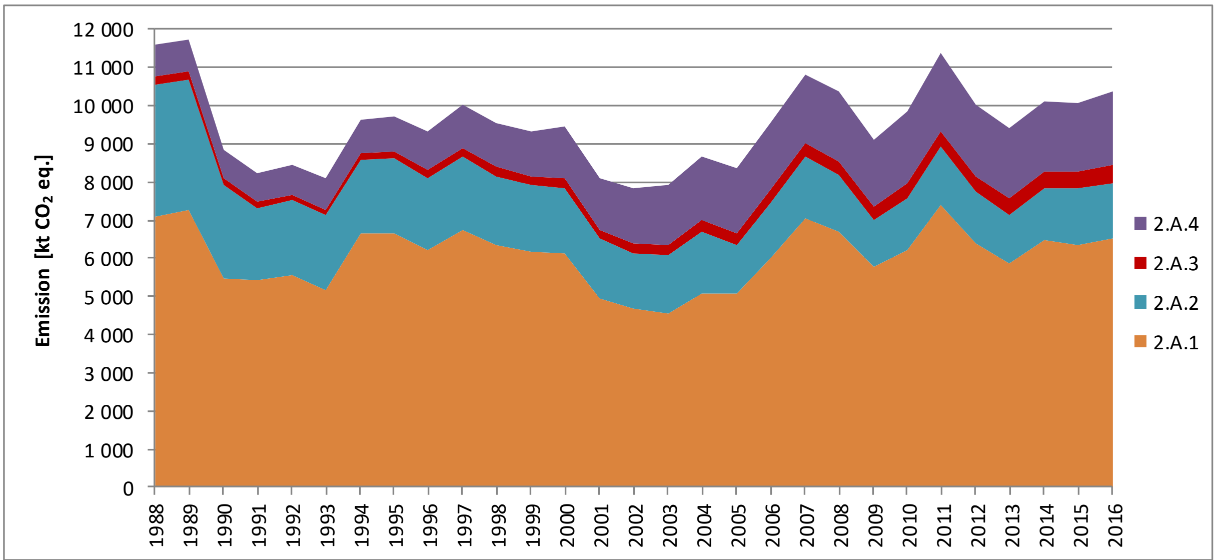

Figure 4.2.1. Emissions from *Mineral industry* sector in years 1988-2016 according to subcategories

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 2016 for installation of clinker production, which participate in the EU ETS [KOBiZE 2017]. This emission was estimated as 6529.7 kt CO_2. Data on clinker production was taken from [GUS 2017b].

The clinker production in the period 1988-2016 is shown on figure 4.2.2. Data on clinker production for the entire inventoried period was taken from [GUS 1989b-2017b].

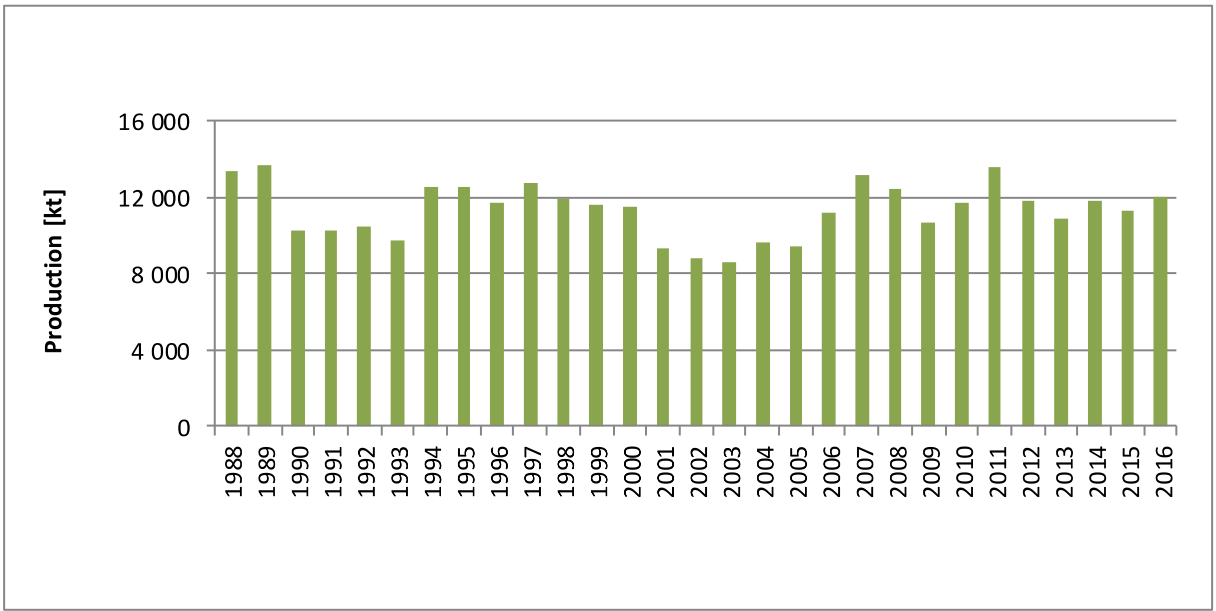

Figure 4.2.2. Clinker production in 1988-2016

Process emission of CO_2 from clinker production was taken from the EU-ETS verified reports for the years: 2005-2016. For earlier 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 for the period 1988-2004 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). Country specific EFs as listed above come from elaboration [IMMB 2006]. Cited report includes emission data for period 1988-2004 but only emission calculation for 2001-2004 was based on country specific data (chemical analysis of clinker, kiln input etc.). The CO_2 emission for the years 1988-2000 was estimated in cited reports based on default calcination factor (525 kg CO2 /tonne clinker) because of lack of adequate country specific data. For this reason Poland uses average EFs value for 2001-2004 as CS EF for the period before 2001 in the inventory.
  Re-attempts to obtain data for calculation of national indicators for clinker production for the years 1988-2000 (in response to the review recommendations) have confirmed that full information needed for that estimation is not available. The difficulty in gathering the necessary information results mainly from the fact that some plants operating in the period 1988-2000 no longer exist. Therefore historical data on input components for cement production process collected currently could be incomplete and unrepresentative. Additionally, Polish Cement Association and the main author of the study [IMMB 2006] confirmed that the data for the 1988-2004 analysis purpose was obtained directly from the cement plants. Wherein clinker production installations provided the best available data for that study.
- for years: 2001-2004 – country specific factors (given above) from [IMMB 2006].

As already mentioned, since 2005 CO_2 process emission from clinker production in GHG inventory corresponds to the sums of emissions provided in the EU-ETS verified reports, due to the fact that all installations for clinker production participate in EU-ETS.

Emissions of CO_2 for installations covered by the EU ETS are estimated for 2013-2016 following the *Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council* (Annex IV section 9). For the earlier years the emission in ETS reports was estimated based on *Ordinance of the Minister of Environment of 12 September 2008 on the way of monitoring of emission amounts of substances covered by the Community Emission Trading Scheme* (Dz. U. Nr 183, poz. 1142).

The ordinance transposes to the Polish law the UE Monitoring and Reporting Guidelines for ETS (Commission Decision 2007/589/EC). Methods applied for CO_2 process emission estimation from clinker production in the EU-ETS are described in ANNEX VII of mentioned EC Decision: *Activity-specific guidelines for installations for the production of cement clinker as listed in Annex I to Directive 2003/87/EC.*

Verification process is one of the most important parts of EU ETS. Each annual emission report prepared by operator is verified (reviewed) by independent verifier. Verification process includes in-site visit and checking if report is in line with installation monitoring plan (approved by Competent Authority – it might by regional or central depends on Member State approach) and Monitoring and Reporting Guidelines (official EU legislation - Commission Decision 2007/589/EC). During verification process of annual emission report verifier checks:

- If permit with complete monitoring plan is updated and validated by Competent Authority;
- list of emission sources;
- types and amount of fuel used in reporting year (with control over measurements instruments – like calibration of meters etc.);
- tiers with uncertainty levels for each emission source and each part of calculation;
- appropriate usage of worldwide/national net caloric values, emission factors and oxidation factors;
- accreditation and standards used in laboratories;
- sampling methodology and frequency;
- control and management of data;
- CEMS technology and meters (if used);
- CO_2 exported outside of the installation (as a part of a fuel or as a product).

After verification process is over verifier issue verification opinion (positive, positive with minor misstatements or negative) with information about action undertake during verification and with precise information about mistakes that he found (if any). Both report and opinion are send to central Competent Authority (in case of Poland – KOBiZE) where they are once again checked (calculation, tiers used etc.) by qualified unit before emission data is uploaded into National Registry. Only reports with positive opinion are accepted.

Each Member State have one or more Accreditation Body that are responsible for accreditation process of Verifiers. Before verifier receive his accreditation he must prove that he have enough experience and knowledge in audit and EU ETS field. Most of EU Accreditation Bodies are organized into European Co-operation for Accreditation and work very closely with each other. They publish standard book for accreditation and verification process (EA document for recognition of Verifiers under EU ETS Directive - http://www.european-accreditation.org) with detailed information about competences of verifiers and with precise information how verification process should look like (with mandatory steps and outcomes).

According to Commission Decision 2007/589/EC there was no obligation to provide information concerning production. Production amounts from installations covered by EU ETS were additionally collected in Poland in accordance with *Ordinance of the Minister of Environment of 12 September 2008 on the way of monitoring of emission amounts of substances covered by the Community Emission Trading Scheme* (Dz. U. Nr 183, poz. 1142).

Data on clinker production provided in ETS reports are comparable to data collected by GUS (differences in production values between GUS data and data based on ETS reports are mostly below 1%).

CO_2 emissions from clinker production in period 1988-2016 are shown in the figure 4.2.3.

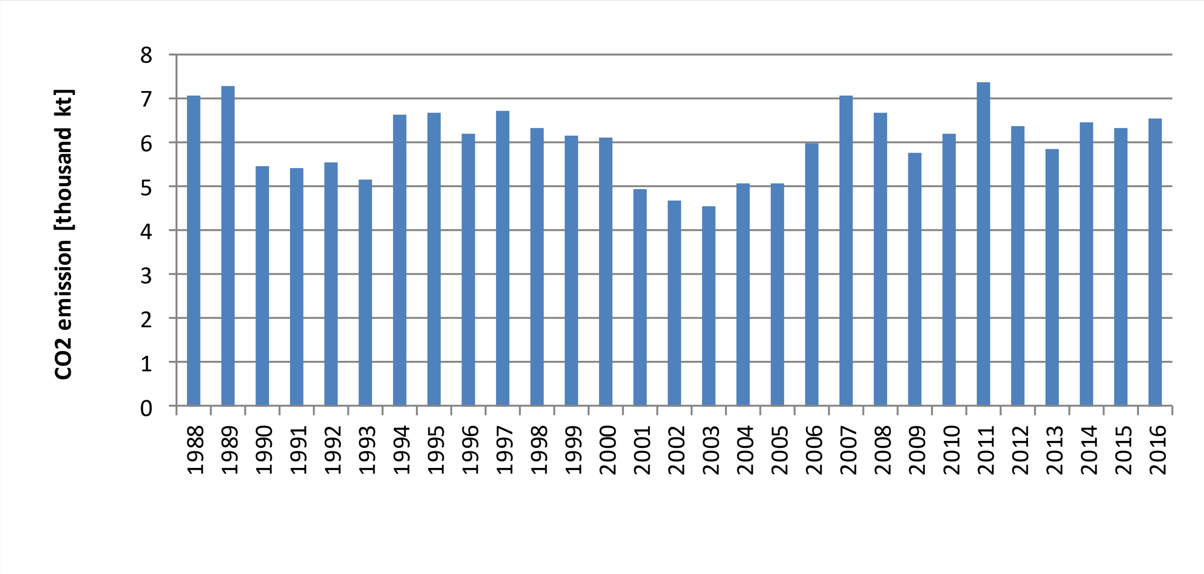

Figure 4.2.3. CO_2 process emission for clinker production in 1988-2016

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 [GUS 1989b-2017b]. 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.

According to information from lime production sector vertical shaft kilns are used in lime production in Poland. This type of kilns generate small amounts of LKD, and it is judged that correction factor for LKD would be negligible and do not need to be estimated (2006 IPCC GLs, Vol. 3, p. 2.24).

The figure 4.2.4 presents data concerning lime production (including dolomite lime) for the entire period. CO_2 emissions in period 1988-2016 are shown in the figure 4.2.5.

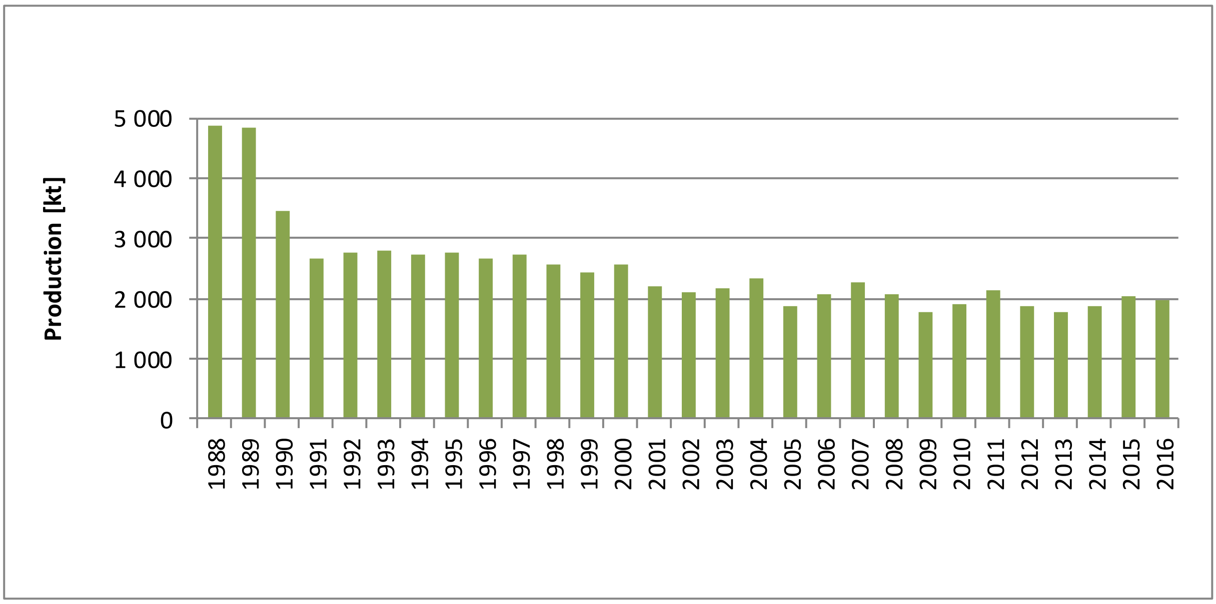

Figure 4.2.4. Lime (including dolomite lime) production in 1988-2016

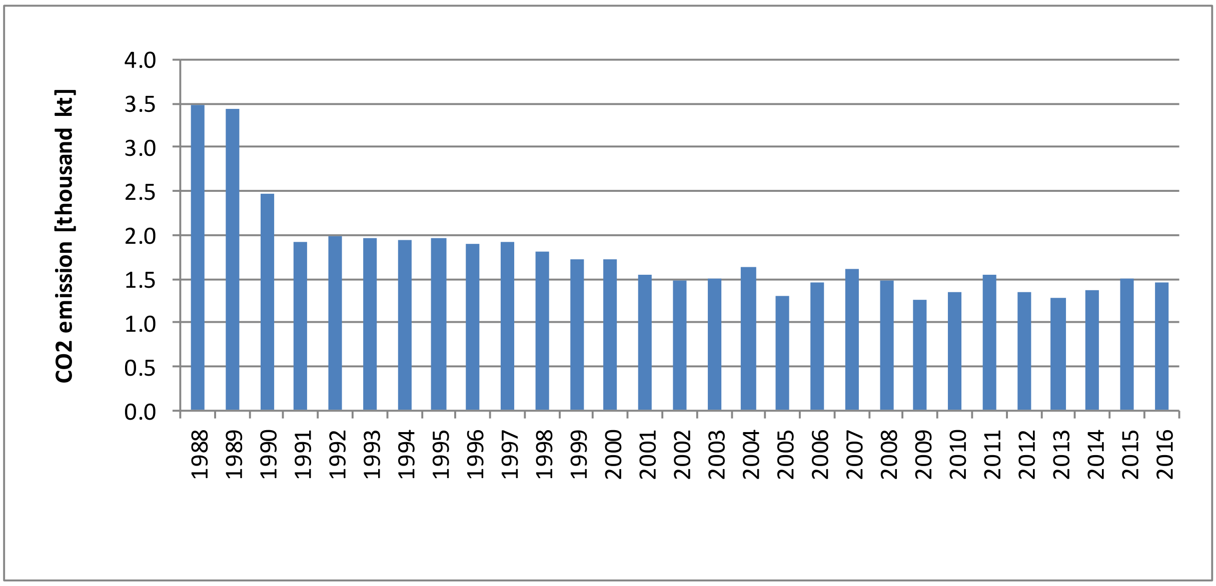

Figure 4.2.5. CO_2 process emission for lime production in 1988-2016

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 0.2 tonnes CO_2/tonne glass was applied for emission estimation in entire period, according to IPCC 2006 GLs – equation 2.13 p. 2.29. In accordance with information obtained from glass production sector, cullet ratio of 20% was assumed.

Glass production and CO_2 emission values from that process in period 1988-2016 are shown in the figures 4.2.6 and 4.2.7 respectively.

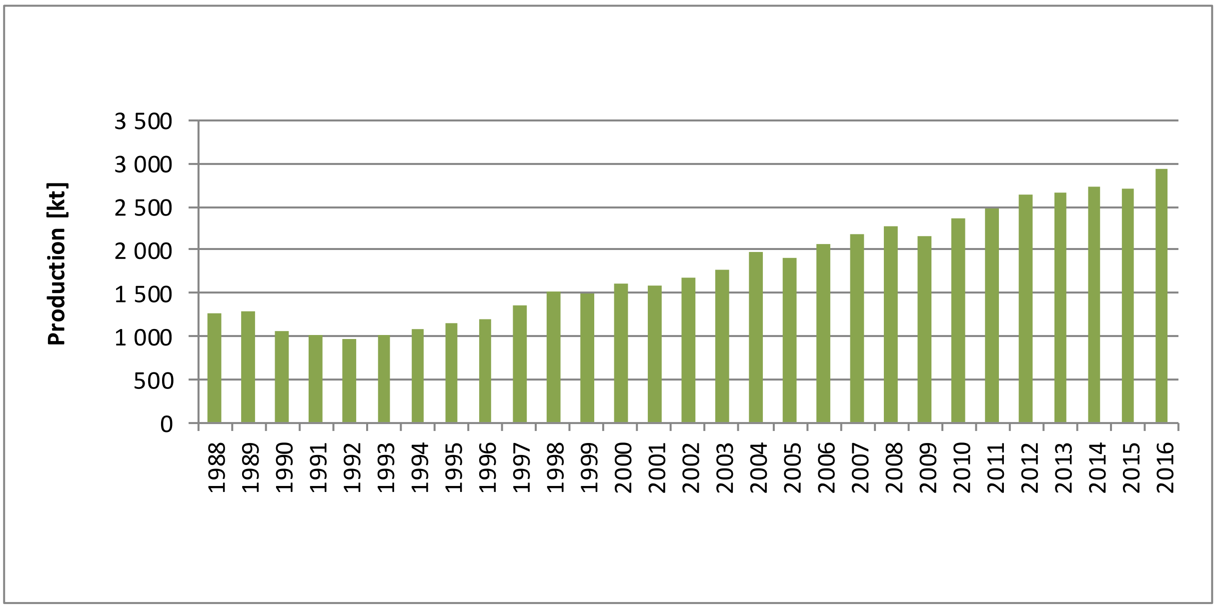

Figure 4.2.6. Glass production in 1988-2016

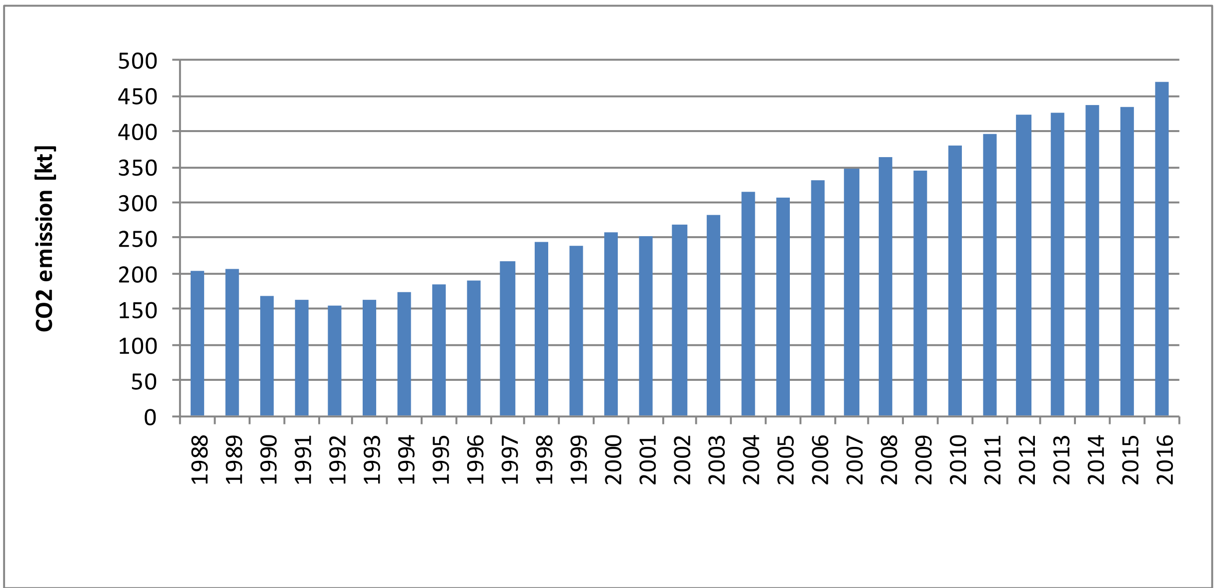

Figure 4.2.7. CO_2 process emission for glass production in 1988-2016

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

This category includes CO_2 emission from sources as follows:

- ceramics
- other uses of soda ash
- non-metallurgical magnesium production
- 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 2005-2016 was grounded on the verified reports for ceramic installation covered by EU ETS [KOBiZE 2017].

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

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
56.69	48.20	54.30	53.88	48.52	51.44	48.77	49.41	49.86	43.52	50.99	51.95

For the years before 2005 average value of EFs from 2005-2013, amounted to 51.23 kg CO_2/t of ceramics, was applied. CO_2 emission values in 2.A.4.a subcategories for entire period 1988-2016 were presented in the figure 4.2.9.

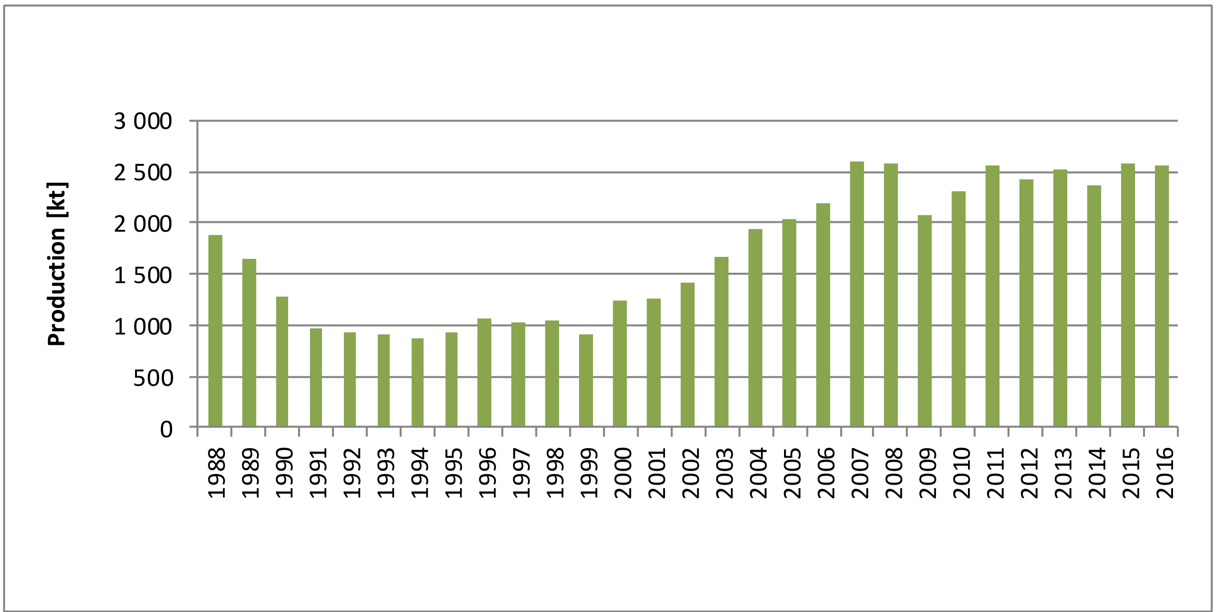

Figure 4.2.8. Ceramic production in 1988-2016

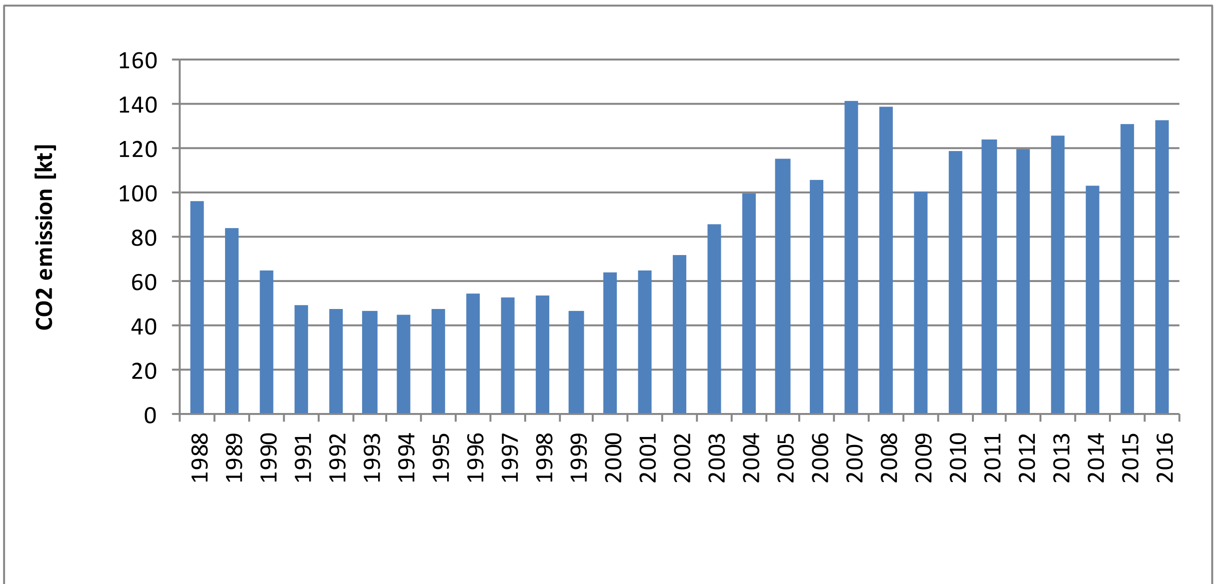

Figure 4.2.9. CO_2 process emission from ceramics in 1988-2016

2.A.4.b. Other uses of soda ash

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 2016* [GUS 2017f]. 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 414.92 kg CO_2/t of soda ash used was applied for inventory calculation for the entire period (EF was taken from IPCC 2006 GLs, tab. 2.1. p. 2.7).

CO_2 emission for the years 1992-2016 was estimated based on data concerning soda ash consumption taken from *Materials Management* [GUS 1994f-2017f]. 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 1993e-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 1988-2016, were presented in the figure 4.2.10.

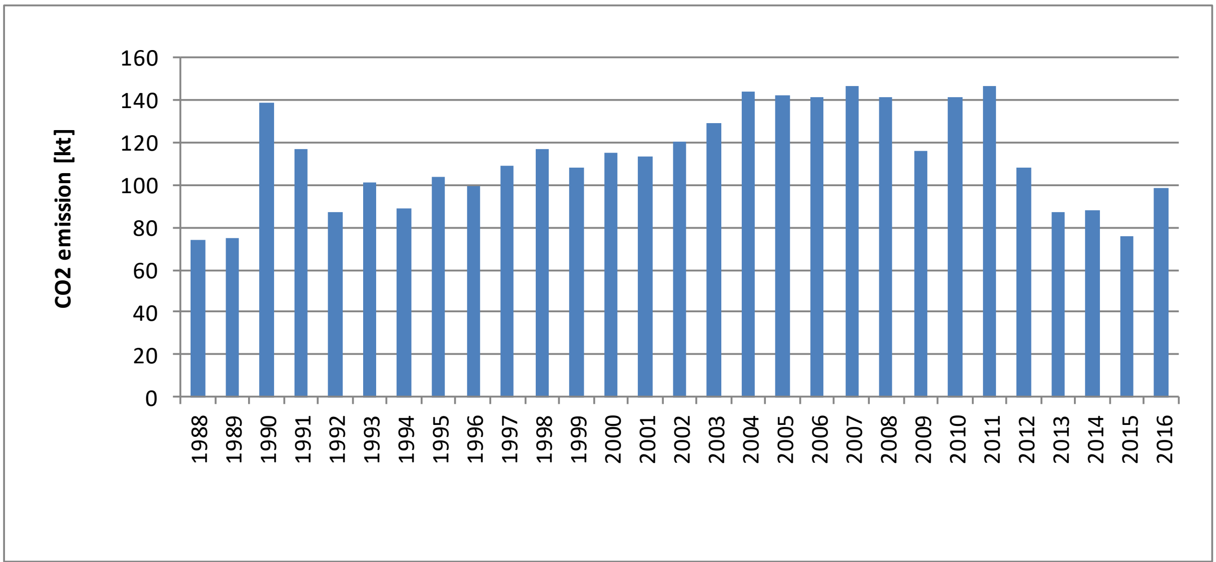

Figure 4.2.10. CO_2 emission values from soda ash use in 2.A.4.b subcategory in the years 1988-2016

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.

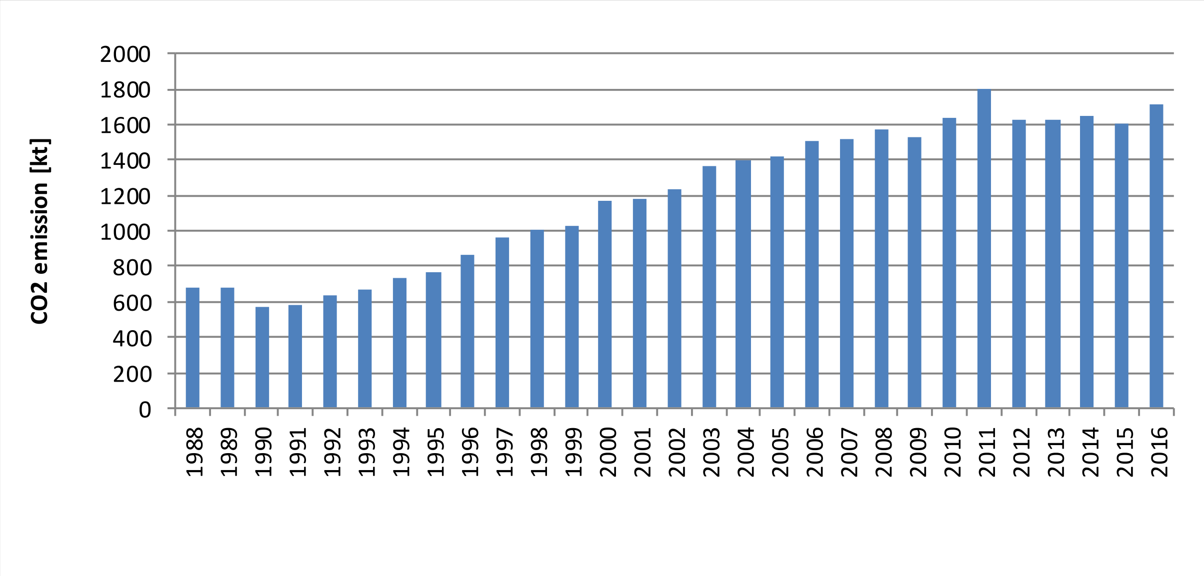

Figure 4.2.11. CO_2 emission from carbonate use in 2.A.4.d subcategory for 1988-2016

4.2.3. Uncertainties and time-series consistency

Uncertainty analysis for the year 2016 for IPCC sector 2. *Industrial processes and product use* 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 1988-2015 ensured consistency for whole time-series.

2016	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	**18 584.91**	**2.04**	**3.26**	3.5%	33.3%	40.5%
A. Mineral Products	10 393.52			5.7%		
B. Chemical Industry	4 902.81	1.48	2.82	4.3%	45.3%	46.5%
C. Metal Production	2 551.77	0.56	0.00	5.2%	18.0%	0.0%
D. Non-energy Products from Fuels and Solvent Use	736.81			13.9%		
G. Other			0.44			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

- CO_2 emission factors for ceramic production in 2014 and 2015 were slightly corrected;
- CO_2 emission from lime production was insignificantly corrected for the year 2015 due to slight adjustment connected with split between particular types of lime.

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
CO_2								
kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
CO_2								
kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
CO_2								
kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	**2012**	**2013**	**2014**	**2015**				
CO_2								
kt	0.00	0.00	0.10	0.03				
%	0.0	0.0	0.0	0.0				

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)

Subsector 2.B.1 *Ammonia production* is the largest contributor to emissions from this category (see figure 4.3.1) – 65.99% in 2016. Adipic acid was produced up to 1994.

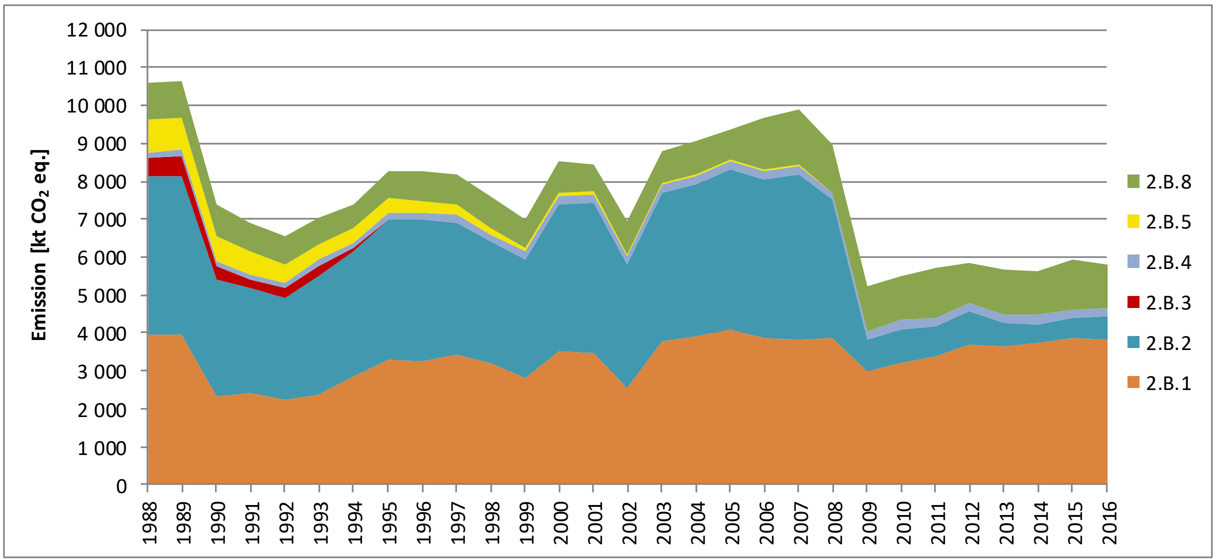

Figure 4.3.1. Emissions from *Chemical industry* category in years 1988-2016 according to subcategories

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 1988-2016 was presented in Annex 3.2). The amount of natural gas consumption expressed in volume units was taken from [GUS 2017e]. In order to calculate CO_2 emission, country specific carbon content in natural gas was estimated, based on the data from verified EU ETS reports provided by ammonia production installations [KOBiZE 2016]. The value of C content was estimated as 0.552 kg C/m^3 for 2016. The corresponding carbon contents for previous years were respectively: 0.545 kg C/m^3 for 2015 and 0.542 kg C/m^3 for 2014. For 2013 that amount was estimated at 0.544 kg C/m^3 and the same value was applied for previous years back to 1988. According to above-mentioned information, the CO_2 process emission from ammonia production was calculated using the following formula:

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

where:

E_{CO2} – CO_2 process emission from ammonia production [t]
$Z_{natural\ gas}$ – natural gas use [thousands m^3]
$C_{content}$ – carbon content in natural gas [kg C/m^3]

This method was used for entire period: 1988-2016. In years 1988-1990, 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 recovered for fertilizer urea production was deducted in calculation of emission for 2.B.1 subcategory. The estimation of CO_2 amounts for subtraction in entire period 1988-2016 were detailed presented in the Annex 3.2.

CO_2 process emissions in the period: 1988-2016 are shown in figure 4.3.2 while the ammonia production values [GUS 1989e-2017e] are presented in figure 4.3.3.

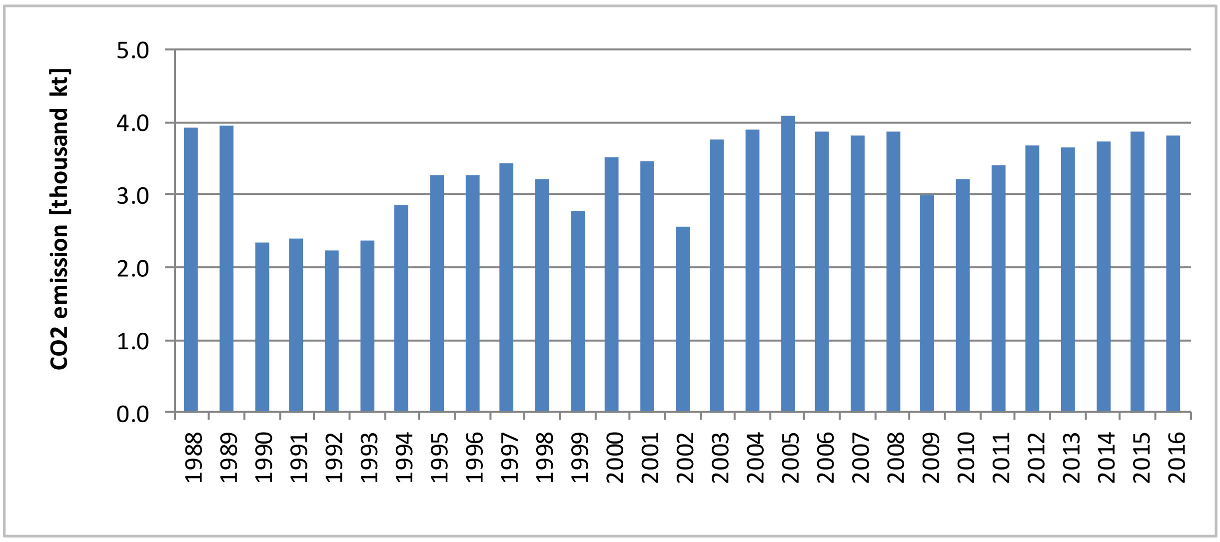

Figure 4.3.2. CO_2 process emission from ammonia production in 1988-2016 (including subtraction of CO_2 connected with fertilizer urea production)

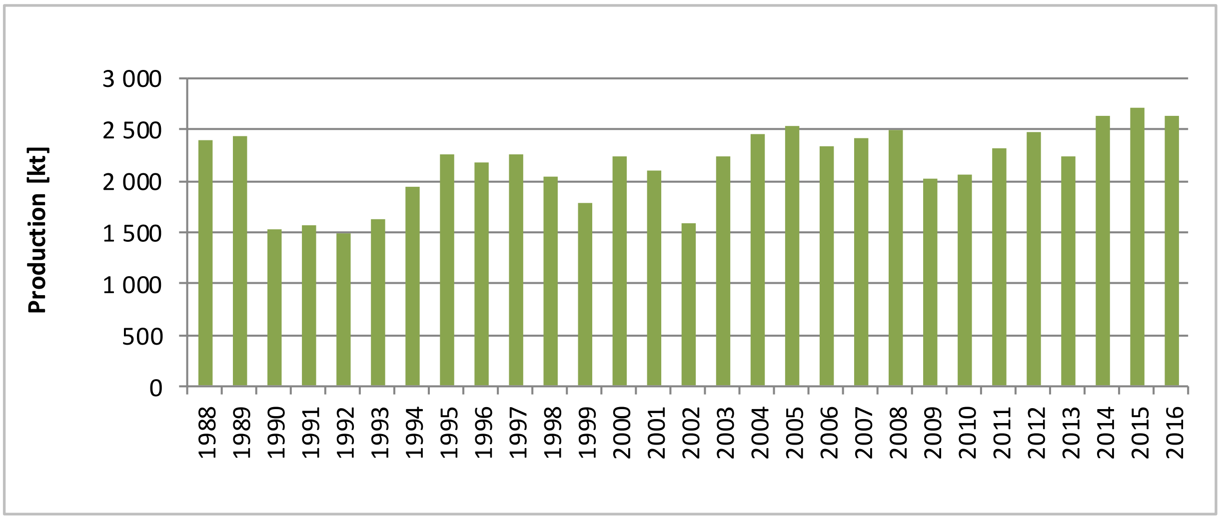

Figure 4.3.3. Production of ammonia in 1988-2016

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

Estimation of N_2O emission from nitric acid production for 2016 was based on annual HNO_3 production data from [GUS 2017b]. The country specific emission factor of 0.87 kg N_2O/t nitric acid for 2016 was estimated based on the reports from all producers of HNO_3 [KOBiZE 2016]. The N_2O emission factors for years 2005-2016 were calculated also based on the reports provided by installations of nitric acid production.

The values of N_2O EFs applied for the years 2005-2016, expressed in kg N_2O/t HNO_3, were as follows:

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
6.36	6.37	6.43	5.40	1.31	1.34	1.21	1.28	0.92	0.70	0.72	0.87

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.

Decline of emission factor value in 2012-2014 is mainly the result of change the catalyst for more effective one in the largest HNO_3 production installation.

The main reason for N_2O EF increas in 2016 is bypassing of nitrous gases outside the catalyst bed for reduction of nitrous oxide in one of the nitric acid production plants.

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-2017b] for the entire period 1988-2016. The amount of production and N_2O emissions from nitric acid production are shown in figures 4.3.4 and 4.3.5, respectively.

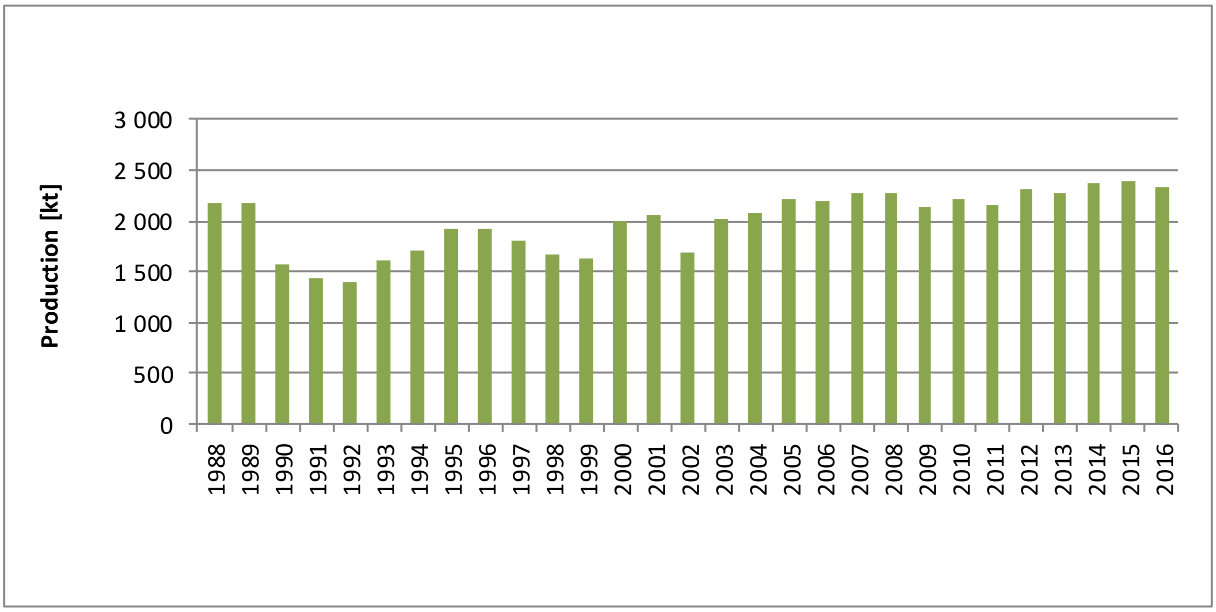

Figure 4.3.4. Production of nitric acid in 1988-2016

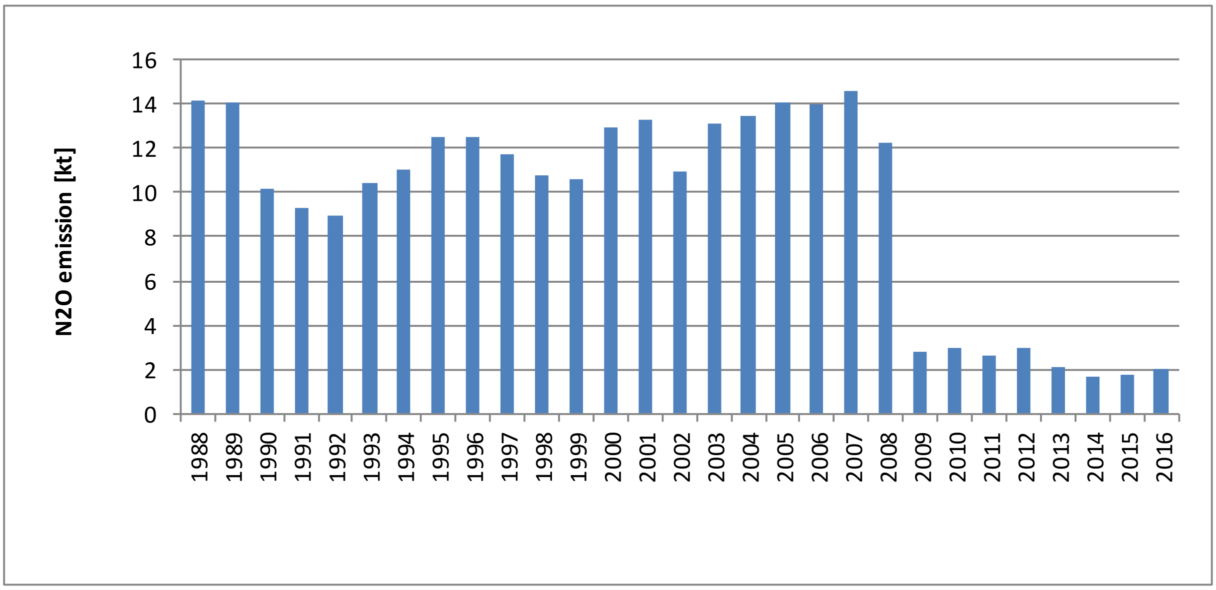

Figure 4.3.5. N_2O process emission for nitric acid production in 1988-2016

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.

N_2O emission factor for this category, which is equal 300 kg N_2O/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 2017b]. 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-2017b] 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 CO_2/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 1988-2016 were estimated based on data on annual production from [GUS 1989b-2017b]. CO_2 EF = 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 = 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 1988-2016 based on the data on annual production amounts taken from [GUS 1989b-2017b]. CO_2 EF = 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 = 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 2002-2016 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 CO_2/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 occurred only in the following 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 were estimated based on annual carbon black production taken from [GUS 1989b-2000b] and [GUS 2001e-2017e] 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-2017e] for the years 1995-2016 and directly from the only styrene producer for previous years (1988-1994). Methane emissions values for the entire period 1988-2016 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

The were no changes in 2.B subsector in the years 1988-2015.

4.3.6. Source-specific planned improvements

No improvements are planned at the moment.

4.4. Metal industry (CRF sector 2.C)

4.4.1. Source category description

Estimation of emissions in 2.C *Metal Industry* 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 79.17% in 2016.

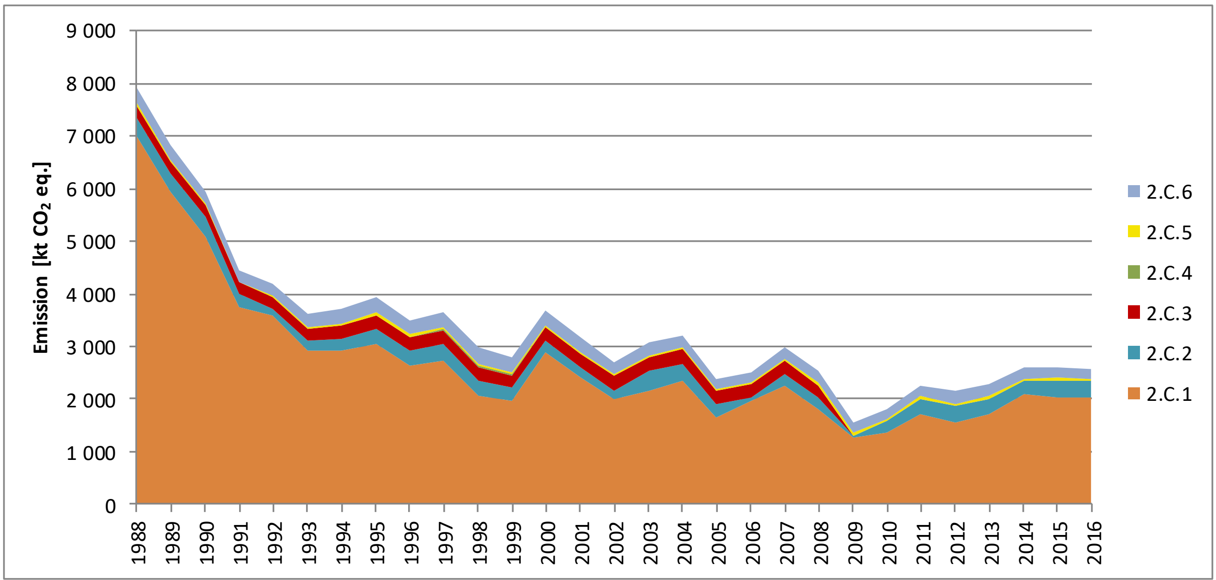

Figure 4.4.1. Emissions from *Metal industry* sector in years 1988-2016 according to subcategories

4.4.2. Methodological issues

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

4.4.2.1.a. Steel (CRF sector 2.C.1.a)

Basic oxygen furnace steel production

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 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 2007-2016. Steel production amounts applied in the C balance were in accordance with data published in yearbook GUS [2005b-2017b].

Table 4.4.1. Carbon balance for steel production in basic oxygen process in years 1988-2016

	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 1988-2016

	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 1988-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014
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	4 620 431
Scrap [t]	1 352 895	1 414 926	1 105 439	727 586	965 296	1 106 613	912 706	925 533	1 046 608
Carbon pick-up agent [t]	1 036	753	8 270	12 826	16 033	24 905	8 845	9 044	7 874
Ferroalloys [t]	68 765	71 480	65 149	40 273	53 926	59 738	53 477	57 253	66 718
Dolomite [t]	35 776	37 149	18 930	10 786	16 375	14 220	15 560	20 627	15 305
Technological indicator [t/t of steel]									
Pig iron	1.080	0.924	0.936	0.924	0.901	0.891	0.908	0.874	0.892
Scrap	0.2346	0.228	0.212	0.225	0.242	0.250	0.211	0.205	0.202
Carbon pick-up agent	0.0002	0.000	0.002	0.004	0.004	0.006	0.002	0.002	0.002
Ferroalloys	0.012	0.012	0.012	0.012	0.013	0.014	0.012	0.013	0.013
Dolomite	0.006	0.006	0.004	0.003	0.004	0.003	0.004	0.005	0.003
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	0.043
Scrap [t C/t]	0.004	0.003	0.008	0.008	0.009	0.009	0.008	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	0.853
Ferroalloys [t C/t]	0.029	0.032	0.035	0.035	0.033	0.028	0.031	0.031	0.033
Dolomite [t C/t]	0.130	0.130	0.124	0.125	0.125	0.125	0.126	0.125	0.126
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	197 002
Steel scrap	5 412	4 297	8 457	5 785	9 109	9 865	7 292	6 999	8 255
Carbon pick-up agent	855	677	6 783	10 839	13 198	20 075	7 277	7 538	6 714
Ferroalloys	2 021	2 288	2 249	1 427	1 761	1 673	1 681	1 769	2 222
Dolomite	4 649	4 829	2 341	1 345	2 047	1 780	1 960	2 586	1 924
Carbon contents in charge – SUM [t]	**226 474**	**251 821**	**227 163**	**146 733**	**176 553**	**199 365**	**185 544**	**187 708**	**216 117**
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**	**5 182 371**
Material-specific carbon content									
Steel [t C/t]	0.004	0.003	0.008	0.008	0.010	0.009	0.008	0.003	0.002
Carbon content in products [t C]									
Steel	23 066	18 304	41 662	25 760	38 441	40 780	34 990	11 919	8 579
Carbon content in products – SUM [t]	**23 066**	**18 304**	**41 662**	**25 760**	**38 441**	**40 780**	**34 990**	**11 919**	**8 579**
C emission from steel production [t]	203 408	233 516	185 501	120 974	138 111	158 585	150 554	175 789	207 538
CO_2 process emission from steel production [kt]	**745.831**	**856.227**	**680.171**	**443.570**	**506.409**	**581.478**	**552.032**	**644 561**	**760 973**
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**	**146.84**

Table 4.4.1. (cont.) Carbon balance for steel production in basic oxygen process in years 1988-2016

	2015	2016
CHARGE		
Pig iron [t]	4 792 153	4 614 066
Scrap [t]	1 023 858	905 766
Carbon pick-up agent [t]	8 414	7 826
Ferroalloys [t]	71 598	64 505
Dolomite [t]	23 850	17 180
Technological indicator [t/t of steel]		
Pig iron	0.894	0.901
Scrap	0.191	0.177
Carbon pick-up agent	0.002	0.002
Ferroalloys	0.013	0.013
Dolomite	0.004	0.003
Material-specific carbon content		
Pig iron [t C/t]	0.043	0.042
Scrap [t C/t]	0.008	0.002
Carbon pick-up agent [t C/t]	0.859	0.872
Ferroalloys [t C/t]	0.029	0.027
Dolomite [t C/t]	0.126	0.125
Carbon contents in charge components [t C]		
Pig iron	203 829	194 579
Steel scrap	7 966	1 814
Carbon pick-up agent	7 229	6 824
Ferroalloys	2 067	1 766
Dolomite	3 003	2 152
Carbon contents in charge – SUM [t]	**224 094**	**207 135**
OUTPUT		
Steel [t]	**5 358 991**	**5 145 076**
Material-specific carbon content		
Steel [t C/t]	0.002	0.002
Carbon content in products [t C]		
Steel	8 860	8 238
Carbon content in products – SUM [t]	**8 860**	**8 238**
C emission from steel production [t]	261 827	198 897
CO_2 process emission from steel production [kt]	**789.194**	**729 290**
CO_2 EMISSION FACTOR [kg CO_2/t of steel]	**147.27**	**141.75**

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-2017b]. 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 1988-2016

	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**	**2014**	**2015**	**2016**	
Production	4502.3	3892.8	4001.4	4352.9	4209.3	3679.0	3617.1	3977.5	4015.6	
CO_2 emission factor	53.44	52.84	50.70	54.98	52.70	61.26	58.44	52.20	56.21	
CO_2 emission	240.58	205.68	202.88	239.30	221.84	225.38	211.40	207.63	225.72	

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 1988-2016 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-2017e]. Output of blast furnace gas was taken from Eurostat database for the period 1990-2016. For the years 1988-1989 that data came from IEA database [IEA] due to data for mentioned years is not available in Eurostat database. Coke input amounts were derived from joint IEA/Eurostat/OECD/UNECE questionnaires including energy balances, submitted every year by Poland to mentioned organisation. Data from Eurostat database was not applied in this area, 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). Coal consumption in BF process was taken from joint IEA/Eurostat/OECD/UNECE questionnaires as well, due to in Eurostat database the coal used as reductant in pig iron production is aggregated in *Final Energy Consumption - Iron and Steel*. Consequently, the deduction of that coal from consumption in 1.A.2.a category was needed (see chapter 3.2.7.2.1). Amounts of other components in BF process were estimated according to technological factors taken from literature [Szargut J. 1983]. These applied coefficients, expressed in tonne per tonne of pig iron produced, were as follows: for dolomite – 0.0845, for limestone – 0.0974, for roasted ore 0.188 and 0.0716 for manganese ore. In accordance with data from steel plants was assumed, that total annual iron ore sinter production is consumed in given year in BF process. Carbon contents in components of charge and output were calculated based on C EFs from 2006 IPCC guidelines (for coke, pig iron, limestone, dolomites) or based on country specific values (data for iron ore comes from [Szargut J. 1983] while for sinter and BF gas − from plants). Carbon balance for blast furnace process for the years 1988-2016 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 1988-2016

	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 [kt]	6 607.5	6 365.7	5 576.0	3 838.0	3 760.0	3 378.0	3 820.0	3 944.0	3 400.0	3 593.0
Coking coal [TJ]										
CHARGE – C content										
Sinter [kg/kg]	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
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/kg]	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Coking coal [kg/GJ]										
CHARGE – total C content [kt]										
Sinter	17.1	15.8	14.2	10.3	10.3	9.2	10.5	10.3	9.9	10.7
Roasted ore	21.7	20.1	18.3	13.8	13.7	13.3	15.0	15.8	13.9	15.7
Dolomite	112.7	104.2	95.1	71.4	71.0	69.1	77.8	81.8	72.1	81.5
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	5 484.2	5 283.5	4 628.1	3 185.5	3 120.8	2 803.7	3 170.6	3 273.5	2 822.0	2 982.2
Coking coal										
C IN CHARGE – SUM	5 774.9	5 552.3	4 873.1	3 369.2	3 303.4	2 980.7	3 369.9	3 482.3	3 006.9	3 190.7
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]	66.88	66.88	66.88	66.88	66.88	66.88	66.88	66.88	66.88	66.88
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	4 983.7	4 799.8	4 211.2	2 863.0	2 728.7	2 551.8	2 953.4	3 045.9	2 612.3	2 763.3
C IN OUTPUT – SUM	5 394.2	5 179.3	4 557.5	3 123.1	2 987.2	2 803.5	3 236.6	3 343.6	2 874.8	3 060.0
DIFFERENCE BETWEEN C IN INPUT and C IN OUTPUT [kt]	380.8	373.0	315.6	246.1	316.2	177.2	133.3	138.7	132.1	130.7
CO_2 EMISSION [kt]	**1 396**	**1 368**	**1 157**	**902**	**1 160**	**650**	**489**	**509**	**484**	**479**
CO_2 EMISSION FACTOR [kg/t]	**136**	**144**	**134**	**139**	**179**	**103**	**69**	**68**	**74**	**65**

Table 4.4.3. (cont.) Carbon balance for blast furnace process in years 1988-2016

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
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	6 954.0
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	1 091.2
Dolomite [kt]	530.6	446.4	549.7	459.9	447.5	477.1	543.1	378.7	468.4	490.5
Limestone [kt]	611.6	514.5	633.6	530.1	515.9	549.9	626.0	436.5	539.9	565.4
Manganese ore [kt]	449.6	378.2	465.8	389.7	379.2	404.2	460.2	320.9	396.9	415.6
Coke [kt]	2 983	2 495	3 386	2 935	2 553	2 753	2 990	2 056	2 549	3 057
Coking coal [TJ]										
CHARGE – C content										
Sinter [kg/kg]	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
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/kg]	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Coking coal [kg/GJ]										
CHARGE – total C content [kt]										
Sinter	8.1	7.7	9.5	8.7	9.0	9.1	10.2	7.3	9.0	8.5
Roasted ore	13.3	11.2	13.8	11.5	11.2	12.0	13.6	9.5	11.7	12.3
Dolomite	69.0	58.0	71.5	59.8	58.2	62.0	70.6	49.2	60.9	63.8
Limestone	73.4	61.7	76.0	63.6	61.9	66.0	75.1	52.4	64.8	67.8
Manganese ore	11.8	9.9	12.2	10.2	9.9	10.6	12.0	8.4	10.4	10.9
Coke	2 475.9	2 070.9	2 810.4	2 436.1	2 119.0	2 285.0	2 481.7	1 706.5	2 115.7	2 537.3
Coking coal										
C IN CHARGE – SUM	2 651.4	2 219.4	2 993.4	2 589.8	2 269.2	2 444.7	2 663.2	1 833.3	2 272.4	2 700.6
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**	**5 804.4**
Blast furnace gas [TJ]	34 289	28 179	37 053	31 904	28 752	31 031	33 836	23 446	28 948	34 626
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]	66.88	66.88	66.88	66.88	66.88	66.88	66.88	66.88	66.88	66.88
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	232.2
Blast furnace gas	2 293.1	1 884.5	2 478.0	2 133.6	1 922.8	2 075.2	2 262.8	1 568.0	1 935.9	2 315.7
C IN OUTPUT – SUM	2 544.3	2 095.8	2 738.2	2 351.3	2 134.7	2 301.1	2 519.9	1 747.2	2 157.7	2 547.8
DIFFERENCE BETWEEN C IN INPUT and C IN OUTPUT [kt]	107.2	123.6	255.2	238.5	134.5	143.6	143.3	86.1	114.8	152.8
CO_2 EMISSION [kt]	**393**	**453**	**936**	**875**	**493**	**526**	**526**	**316**	**421**	**560**
CO_2 EMISSION FACTOR [kg/t]	**63**	**86**	**144**	**161**	**93**	**93**	**82**	**70**	**76**	**97**

Table 4.4.3. (cont.) Carbon balance for blast furnace process in years: 1988-2016

	2008	2009	2010	2011	2012	2013	2014	2015	2016
CHARGE – amount used in process in given year									
Sinter [kt]	6 306.4	4 362.6	5 837.3	6 512.8	6 672.5	6 854.2	7 389.4	7 429.9	6 850.5
Roasted ore [kt]	927.6	560.9	683.9	747.3	741.0	754.2	871.8	1 056.7	878.7
Dolomite [kt]	416.9	252.1	307.4	335.9	333.1	339.0	391.9	475.0	394.9
Limestone [kt]	480.6	290.6	354.3	387.2	383.9	390.8	451.7	547.5	455.2
Manganese ore [kt]	353.3	213.6	260.5	284.6	282.2	287.3	332.0	402.5	334.6
Coke [kt]	2 521	1 561	1 827	1 878	1 830	1 898	2 227	2 280	2 193
Coking coal [TJ]			957	2 326	5 977	4 205	5 465	7 998	8 374
CHARGE – C content									
Sinter [kg/kg]	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0014
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/kg]	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Coking coal [kg/GJ]			26.02	26.03	25.97	26.01	26.02	26.02	26.02
CHARGE – total C content [kt]									
Sinter	7.6	7.1	9.1	11.1	9.3	8.0	9.3	9.9	9.3
Roasted ore	10.4	6.3	7.7	8.4	8.3	8.5	9.8	11.9	9.9
Dolomite	54.2	32.8	40.0	43.7	43.3	44.1	50.9	61.7	51.3
Limestone	57.7	34.9	42.5	46.5	46.1	46.9	54.2	65.7	54.6
Manganese ore	9.2	5.6	6.8	7.4	7.4	7.5	8.7	10.5	8.8
Coke	2 092.4	1 295.6	1 516.4	1 558.7	1 518.9	1 575.3	1 848.4	1 892.3	1 819.8
Coking coal			24.9	60.5	155.2	109.4	142.2	208.1	217.9
C IN CHARGE – SUM	2 231.6	1 382.3	1 647.4	1 736.3	1 788.5	1 799.7	2 123.5	2 260.2	2 171.6
OUTPUT IN GIVEN YEAR									
Pig iron [kt]	**4 933.8**	**2 983.5**	**3 638.0**	**3 974.9**	**3 941.4**	**4 012.0**	**4 637.5**	**5 620.8**	**4 673.7**
Blast furnace gas [TJ]	28 551	17 610	22 022	22 271	22 684	22 530	25 802	26 470	25 158
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]	68.37	67.85	65.7	65.51	66.97	67.12	67.31	69.90	70.58
OUTPUT – total C content [kt]									
Pig iron	197.4	119.3	145.5	159.0	157.7	160.5	185.5	224.8	186.9
Blast furnace gas	1 952.2	1 194.8	1 446.3	1 459.1	1 519.2	1 512.2	1 736.7	1 850.3	1 775.7
C IN OUTPUT – SUM	2 149.5	1 314.1	1 591.8	1 618.1	1 676.8	1 672.7	1 922.2	2 075.1	1 962.7
DIFFERENCE BETWEEN C IN INPUT and C IN OUTPUT [kt]	82.1	68.2	55.6	118.3	111.7	127.0	201.4	185.0	208.9
CO_2 EMISSION [kt]	**301**	**250**	**204**	**434**	**410**	**466**	**738**	**679**	**766**
CO_2 EMISSION FACTOR [kg/t]	**61**	**84**	**56**	**109**	**104**	**116**	**159**	**121**	**164**

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 2016 was based on the data from the EU ETS verified reports on annual emissions of CO_2 from iron ore sinter installations [KOBiZE 2017]. 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 2005-2015 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 2017]. 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 2017].

For the entire period 1988-2016 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 1988-2016 [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**	**2014**	**2015**	**2016**	
Production	6306.4	4362.6	5837.3	6512.8	6672.5	6854.2	7389.4	7429.9	6850.5	
CO_2 emission factor	91.11	82.25	75.77	69.29	52.63	51.86	49.10	48.09	44.00	
CO_2 emission	574.59	358.80	442.32	451.29	351.14	355.48	362.79	357.28	301.43	

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 2017b]. 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 1988-2015 CO_2 and CH_4 process emission from ferroalloys production was estimated also based on annual ferrosilicon production taken from [GUS 1989b-2016b] (figure 4.4.2) and emission factors as in 2016.

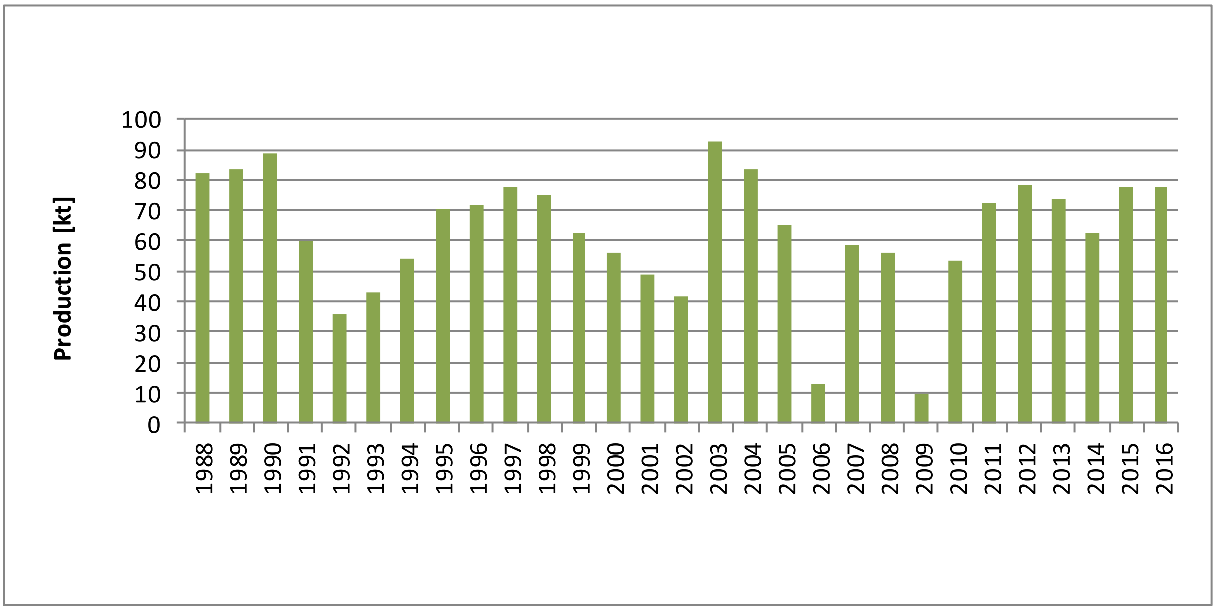

Figure 4.4.2. Production of ferrosilicon in 1988-2016

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 1988-2016 were estimated based on annual lead productions taken from GUS yearbooks [GUS 1989b-2017b]. 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.

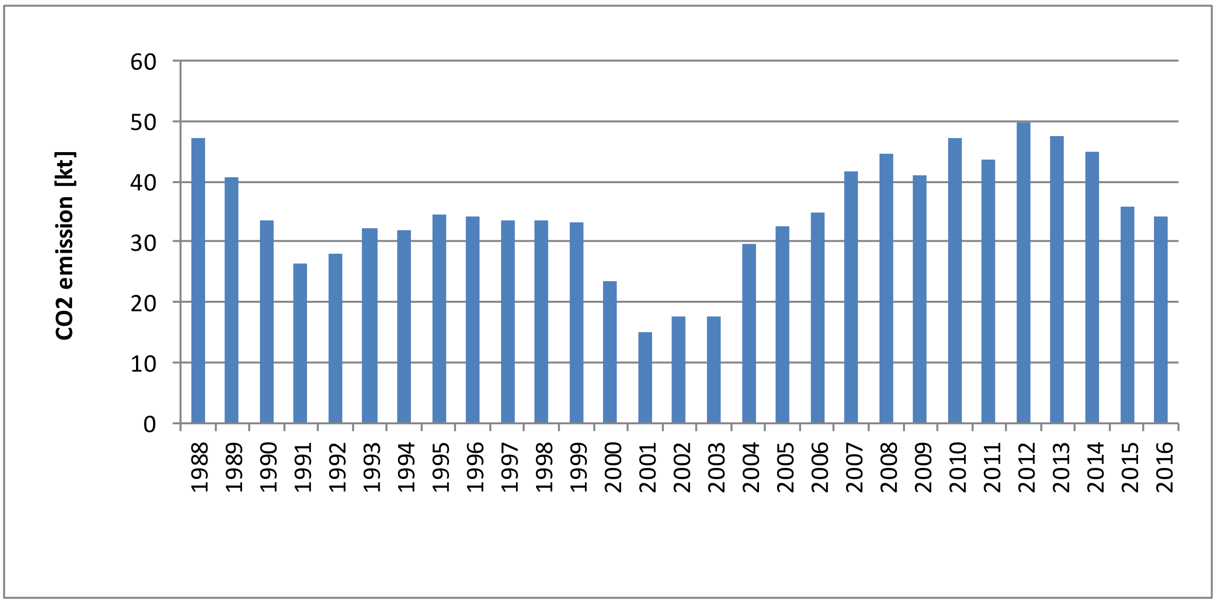

Figure 4.4.3. CO_2 process emission for lead production in 1988-2016

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

CO_2 process emission from zinc production for the years 1988-2016 was estimated based on annual zinc production taken from GUS yearbooks [GUS 1989b-2017b]. 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.

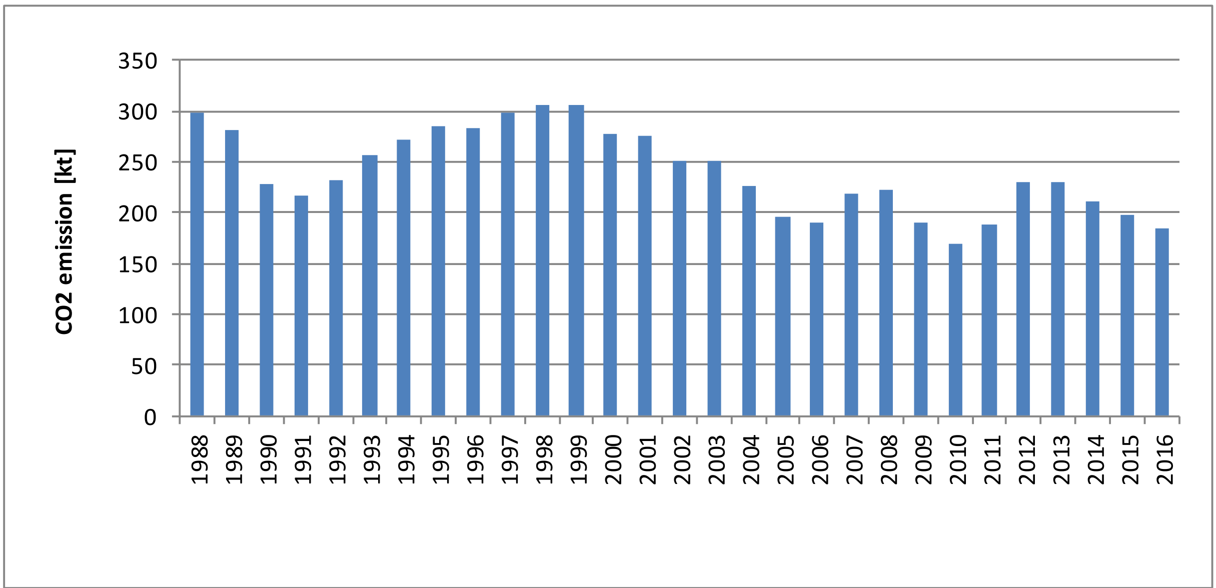

Figure 4.4.4. CO_2 process emission for zinc production in 1988-2016

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

- Zinc production value for 2015 was updated, which had the most significant impact on the change of CO_2 emission in 2.C category;
- Ferroalloys production for 2015 was updated;
- AD for steel production in electric furnace was updated for 2015.

Table 4.4.5. Changes of GHG emission values in 2.C subcategory as a result of recalculations

Change	1988	1989	1990	1991	1992	1993	1994	1995
				CO_2				
kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
				CO_2				
kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
				CO_2				
kt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	**2012**	**2013**	**2014**	**2015**				
		CO_2						
kt	0.00	0.00	0.00	-15.29				
%	0.0	0.0	0.0	-0.6				

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:

a) *Lubricant use* (2.D.1)
b) *Paraffin wax use* (2.D.2)
c) *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) – about 68.5% in 2016.

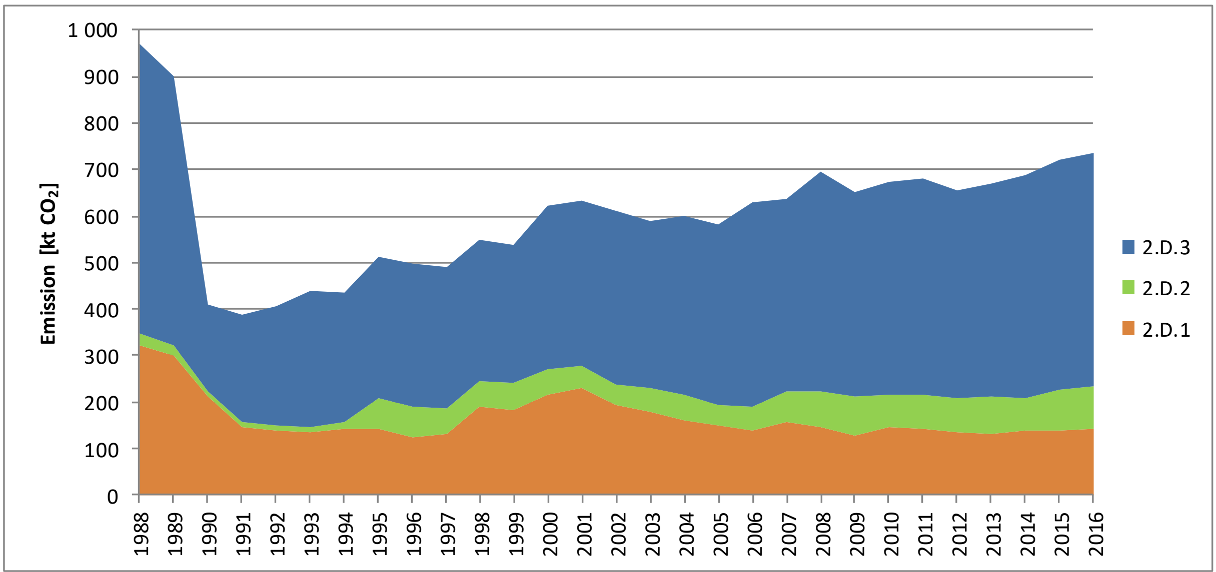

Figure 4.5.1. Emissions from *Non Energy Product from Fuels and Solvent Use* sector in years 1988-2016 according to subcategories

4.5.2. Methodological issues

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

CO_2 emissions concerning non-energy use of lubricants were estimated based on Tier 1 method according to IPCC 2006 guidelines. Calculations were made in accordance with the following formula:

$$CO_{2\ emissions} = LC \times CC \times ODU \times 44/12$$

where:
LC – non-energy use of lubricants, TJ
CC – carbon content of lubricants (carbon emission factor), t C/TJ
ODU – oxidised during use factor
44/12 – mass ratio of CO_2/C

Carbon content of lubricants is default value equal 20 t C/TJ. ODU factor for lubricant is country specific and is equal 0.5.

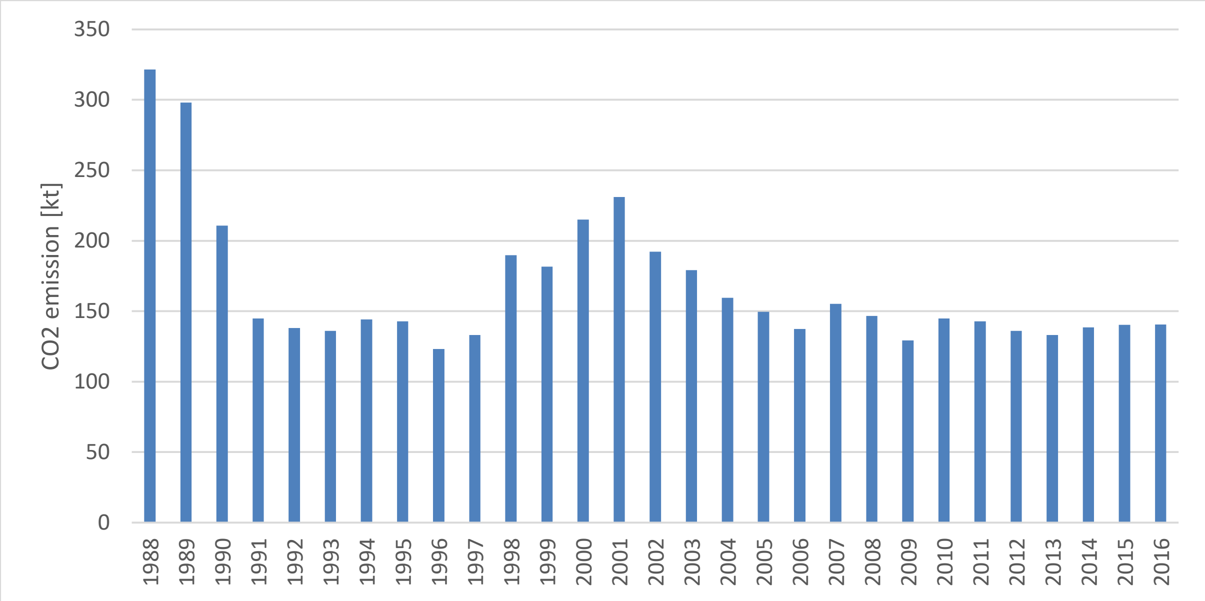

Figure 4.5.2. CO_2 emissions from non-energy use of lubricants in years 1988-2016

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

CO_2 emissions concerning non-energy use of paraffin wax were estimated based on Tier 1 method according to IPCC 2006 guidelines. Calculations were made in accordance with the following formula:

$$CO_{2\ emissions} = PW \times CC \times ODU \times 44/12$$

where:
PW – non-energy use of paraffin wax, TJ
CC – carbon content of paraffin wax (carbon emission factor), t C/TJ
ODU – oxidised during use factor
44/12 – mass ratio of CO_2/C

Carbon content of paraffin wax is default value equal 20 t C/TJ. ODU factor for paraffin wax is default value equal 0.2.

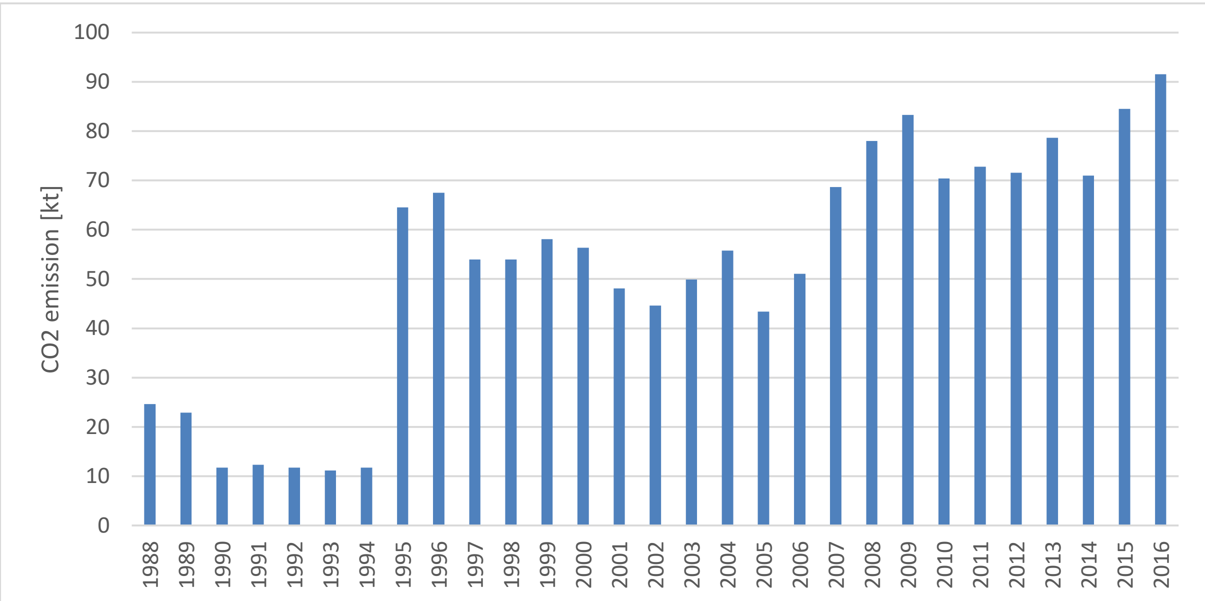

Figure 4.5.3. CO_2 emissions from non-energy use of paraffin waxes in years 1988-2016

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 N_2O emissions from the use of N_2O for anesthesia and in food industry – to make whipped cream) is reported sub-category 2.G.3 (2.G.3.a and 2.G.3.b).

Total emission of GHG in this sector in 2016 was estimated to 482.3 kt CO_2. This emission decreased by 29% from year 1988 to 2016 (Figure 4.5.4 and 4.5.5).

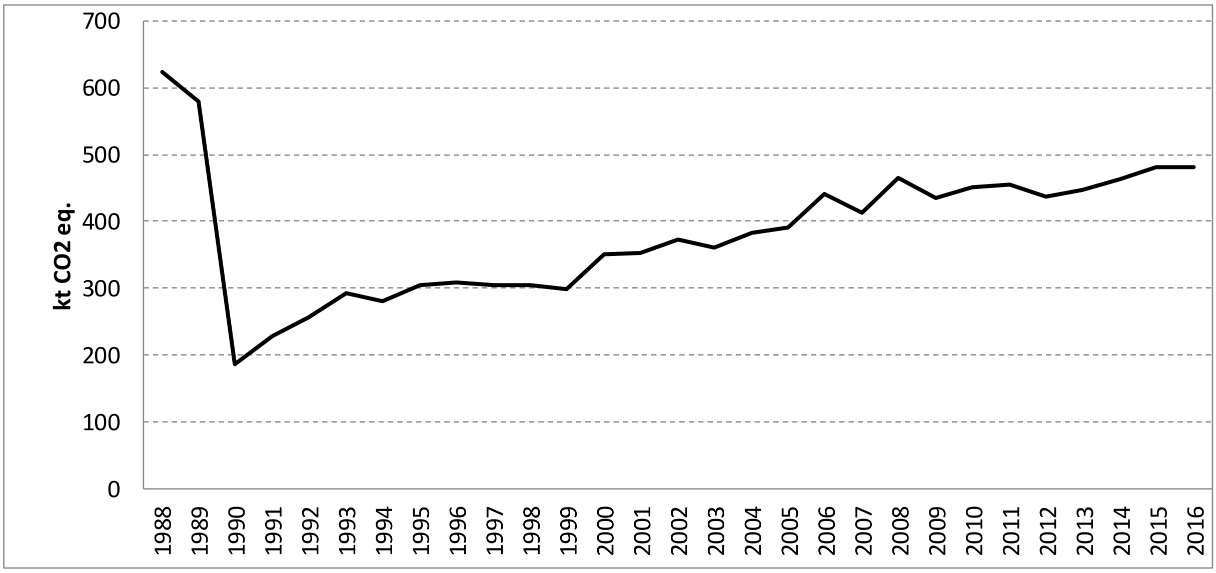

Figure 4.5.4. GHG emission from Solvent and Other Product Use sector in 1988-2016

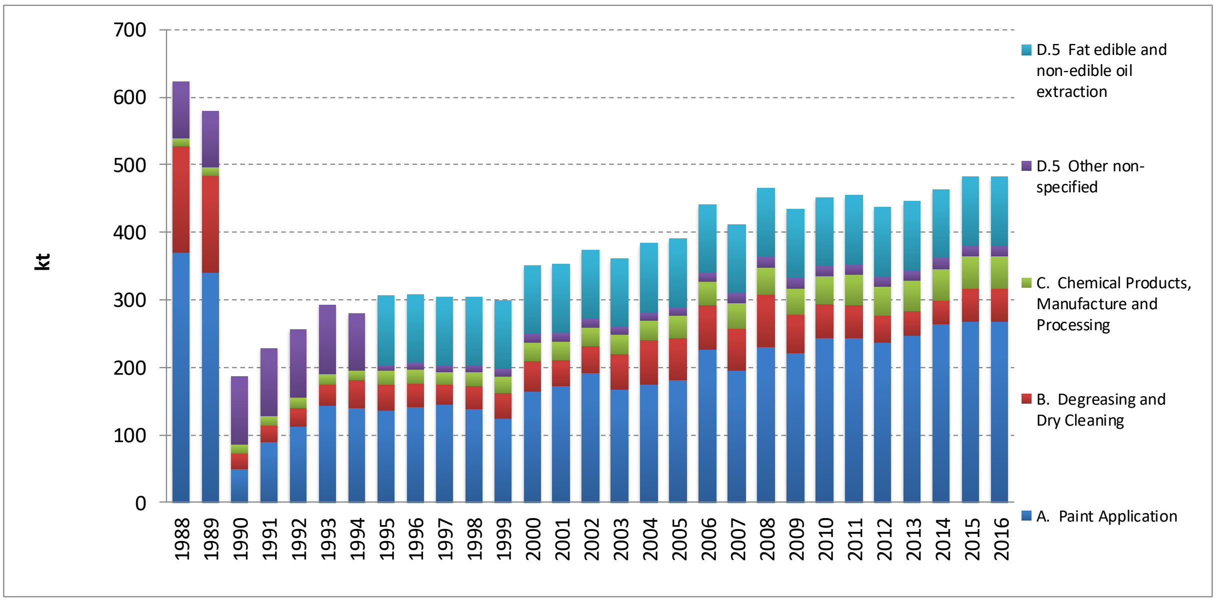

Figure 4.5.5. CO_2 emission from Solvent and Other Product Use sector in 1988-2016

Calculations of CO_2 emissions within Sector Solvent Use, using the common methodology, were carried out on the basis of results of NMVOC emissions [EMEP 2015]. CO_2 emission factor was determined assuming, that carbon content in NMVOC is 60% [IPCC 2006, chapter 5.5.1., page 5.16.].Then carbon content has been calculated in a stoichiometric way to CO_2. Calculations were made in accordance with the following formula:

$$\mathbf{CO_2 = 0.60 * 44/12 * NMVOC}$$

where:

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

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.

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. CO_2 emissions from urea based catalyst

For estimating CO_2 emissions from urea-based catalyst additives in catalytic converters model COPERT 4 was used. The model assumed that consumption of urea is equal share of fuel consumption. For diesel passenger cars Euro VI the consumption of urea is equal 2% of fuel consumption, the selective catalytic reduction (SCR) ratio being equal to 10%; for diesel heavy duty trucks and buses, the consumption of urea is assumed to be equal 6% of fuel consumption at Euro V level (SCR ratio = 76.2%) and equal 3.5% at Euro VI level (SCR ratio = 100%). The purity (the mass fraction of urea in the urea-based additive), the default value of 32.5% has been used (IPCC 2006).

4.5.3. Uncertainties and time-series consistency

See chapter 4.2.3

4.5.4. Source-specific QA/QC and verification

See chapter 4.2.4

4.5.5. Source-specific recalculations

Not done.

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)

No sources of f-gases were identified for that sector for whole time seresies, thus activity data and emission were reported as not occurring.

4.7. Product uses as substitutes for ODS (CRF sector 2.F) and other minor sources of f-gases emissions

4.7.1. Source category description

Data used to estimate emissions in preparation of the greenhouse gas inventories is based on aggregated data collected by operators under Article 3(6) of Regulation (EC) No 842/2006. Use of the same data source for both obligations results in full consistency between datasets. Data consistency checks are performed on yearly basis for the whole reported time series.

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 2018].

To assure transparency and completeness of the description in the 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.

This chapter also includes description of **SF_6 emissions** from IPCC categories **2.C.4** ***Magnesium production*** and **2.G.1** ***Electrical equipment*.**

Implementation of IPCC 2006 Guidelines resulted in number of changes in methodology – most notable 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 NF_3, 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. During preparation of f-gases inventory for submission 2018 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),
- 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. Due to availability of new information some activity data were revised in submission 2018 (described in recalculation chapter of this section). Amount of f-gases input in each equipment type was given in table 4.7.1 below.

Methodology used for estimates of f-gases is IPCC 2006 Guidelines, which is mandatory for submission 2018. 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 of categories (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 (small hermetic MT)	0.24
Commercial refrigeration (small hermetic LT)	0.24
Commercial refrigeration (single condensing units MT)	3.60
Commercial refrigeration (single condensing units LT)	2.70
Commercial refrigeration (large multipack MT)	100.00
Commercial refrigeration (large multipack LT)	50.00
Stationary air-conditioning (small split)	0.90
Stationary air-conditioning (medium split)	2.25
Stationary air-conditioning (large split)	5.60
Stationary air-conditioning (packaged systems)	20.0
Stationary air-conditioning (VRF systems)	25.0
Stationary air-conditioning (small chillers)	30.0
Stationary air-conditioning (medium chillers)	150.0
Stationary air-conditioning (large chillers)	500.0
Passenger cars with air-conditioning	1.20
Public transport	1.50
Trucks	1.50
Trailers	5.50
Wagon, tank, cold rooms	5.50
Cargo railway cars	5.50
Tram cars	5.50
Equipment used for refrigeration	5.50

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	2014	2015	2016
Stationary air-conditioning	0	0	0	0	0	25	30	35	35	35	35	35	35	35	35	35	35	35	35	32	32	32

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	2014	2015	2016
Commercial air-conditioning	0	0	5	10	15	20	20	25	30	25	30	30	30	30	29	28	27	27	27	25	25	25
Stationary air-conditioning	0	0	0	0	0	25	30	35	35	35	38	38	38	38	38	38	38	38	38	35	35	35
Transport refrigeration	0	0	0	0	0	11	11	11	11	11	11	22	22	22	22	33	33	41	41	41	41	41

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	2014	2015	2016
Domestic refrigerators	50	70	100	100	100	100	100	100	0	0	0	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	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	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	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	100	100	100
Public transport	10	10	20	25	30	30	30	30	40	40	40	50	50	50	60	60	60	60	60	60	60	60
Trucks	0	0	15	20	25	25	25	30	30	30	40	40	40	50	50	50	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	25	25	25
Wagon, tank, cold rooms	0	0	0	0	0	1	1	1	1	1	1	3	3	3	3	4	4	5	5	5	5	5

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	2014	2015	2016
Cargo railway cars	0	0	0	0	0	1	1	1	1	1	1	3	3	3	3	4	4	5	5	5	5	5
Tram cars	0	0	0	0	0	1	1	1	1	1	1	3	3	3	3	4	4	5	5	5	5	5
Equipment used for refrigeration	0	0	0	0	0	1	1	1	1	1	1	3	3	3	3	4	4	5	5	5	5	5

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	2014	2015	2016
Commercial air-conditioning	0	0	7	15	20	25	25	35	35	35	40	40	40	40	39	39	38	38	38	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	2	2	2
Transport refrigeration	0	0	0	0	0	13	13	13	13	13	13	26	26	26	26	38	48	48	48	48	48	48

Table 4.7.8 shows aggregated national total HFCs emissions over 1995-2016 expressed in CO_2 equivalents and HFCs emission in sub-sector: 2.F.1 *Refrigeration and Air Conditioning*. Prior to 1995, HFCs were not used in Poland.

Table 4.7.8. HFCs emissions in 2.F.1 *Refrigeration and Air Conditioning* 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	117 175	134 693
1996	252 869	335 495
1997	355 414	481 018
1998	449 088	569 317
1999	659 903	780 466
2000	1 255 433	1 366 497
2001	1 751 664	1 925 337
2002	2 307 438	2 505 928
2003	2 977 385	3 077 997
2004	3 331 905	3 733 225
2005	3 845 289	4 556 732
2006	4 469 814	5 408 051
2007	5 107 581	6 009 796
2008	5 643 806	6 334 889
2009	5 743 324	6 289 669
2010	6 577 231	7 006 363
2011	7 169 565	7 622 603
2012	7 500 391	7 959 909
2013	7 833 004	8 356 092
2014	8 437 179	8 977 997
2015	8 463 164	8 969 070
2016	8 449 447	8 955 353

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:

- EF for HFC-134a: new product = 95% first year; 2.5% next years
- EF for HFC-227ea: new product = 10% first year; 4.5% next years
- EF for HFC-365mfc: new product = 25% first year; 1.5% next years
- EF for HFC-245ca: new product = 25% first year; 1.5% next years
- 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.

At the moment of the publication of this version of the NIR, this chapter covers initial data for submission 2018. In case when updated data is not available, values and assumptions from previous submission were applied.

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 CO_2 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	17 518	NO
1996	NO	43	82 583	NO
1997	NO	121	125 483	NO
1998	NO	234	119 995	NO
1999	11 440	1 408	107 715	NO
2000	11 440	1 580	98 044	NO
2001	11 440	3 517	158 716	NO
2002	42	3 008	195 441	NO
2003	1 561	9 097	89 954	NO
2004	9 707	7 959	383 655	NO
2005	318 273	11 930	380 716	524
2006	352 563	15 114	569 559	1 000
2007	395 357	21 341	484 877	640
2008	347 947	25 107	317 701	328
2009	245 586	30 143	269 631	984
2010	263 026	40 387	123 484	2 234
2011	277 983	47 156	125 112	2 786
2012	277 067	54 565	126 268	1 618
2013	336 316	61 407	124 955	410
2014	343 833	71 131	125 445	410
2015	300 877	78 749	125 816	465
2016	300 877	78 749	125 816	465

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:

- EF for HFC-227ea: new product = 1% first year; 5% next years
- 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 4.7.9 above.
At the moment of the publication of this version of the NIR, this chapter covers initial data for submission 2018. In case when updated data is not available, values and assumptions from previous submission were applied.

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:

- EF for HFC-134a: import for production of technical aerosols = 50% first year; 50% next year
- EF for HFC-134a: import of technical aerosols = 50% first year; 50% next year
- EF for HFC-134a: import for production of medical aerosols = 100% first year
- 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. At the moment of the publication of this version of the NIR, this chapter covers initial data for submission 2018. In case when updated data is not available, values and assumptions from previous submission were applied.

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:

- EF for HFC-365mfc: 50% first year; 50% next year
- 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.
At the moment of the publication of this version of the NIR, this chapter covers initial data for submission 2018. In case when updated data is not available, values and assumptions from previous submission were applied.

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 1988-2015 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. Aluminium production in Poland stopped in 2008 and is not occurring since then.

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
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
2014	NO	13 903	13 903
2015	NO	13 208	13 208
2016	NO	13 208	13 208

NO – emission not occurring

<u>SF_6</u>

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 = 1 kg 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: 1988-2016. At the moment of the publication of this version of the NIR, this chapter covers initial data for submission 2018. In case when updated data is not available, values and assumptions from previous submission were applied.

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 SF_6 in use (1995), EF = 0.02 Mg/Mg (since 1996)

Table 4.7.11 presented below includes the activity data used for estimation SF_6 emissions over the period: 1994-2016. At the moment of the publication of this version of the NIR, this chapter covers initial data for submission 2018. In case when updated data is not available, values and assumptions from previous submission were applied.

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* [Mg]

Activity characteristic for the source sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2.C *Metal industry*												
4. *Magnesium production* – amount of alloy used to produce casting	320	400	400	345	291	236	181	127	72	46	20	30
2.G *Other product manufacture and use*												
1. *Electrical equipment* – amount of SF_6 in use	NO	11.00	14.02	17.05	20.07	23.10	26.12	28.70	32.04	33.75	36.45	40.57
1. *Electrical equipment* – amount of imported SF_6	NO	NO	0.60	0.60	2.00	2.33	2.66	3.30	4.16	2.50	3.59	5.16

Activity characteristic for the source sector	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2.C *Metal industry*											
4. *Magnesium production* – amount of alloy used to produce casting	65	100	100	100	100	100	100	100	100	100	100
2.G *Other product manufacture and use*											
1. *Electrical equipment* – amount of SF_6 in use	46.23	48.63	51.32	55.80	57.97	61.50	65.66	71.70	78.95	78.95	78.95
1. *Electrical equipment* – amount of imported SF_6	6.89	3.54	3.89	5.86	3.50	4.99	5.73	7.82	9.24	9.24	9.24

Table 4.7.12 below shows aggregated national total SF_6 emissions over 1994-2016 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 production* and 2.G.1 *Electrical equipment* compared to national total emission [t]

Year	SF_6 emissions in 2.C.4 *Magnesium production*	SF_6 emissions in 2.G.1 *Electrical equipment*	Total SF_6 emissions
1994	0.58	NO	0.58
1995	0.73	0.55	1.28
1996	0.73	0.32	1.04
1997	0.63	0.38	1.00
1998	0.53	0.52	1.05
1999	0.43	0.60	1.03
2000	0.33	0.68	1.01
2001	0.23	0.77	1.00
2002	0.13	0.89	1.02
2003	0.08	0.82	0.91
2004	0.04	0.94	0.98
2005	0.05	1.12	1.18
2006	0.12	1.34	1.46
2007	0.18	1.18	1.37
2008	0.18	1.26	1.44
2009	0.18	1.47	1.65
2010	0.18	1.37	1.55
2011	0.18	1.53	1.71
2012	0.18	1.66	1.84
2013	0.18	1.90	2.08
2014	0.18	2.13	2.32
2015	0.18	3.20	3.38
2016	0.18	3.20	3.38

NO – emission not occurring

4.7.3. Uncertainties and time-series consistency

Uncertainty analysis made for industrial gases HFC, PFC and SF_6 was significantly improved in submission 2017, as response to recommendations of the previous UNFCCC reviews. Previously uncertainty assumptions were applied directly to emission values of each pollutant due to lack of available information. In submission 2018 some of the applied assumptions were revised to better reflect national circumstances and in result some of the uncertainties increased.

Present calculation model was revised and extended to include uncertainties applied to activity data and emission factors. Uncertainty assessment is now performed taking into account information given on for different subcategories and single f-gases. Uncertainty is also assessed separately for manufacture, operating and decommissioning of f-gases containing equipment.

Overall results are estimated using GWP potential from IPCCC 4AR. To ensure consistency with the approach taken in the NIR uncertainty assessment model for f-gases covers complete set of categories resulting in emission of gases (2.C *Metal production*, 2.F *Product uses as substitutes for ODS* and 2.G. *Other product manufacture and use*). More details on assumed input uncertainties for each of the subcategories and gases are given in annex 8 describing uncertainty assessment for whole inventory.

Uncertainty of f-gases	From manufacturing	From stocks	From disposal	Total	Contributing f-gases
TOTAL	**4.55%**	**15.36%**	**13.75%**	**14.72%**	**HFC, PFC, SF_6**
C. Metal production	7.07%	-	-	7.07%	SF_6
F. Product uses as substitutes for ODS	4.99%	15.44%	13.75%	15.48%	HFC,PFC
G. Other product manufacture and use	5.39%	7.07%	-	4.79%	SF_6

4.7.4. Source-specific QA/QC and verification

See chapter 4.2.4.

4.7.5. Source-specific recalculations

Activity data for estimating HFCs emission from 2.F.1 *Refrigeration and air conditioning* were revised to reflect new data obtained from the market.

Example results of the recalculations for 2015 were presented in table below:

kt of CO_2 eq.	HFCs	PFCs	SF_6
Previous submission	8948.85	13.21	77.03
Latest submission	8969.07	13.21	77.03
Difference	20.22	0.00	0.00
%	0.23%	0.00%	0.00%

4.7.6. Source-specific planned improvements

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

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

SF_6 emissions from sector 2.G.1 *Electrical equipment* is described in chapter 4.7.2.

The N_2O use in medical applications and as propellent in whipped-cream aerosol cans are covered in this subsector.

2.G.3.a. Other Product Manufacture and Use – Medical applications (Anaesthesia)

N_2O emission from anaesthesiology was estimated based on country study: "Strategy of reduction of GHG emission until 2020 in the division into separate gases (N_2O, HFCs, PFCs and SF_6) and sectors" elaborated by the Institute of Environmental Protection [IOŚ 2001]. Due to lack of available data the value established in 2001 amounting to 0.4 kt is annually applied for entire series. Steps are undertaken to update this emission based on available medical and market data.

2.G.3.b. Propellant for pressure and aerosol products

The country study has been performed to develop methodology of estimating domestic N_2O emission from use as a propellant in aerosol products, primarily in food industry (2.G.3.b): "The methodology for estimating N_2O emissions in food industry (primarily as a propellant in aerosol products) for reporting to the national inventory of emissions and removals of greenhouse gases" (National Centre for Emission Management 2017, in Polish) [KOBIZE 2017]. Based on this analysis it was assumed that the main product taken into consideration in emission calculations is wheapped cream where entire propelent is released from container. The emission values related to this subcategory range from 0 in 1988 up to 0.044 kt N_2O in 2016.

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 subcategories from sector 3. have been identified as key sources (excluding LULUCF):

IPCC Source Categories	GHG	Identification criteria (Level, Trend, Qualitative)		
3.A Enteric Fermentation	CH_4	L	T	
3.B Manure Management	N_2O	L		
3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	L	T	
3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	L		
3.G Liming	CO_2		T	

Share of these subcategories in total Poland's GHG emissions amounts ca. 7.06%.

Total emissions of GHG in Agriculture sector presented as carbon dioxide equivalent amounted to 30.1 Mt in 2016 and decreased since 1988 by about 37%. 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 54% of Polish farms are smaller than 5 hectares and 76% of farms are up to 10 hectares [GUS R4 2017].

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 0.2 million in 2016). 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.

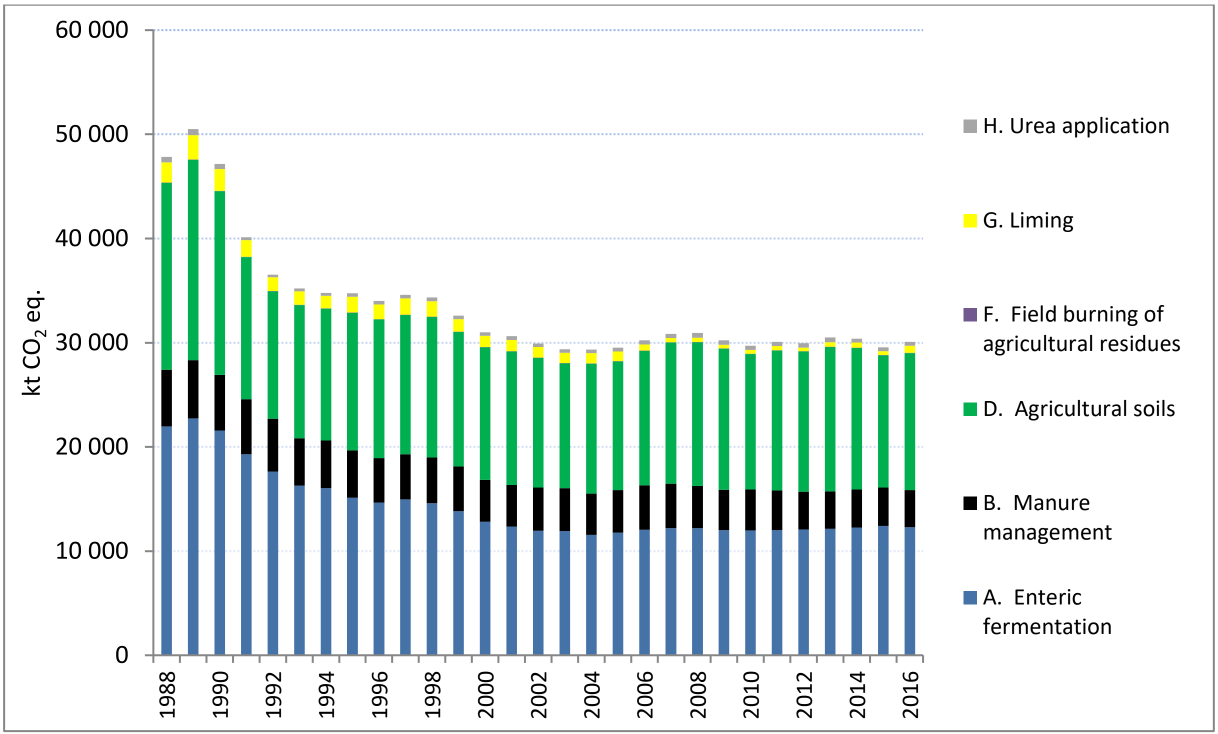

Figure 5.1. Total greenhouse gas emissions related to the Polish agriculture according to main source categories

In 2016, in relation to the previous year, gross agricultural output increased by 7.1%. This increase was the result of a growth in crop production (by 10.3%) and a growth in animal production (by 3.8%). The increase in crop production was achieved by increasing the harvest of most crops. Higher than last year crop yields were among others the result of favorable thermo-humidity conditions occurring during the growing season as well as the growth in fertilization. The growth in level of livestock production resulted from an increase in the production of all main species of livestock as well as hen eggs. Cow's milk production remained at a level similar to that of the previous year. During the year the profitability of milk production and pigs breeding gradually improved. Prices of cattle and poultry for slaughter have declined.

With the increase in the supply of agricultural products on domestic and foreign markets, price declines were predominant. The area of agricultural land in the use of farms amounted like a year ago about 14.5 million ha. The total sown area for harvest in 2016 reached 10.6 million ha and was less by 1.1% of the sown area in the previous year. The sown area under cereals, legumes for grain, as well as industrial crops (including rape and turnip rape) decreased primarily.

Year 2016 was following year in which market conditions of agricultural production have worsened. The index of prices relations ("price scissors") amounted to 99.0 in comparison of 97.3 in 2015. The decrease rate of agricultural prices of products sold by individual farmers was higher than the decrease rate of the average prices of goods and services purchased for the current agricultural production and investment purposes. Consumption of mineral fertilizers (NPK) per 1 ha of agricultural land in the farming year 2015/16 has increased in comparison to the previous period by 5.8% and amounted to 130.3 kg. There also has been reported an increase in the consumption of lime fertilizers. Average consumption of lime fertilizers amounted to approx. 68 kg per 1 ha of agricultural land against approx. 36 kg in 2015. [GUS R4 2017].

Contribution of Agriculture in national emissions excluding LULUCF is about 7.6% in 2016. Among GHGs the highest contribution has N_2O – 50.4%, then CH_4 – 46.2% and CO_2 – 3.5%. The biggest share in GHG Agricultural emissions have 2 sectors: Agricultural soils – 43.7% and Enteric fermentation – 40.8%. Manure management is responsible for about 11.9% GHG emissions, liming and urea application respectively for 2.2 and 1.3%. Share of CH_4 and N_2O emissions from Field burning of agricultural residues are minor – only about 0.1%.

The review of trends by gases and subsectors are given in Figures 5.2−5.4. Carbon dioxide emissions in Agriculture sector come from liming and urea application – responsible for 64% and 36% respectively in 2016. (Fig. 5.2).

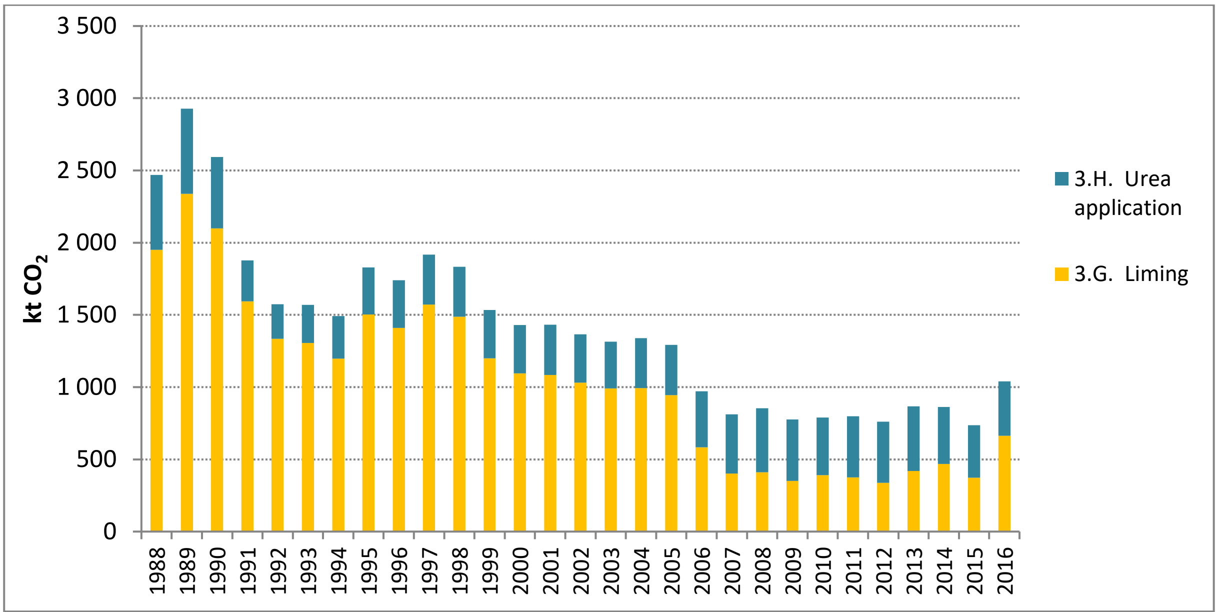

Figure 5.2. Carbon dioxide emissions from the Polish agriculture according to subcategories

As relates to methane emissions most of them originated from enteric fermentation (88.5%) and about 11.4% is related to manure management in 2016. Share of field burning of agricultural residues represent only 0.2% of emissions (Fig. 5.3).

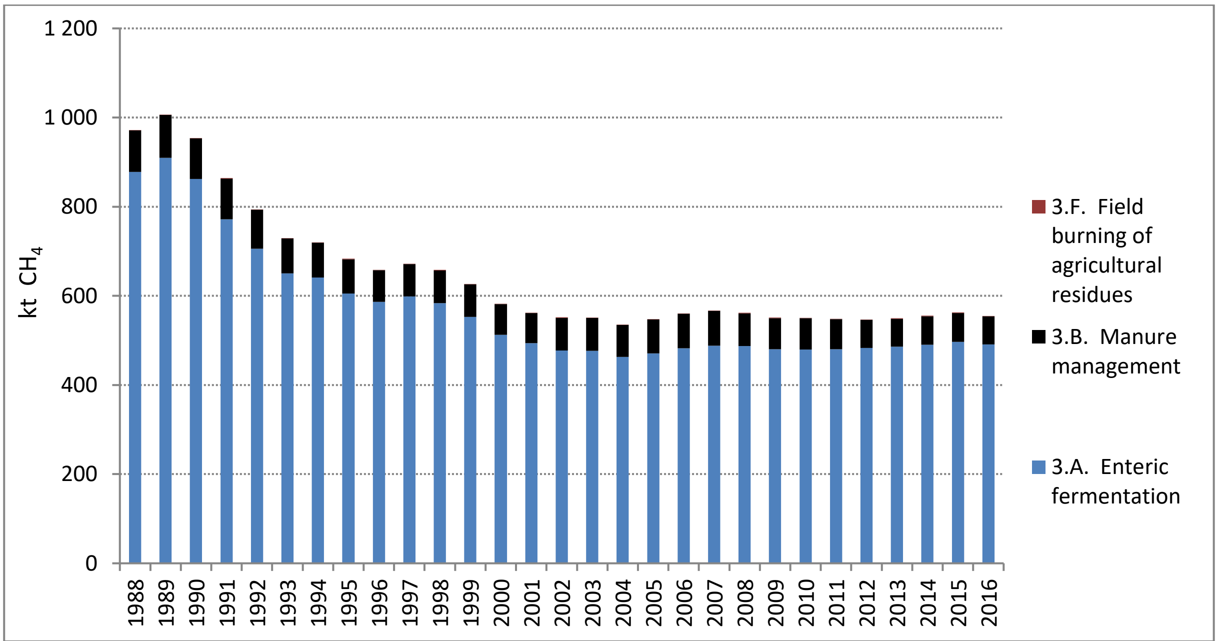

Figure 5.3. Methane emissions from the Polish agriculture according to subcategories

As concerns the nitrous oxide emissions, the main source of emissions in 2016 is agricultural soils responsible for 86.6% while manure management − for 13.3%. Emissions from field burning of agricultural residues are negligible (0.08%) (Fig. 5.4).

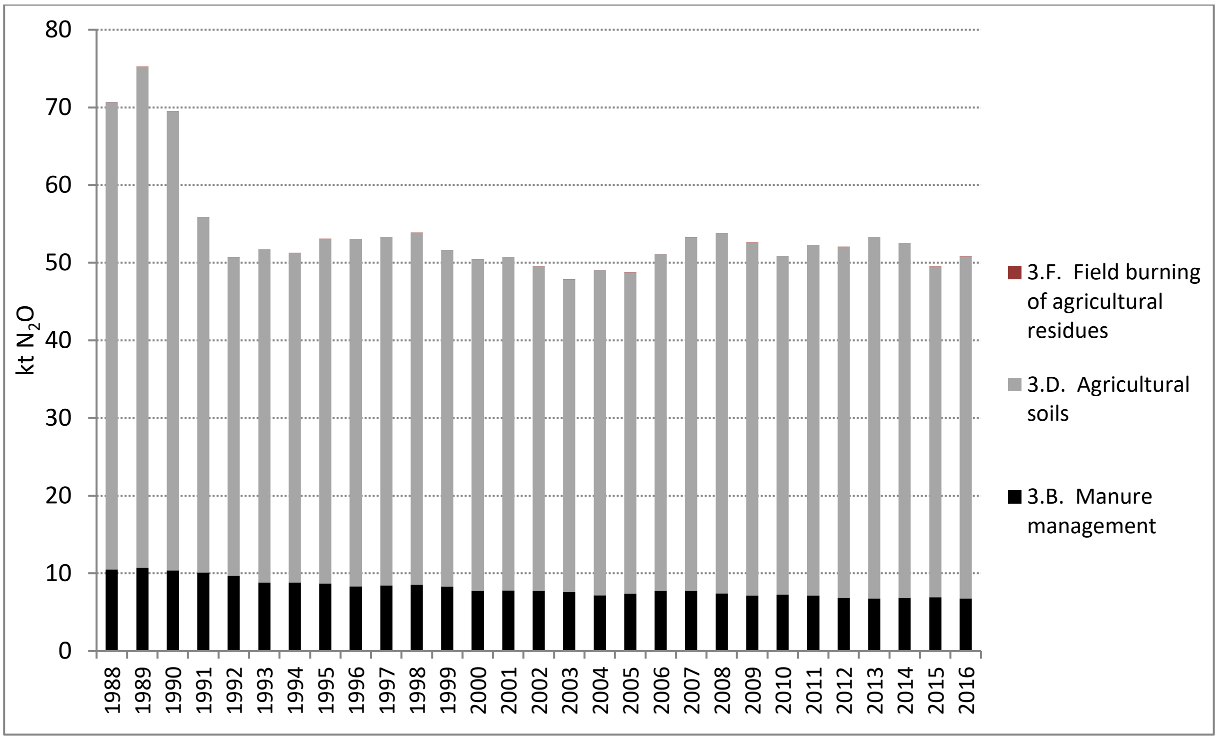

Figure 5.4. Nitrous oxide emissions from the Polish agriculture according to subcategories

5.2. Enteric Fermentation (CRF sector 3.A)

5.2.1. Source category description

CH_4 emissions from animals' enteric fermentation in 2016 amounted to 491.1 kt CH_4 and decreased since 1988 by 44%. 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 reaches 95% in 1988-2016. At the same time CH_4 emission reduction for dairy cattle exceeded 44% (table 5.1)

Table 5.1. Trends in CH_4 emissions from enteric fermentation in 1988-2016 [kt CH_4]

Year	Dairy cattle	Non-dairy cattle	Sheep	Goats	Horses	Swine	Total
1988	525.16	268.70	35.02	0.90	18.92	29.41	878.10
1989	548.45	279.54	35.27	0.90	17.51	28.25	909.93
1990	532.09	249.77	33.27	0.90	16.94	29.20	862.16
1991	487.69	207.69	25.87	0.90	16.90	32.80	771.85
1992	447.52	192.86	14.96	0.90	16.20	33.13	705.56
1993	418.28	178.01	10.14	0.90	15.14	28.29	650.75
1994	406.63	186.31	6.96	0.90	11.20	29.20	641.19
1995	375.20	181.07	5.70	0.90	11.45	30.63	604.95
1996	365.48	178.47	4.42	0.90	10.24	26.95	586.46
1997	371.33	185.33	3.93	0.91	10.04	27.20	598.74
1998	375.88	164.16	3.62	0.93	10.10	28.75	583.45
1999	360.69	150.66	3.14	0.91	9.92	27.81	553.11
2000	329.82	143.74	2.90	0.88	9.89	25.68	512.92
2001	324.37	130.14	2.74	0.86	9.83	25.66	493.60
2002	310.39	129.62	2.76	0.97	5.94	27.94	477.62
2003	314.34	124.70	2.70	0.96	5.99	27.91	476.61
2004	304.64	123.42	2.54	0.88	5.78	25.48	462.75
2005	306.41	128.69	2.53	0.71	5.62	27.17	471.12
2006	310.54	134.95	2.41	0.65	5.53	28.32	482.39
2007	310.77	141.01	2.66	0.72	5.92	27.19	488.27
2008	312.93	142.62	2.59	0.68	5.86	23.14	487.81
2009	302.21	148.08	2.29	0.59	5.36	21.42	479.96
2010	298.62	151.30	2.06	0.54	4.75	22.30	479.57
2011	297.52	155.41	2.01	0.56	4.58	20.26	480.34
2012	298.63	160.34	2.13	0.45	4.00	17.37	482.93
2013	297.26	166.10	1.78	0.41	3.73	16.74	486.03
2014	295.60	171.31	1.61	0.41	3.73	17.59	490.25
2015	298.80	174.56	1.82	0.41	3.73	17.46	496.78
2016	290.70	178.61	1.91	0.22	3.34	16.30	491.09
share [%] in 2016	*59.2*	*36.4*	*0.4*	*0.0*	*0.7*	*3.3*	*100.0*
change [%] 1988-2016	*-44.6*	*-33.5*	*-94.5*	*-75.3*	*-82.4*	*-44.6*	*-44.1*

5.2.2. Methodological issues

Generally data on animal population is collected by Central Statistical Office and is published on an annual basis in Statistical Yearbook of the Republic of Poland [GUS (1989-2016)] but also in other agricultural statistical publications and the Local Bank Data in the Central Statistical Office [GUS R1 2017]. Annual average population (AAP), as it is described in the [2006 IPCC GLs, in Chapter 10.2.2 page 10.8], can be obtained as one-time animal inventory data, especially for static animal populations (like dairy cattle or breeding swine). It should be noted that in Poland the June sample survey is a common date for collecting data by national statistics on all main livestock numbers and covers entire trend since the base year 1988. The exception here is swine population for which data in 1998-2013 were collected also in summer but in July. It should be mentioned that for the last years sample surveys for cattle, sheep and poultry are performed twice a year (June, December) while for swine - three times a year (March, June and December) but the dates for additional sampling are not consistent and use to change since 1988. On the other hand population of horses and goats is collected once a year, in June, only. Additionally, for the first years of the inventoried series, only one annual number of livestock is available (June) for all main animal categories. In conclusion, application of the June survey results is justified and in fact the only one available to ensure timeseries consistency

Even more - comparison of differences in livestock population in the surveyed months performed for the same year indicated that summer populations are the highest in most of cases of the given year, thus use of summer statistical data should not lead to underestimation of the emission. The population data on livestock applied for GHG inventory correlates also with the numbers available in the FAO database what can be checked for consistency. Detail methodological information related to collecting data on livestock population by Central Statistical Office is given in Annex 5.

Trend of animal population (excluding cattle) in 1988−2016 is given in table 5.2. 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. Also data on rabbits and 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], 2010 [GUS R8 2010] and 2013 [GUS R9 2014] when Agricultural Censuses were performed or other periodic studies were published containing required data. Interpolation was used for lacking years, for 2014-2016 data from 2013 was used. No information on deer population is available.

Table 5.2. Trends of livestock population in 1988-2016

Years	Livestock population [thousands]						
	Sheep	Goats	Horses	Swine	Poultry	Rabbits	Fur-bearing animals
1988	4 377	179	1 051	19 605	234 605	1 091	483
1989	4 409	179	973	18 835	253 301	1 091	441
1990	4 159	179	941	19 464	216 341	1 091	399
1991	3 234	179	939	21 868	209 090	1 091	357
1992	1 870	179	900	22 086	192 880	1 091	314
1993	1 268	179	841	18 860	188 759	1 091	272
1994	870	179	622	19 466	194 661	1 091	230
1995	713	179	636	20 418	185 745	1 091	187
1996	552	179	569	17 964	203 873	1 091	145
1997	491	182	558	18 135	197 400	1 054	164
1998	453	186	561	19 168	197 193	1 017	183
1999	392	181	551	18 538	197 267	981	201
2000	362	177	550	17 122	194 126	944	220
2001	343	172	546	17 105	202 519	907	239
2002	345	193	330	18 629	193 996	870	257
2003	338	192	333	18 605	143 457	840	281
2004	318	176	321	16 988	128 835	811	305
2005	316	142	312	18 112	122 755	781	329
2006	301	130	307	18 881	122 068	751	353
2007	332	144	329	18 129	133 475	721	377
2008	324	136	325	15 425	141 615	691	401
2009	286	119	298	14 279	125 878	661	425
2010	258	108	264	14 865	140 997	632	449
2011	251	112	254	13 509	139 837	550	427
2012	267	90	222	11 581	127 130	468	404
2013	223	82	207	11 162	134 584	386	382
2014	201	82	207	11 724	142 342	386	382
2015	228	82	207	11 640	159 422	386	382
2016	239	44	185	10 865	183 786	386	382

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 1988-2016 [thousands]

Years	Dairy cattle	Non-dairy cattle			
		young cattle < 1 year	young cattle 1-2 years	heifers > 2 years	bulls > 2 years
1988	4 806	*2 879*	*2 025*	*401*	*211*
1989	4 994	*2 996*	*2 107*	*417*	*219*
1990	4 919	*2 678*	*1 883*	*373*	*196*
1991	4 577	*2 227*	*1 567*	*310*	*163*
1992	4 257	*2 069*	*1 456*	*288*	*151*
1993	3 983	*1 910*	*1 344*	*266*	*140*
1994	3 863	*2 001*	*1 407*	*279*	*146*
1995	3 579	*1 946*	*1 368*	*271*	*142*
1996	3 461	*1 919*	*1 349*	*267*	*140*
1997	3 490	*1 992*	*1 401*	*278*	*146*
1998	3 542	1 799	1 235	280	99
1999	3 418	1 647	1 108	283	99
2000	3 098	1 572	1 101	231	81
2001	3 005	1 472	973	210	74
2002	2 873	1 384	1 084	142	50
2003	2 898	1 349	932	229	81
2004	2 796	1 309	916	246	86
2005	2 795	1 425	978	209	76
2006	2 824	1 428	1 040	224	90
2007	2 787	1 473	1 072	265	99
2008	2 806	1 502	1 102	263	83
2009	2 688	1 472	1 204	238	99
2010	2 656	1 457	1 244	276	92
2011	2 626	1 481	1 300	242	113
2012	2 578	1 469	1 344	239	147
2013	2 531	1 586	1 422	178	144
2014	2 479	1 609	1 433	259	141
2015	2 444	1 669	1 529	222	97
2016	2 332	1 728	1 576	215	87

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]:

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

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 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) using the equation 10.16 from [IPCC 2006]:

$$GE = \left[\frac{\left(NE_m + NE_a + NE_l + NE_{work} + NE_p\right)}{REM} + \frac{NE_g}{REG}\right] / \frac{DE\%}{100}$$

Where:

GE = gross energy, MJ/day
NE_m = net energy required by the animal for maintenance (Equation 10.3), MJ/day
NE_a = net energy for animal activity (Equation 10.4), MJ/day
NE_l = net energy for lactation (Equations 10.8), MJ/day
NEwork = net energy for work (Equation 10.11), MJ/day (assumed zero)
NEp = net energy required for pregnancy (Equation 10.13), MJ/day
REM = ratio of net energy available in a diet for maintenance to digestible energy consumed (Equation 10.14)
NEg = net energy needed for growth (Equation 10.6), MJ/day
REG = ratio of net energy available for growth in a diet to digestible energy consumed (Equation 10.15)
DE%= digestible energy expressed as a percentage of gross energy

Parameters required for estimation of GE factor for dairy cattle like pregnancy [GUS R1 2017], milk production [GUS M 2017], percent of fat in milk [GUS R 2017] 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% since 2012. As concerns non-dairy cattle, DE parameters for 1988-2016 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 were taken from IPCC 2006 GLs (C_{fi} − table 10.4, C_a − table 10.5, $C_{pregnancy}$ − 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 124.6 kg CH_4/animal/year in 2016, following GE changes. The CS emission factor is higher than the IPCC default one (89 kg CH_4/animal/year for Eastern Europe with average milk production 2550 kg/head/yr) due to increasing intensification of dairy cattle production, characterised among others, with growing milk production (tab. 5.4) and is in the lower range of EFs applied by other European countries (107 – 154 kg CH_4/animal/year in 2015) due to specific dairy cattle breeding conditions described below.

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]. Specific methane emission factors for entire trend for non-dairy cattle are presented in table 5.5. The values of EFs vary from 48.7 kg CH_4/animal/year in 1988 up to 49.5 kg CH_4/animal/year in 2016. The CS weighted mean EF for non-dairy cattle is lower than the IPCC default one amounting to 58 kg CH_4/animal/year for Eastern Europe what relates to high share of youngest cattle (< 1 year) among this category (53% in 1998 and 48% in 2016) (table 5.3). At the same time the Polish CH_4 CS EF for non-dairy cattle is at similar level than EFs reported by other European countries, varying from 41 to 65 kg CH_4/animal/year in 2015.

As relates to dairy cattle breeding and impact on milk productivity, three main factors influence the most: feeding, genetic and environmental. Observed in Poland increased milk productivity, especially after joining the EU in 2004, is related to all three factors, but genetic progress (mostly selection and increasing share of HF cattle) influences here the littlest. Still mean milk production in Poland is about 30% lower than, for instance, in Germany. The feeding factor has the highest impact on milk productivity improvement for country specific dairy cattle population based on research made by the National Research Institute of Animal Production. The feeding model reshaped into good quality maize silage used for forage at the milk market. Significant investments were made on farms with changing from tied to free-stall maintenance systems in parallel with modernisation of cowsheds for semi-open buildings with curtain ventilation. Also thermal stress has been eliminated in herds with increasing milk productivity for both: high and low temperatures (elimination of pasturage during heat waves and thermal modernisation of barns).

Genetic progress still remains the most expensive way of increasing milk productivity. As the income of milk farms is relatively low most of them decides to cross/mix existing cattle with Holstein- Friesian (KF) breed than to purchase pure breed cattle. Mean share of HF mix within these herds is about 70%. However the remaining 70% of domestic dairy cows population is based on the Polish Black-White breed, Simental and Jersey characterised with lower body mass than HF. In Poland small milky farms still dominate having 15-30 dairy cattle for which genetic progress is too expensive. Moreover Simental breed is maintained at the mountainous areas where fodder is much worse taking into account climatic conditions. Based on this characterisation of dairy cattle in Poland it is assumed the mean body weight for dairy cows used in the inventory is 500 kg following the official livestock unit parameter as determined by the National Research Institute of Animal Production.

Table 5.4. Average annual milk production, daily gross energy intake (GE) and CH_4 emissions factors for dairy cattle in 1988–2016

Years	Average milk production [litres/cow/yr]	GE (gross energy intake) [MJ/cow/day]	Emission Factor [kg CH_4/animal/year]
1988	3 165	256	109
1989	3 260	258	110
1990	3 151	254	108
1991	3 082	250	107
1992	3 015	247	105
1993	3 075	246	105
1994	3 121	247	105
1995	3 136	246	105
1996	3 249	248	106
1997	3 370	250	106
1998	3 491	249	106
1999	3 510	248	106
2000	3 668	250	106
2001	3 828	253	108

Years	Average milk production [litres/cow/yr]	GE (gross energy intake) [MJ/cow/day]	Emission Factor [kg CH_4/animal/year]
2002	3 902	253	108
2003	3 969	254	108
2004	4 082	256	109
2005	4 147	257	110
2006	4 200	258	110
2007	4 292	262	112
2008	4 351	262	112
2009	4 455	264	112
2010	4 487	264	112
2011	4 618	266	113
2012	4 845	272	116
2013	4 978	276	117
2014	5 164	280	119
2015	5 395	287	122
2016	5 563	292	125

Table 5.5. Trends of emission factors for cattle with detail breakdown of non-dairy cattle population in 1988-2016 [kg CH_4/head/yr]

Years	Non-dairy cattle weighted mean EF	Non-dairy cattle EF			
		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	49.90	32.11	67.29	48.65	75.59
2014	49.78	32.11	67.29	48.65	75.59
2015	49.65	32.11	67.29	48.65	75.59
2016	49.52	32.11	67.29	48.65	75.59

5.2.3. Uncertainties and time-series consistency

Uncertainty analysis for the year 2016 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 1988-2015 ensured consistency for whole time-series.

2016	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 Emission uncertainty [%]	CH_4 Emission uncertainty [%]	N_2O Emission uncertainty [%]
3. Agriculture	1 040.09	**555.20**	**50.85**	18.0%	29.4%	61.4%
A. Enteric Fermentation		491.09			32.2%	
B. Manure Management		63.13	6.75		61.1%	34.0%
D. Agricultural Soils			44.06			70.6%
F. Field Burning of Agricultural Residues		0.99	0.04		18.8%	101.4%
G. Liming	663.34			22.4%		
H. Urea application	376.75			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

- No recalculations were made

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

Change	1988	1989	1990	1991	1992	1993
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2012**	**2013**	**2014**	**2015**		
kt	0	0	0	0		
%	0	0	0	0		

5.2.6. Source-specific planned improvements

No further improvements are planned at the moment.

5.3. Manure Management (CRF sector 3.B)

5.3.1. Source category description

CH_4 emissions related to animal manure management in 2016 amounted to 63 kt and decreased since 1988 by about 32%. Most of CH_4 emissions come from manure generated by cattle (57%) and swine (34%).

Table 5.7. Trends in CH_4 emissions from manure management according to livestock categories in 1988-2016

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	36.66	5.94	0.42	93.44
1989	37.49	13.81	0.84	0.02	1.52	35.27	6.66	0.39	95.99
1990	35.97	10.01	0.79	0.02	1.47	36.50	5.82	0.36	90.95
1991	32.99	9.37	0.61	0.02	1.46	41.07	5.57	0.33	91.43
1992	29.92	8.66	0.36	0.02	1.40	41.55	5.25	0.30	87.46
1993	27.50	7.74	0.24	0.02	1.31	35.53	5.20	0.27	77.82
1994	26.75	8.02	0.17	0.02	0.97	36.73	5.54	0.24	78.44
1995	24.69	7.61	0.14	0.02	0.99	38.58	5.17	0.21	77.42
1996	23.61	7.33	0.10	0.02	0.89	34.00	5.12	0.19	71.27
1997	24.37	7.44	0.09	0.02	0.87	34.37	5.00	0.20	72.37
1998	24.10	6.74	0.09	0.02	0.88	36.57	5.19	0.21	73.79
1999	24.96	6.35	0.07	0.02	0.86	35.33	5.23	0.22	73.05
2000	23.25	6.16	0.07	0.02	0.86	32.63	5.26	0.23	68.48
2001	22.79	5.66	0.07	0.02	0.85	32.74	5.43	0.23	67.80
2002	25.90	5.67	0.07	0.03	0.51	35.72	5.20	0.24	73.34
2003	28.56	5.54	0.06	0.03	0.52	35.65	3.62	0.26	74.24
2004	29.91	5.48	0.06	0.02	0.50	32.54	3.32	0.27	72.10
2005	30.24	5.71	0.06	0.02	0.49	35.53	3.26	0.29	75.59
2006	30.31	5.85	0.06	0.02	0.48	37.37	3.33	0.30	77.71
2007	30.83	6.18	0.06	0.02	0.51	36.39	3.60	0.31	77.92
2008	31.20	6.26	0.06	0.02	0.51	30.87	3.88	0.33	73.13
2009	29.91	6.44	0.05	0.02	0.46	29.40	3.59	0.34	70.21
2010	28.60	6.64	0.05	0.01	0.41	30.36	3.84	0.36	70.27
2011	29.01	6.81	0.05	0.01	0.40	26.95	3.86	0.33	67.42
2012	29.01	6.79	0.05	0.01	0.35	23.19	3.76	0.31	63.47
2013	28.88	7.11	0.04	0.01	0.32	22.30	3.75	0.29	62.71
2014	28.72	7.43	0.04	0.01	0.32	23.38	3.93	0.29	64.12
2015	29.03	7.55	0.04	0.01	0.32	23.16	4.37	0.29	64.77
2016	28.24	7.71	0.05	0.01	0.29	21.58	4.97	0.29	63.13
share [%] in 2016	*44.7*	*12.2*	*0.1*	*0.0*	*0.5*	*34.2*	*7.9*	*0.5*	*100.0*
change [%] 1988-2016	*-21.5*	*-35.6*	*-94.5*	*-75.3*	*-82.4*	*-41.1*	*-16.4*	*-30.2*	*-32.4*

Generally decreasing trend is observed in CH_4 emissions from manure management for all livestock sub-categories, where the biggest drop over time occurred to sheep breeding where CH_4 emissions dropped by 95% in 1988-2065 (tab. 5.7). The main reason for decreasing emissions are diminishing livestock populations and conditions described in previous chapter.

N_2O emissions from manure management amounted to 6.8 kt in 2016 and drop since 1988 by 36% what is associated mostly with the diminishing livestock population. Direct emissions are responsible for about 49% and indirect for 51% of N_2O emissions in this category (fig. 5.5).

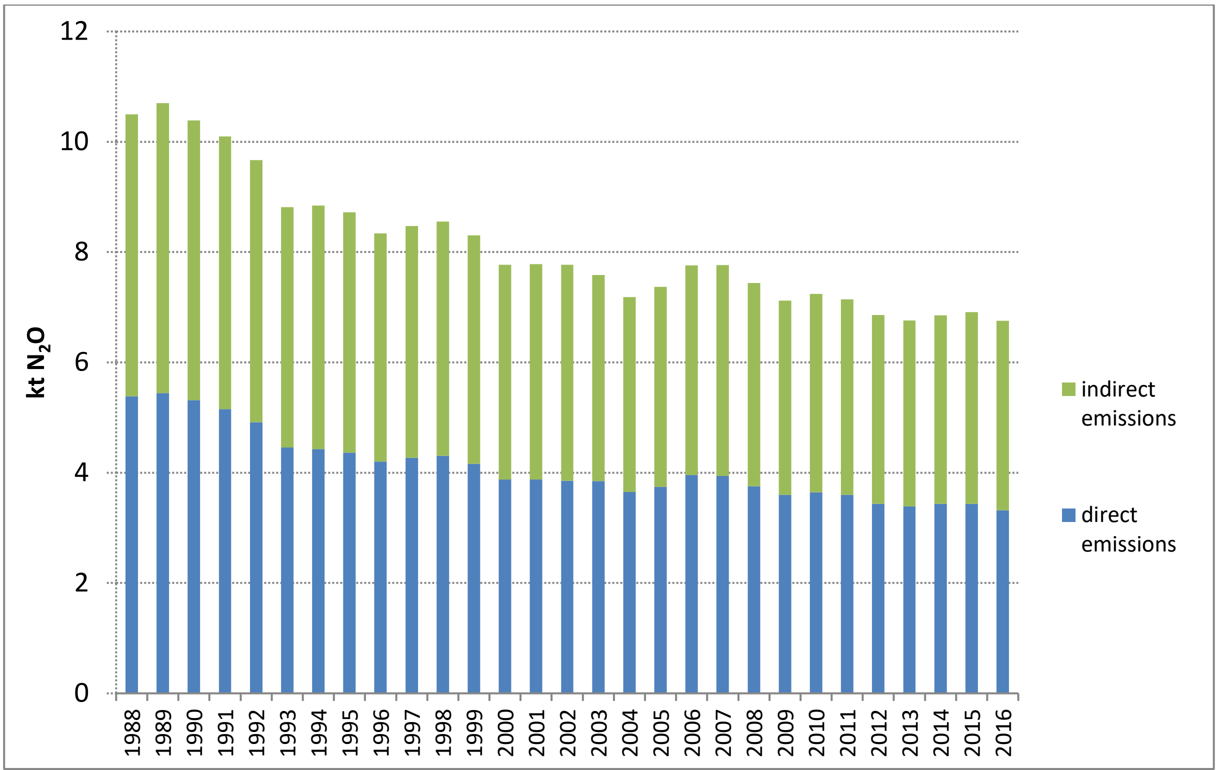

Figure 5.5. Trends of N_2O emissions (in division for direct and indirect) from manure management

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).

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 2013-2016.

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 litter-free systems and 89% on solid storage [Walczak 2011, 2012, 2013].

It should be noted that generally in Poland prevail small farms (56% farms breed livestock, 54% farms have up to 5 ha and only 9% farms have more than 20 ha) where solid systems for animal management are commonly used due to lower investment costs. Liquid systems are applied only at big farms, for instance for dairy cattle - 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.

The data on AWMS shares for livestock is prepared by the Institute of Animal Production where the database has been established and is permanently developed and improved. The database covers livestock population together with their waste management systems (solid, liquid) to determine impact of animal production on natural environment. This database covers animal breeding according to groups (technological and age) for Poland and has been constructed based on livestock monitoring on farms across country in frames of Multiannual Program: "Protection and management of national genetic resources of livestock in the sustainable use conditions" in 2011-2015. Steps are undertaken to include AWMS data in the next Agricultural Census (2020) in cooperation with Central Statistical Office as well as there is a prospect of collecting such AWMS data before 2020 in the satellite research made by the Central Statistical Office on a representative sample of farms.

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
2016	10.5	79.2	10.3	5.1	82.9	12.0	24.3	75.7	0.0

5.3.2.1. Estimation of CH_4 emissions from manure management

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

$$EF = Vs * 365\frac{days}{year} * B_o * 0.67\frac{kg}{m^3} * \sum MCF * MS$$

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 2006 IPCC 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. The CS methane EFs for dairy cattle range from around 7 kg CH_4/animal/year in 199.ties to 12 kg CH_4/animal/year in 2016. EFs for later years are close to the IPCC default ones (11 kg CH_4/animal/year for cool climate ≤10°C). The EFs range between European countries is relatively high: from 3 up to 29 kg CH_4/animal/year depending, among others, on AWMS shares and climatic conditions. The rising trend of Polish EFs for dairy cattle is mostly related to increasing share of liquid systems since 1988. On the other hand the methane CS EFs for non-dairy cattle is around 2 kg CH_4/animal/year in entire period and is lower than the IPCC default EF (6 kg CH_4/animal/year) due to small share of liquid systems applied (see also table 5.8).

For swine also the above mentioned equation was used in calculation of emission factors but the default values for Vs, B_o and MCF were applied (IPCC 2006). The weighted mean CH_4 EF calculated as described above for market swine is 1.9 kg CH_4/animal/year and for breeding swine 3.1 kg

CH_4/animal/year and both EFs are lower than the IPCC default EFs (3 kg CH_4/animal/year for market swine and 4 kg CH_4/animal/year for breeding swine). The range of CH_4 EFs for manure management for swine in European countries varies significantly depending, among others, on climatic conditions and AWMS share: from 1 in Northern Europe to even 16 kg CH_4/animal/year in the south.

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.

Methane conversion factors (MFCs) for all systems were taken from the table 10.17 of the 2006 IPCC Guidelines for cool climate ≤ 10°C: 1% for pasture/range/paddock, 2% for solid storage and for 17% liquid/slurry systems. As the information on share of liquid systems with and without crust are not presently recognised in detail the conservative approach was taken to use the higher value of MCF characterising slurry system without natural crust cover for cool climate conditions.

Methane combusted in biogas plants, including agriculture biogas plants, is included in energy sector. Separation of methane emissions from anaerobic digesters based specifically on livestock manure is not possible due to lack of detail data on the amount and type of animal manure used as input. Apart from manure also other substrates (crops, slaughter waste) are applied in biogas plants. Additionally 2006 IPCC Guidelines do not provide comprehensive methodology for anaerobic digesters, were MCF for anaerobic digesters is not specified, rangining from 0 to 100%, and information necessary for establishing country specific MCF using Formula 1 given in Table 10.17 require detail data from biogas installations that is not available in national statistics.

Table 5.9. Methane-producing potential (B_o), volatile solids excreted (Vs) and CH_4 emission factors for manure management in 2016

Livestock	EF Emission Factor [kg CH_4/animal/year]	Vs Volatile Solids Excreted [kg d.m./animal/day]	B_o Methane-producing potential [m^3 CH_4/kg Vs]
Dairy cattle	12.11	5.93	0.24
Non-dairy cattle	2.14	1.88	0.17
Market swine Breeding swine	1.92 3.07	Market swine: 0.30 Breeding swine: 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):

$$\mathrm{N_2O_{D(mm)}} = [\sum_S [\sum_T (N_{(T)} * Nex_{(T)} * MS_{(T,S)})] * EF_{3(S)}] * \frac{44}{28}$$

where:

$N_2O_{D(mm)}$ – direct N_2O 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

As the data on animals' nitrogen excretion rates (kg N/head/year) is country specific one [IUNG, Kopiński 2014] it could be assumed that the *Tier 2* method is applied for all livestock categories (apart from fur-bearing animals). 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. The Nex parameters for dairy cattle differ in time what is related mostly to increasing milk production where mean milk yield exceeded 4500 litters/yr on average in 2011 (table 5.4). Country specific Nex values 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 (table 5.10).

The exemptions are sheep and goats where Nex values for Poland are among group of countries with lower factor then the default ones in 2006 IPCC GLs. The country specific Nex values were established based on livestock categories raised in Poland as well as country specific conditions and international literature and research. Sheep (as well as goats) in Poland are fed on pastures for around half a year and housed for another half. Sheep and goats are fed mostly on roughage from extensive pastures and meadows. Winter feeding cover hay, straw and root crops. Additional protein fodder is not widely applied among sheep and goats, if applied it is limited to lambs. It should be mentioned here that Nex is established for entire group of sheep of which about 30% are lambs and other immature animals.

For rabbits and other fur-bearing animals the *Tier 1* method and default Nex values were used from [IPCC 2006, table 10.19] where Nex for rabbits amounts to 8.1 kg N/head/yr and Nex for other fur-bearing animals is the weighted mean value of 6.36 kg N/head/yr, established based on population of foxes and minks (respectively 12.09 for foxes and 4.59 kg N/head/yr for minks).

Table 5.10. Country specific Nitrogen excretion rates (Nex) in manure by livestock categories

Livestock	Nex [kg/head/year]		
	CS	UNECE 2001	2006 IPCC (based on default animal mass)
Dairy cattle: 1988–1995 1996–2000 2001–2005 2006–2010 Since 2011	 65.0 70.0 75.0 80.0 83.0	60 – 110 (< 5000 kg milk/cow/yr) 100 - 140 (5000-6000 kg milk/cow/yr; low amount of concentrate) 80 – 100 (5000-6000 kg milk/cow/yr; >500 kg concentrate/yr) 110 - 140 (9000-10000 kg milk/cow/yr)	70.26
Non-dairy cattle: calves up to 1 year Young cattle 1–2 years Heifers above 2 years Bulls above 2 years	 19.0 46.0 53.0 65.0	Beef cattle: 40-50 Extensive (maily grazing) 35-45 Intensive (corn silage etc.)	49.95
Swine: piglets (< 20 kg) piglets (20-50 kg) fattening pigs (> 50 kg) sows butcher hogs	 2.6 9.0 15.0 20.0 18.0	10-18 30-40 (including piglets to 25 kg)	Market – 10.04 Breeding – 30.22
Sheep	9.5	-	15.93
Goats	8.0	-	17.99
Horses	55.0	-	41.28
Poultry: Laying hens Broilers Turkeys Ducks	 0.8 0.2 1.6 1.0	 0.60 – 0.80 0.35 – 0.50	 0.54 0.36 1.84 0.82

Default values of N_2O emission factors for given management systems from [IPCC 2006, table 10.21] were applied (table 5.11). As the information on share of liquid systems with and without crust are not presently recognised in detail the conservative approach was taken to use the higher value of N_2O EF characterising slurry system with natural crust cover.

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 the difference between Nitrogen loss from manure management $Frac_{Loss}M$ (IPCC 2006 Table 10.23) and Nitrogen loss due to volatilisation of NH_3 and NOx from manure management $Frac_{Gass}MS$ (IPCC 2006 Table 10.22).

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

- correction of weighted mean Nex value for other cattle (N_2O)

Table 5.12. Changes in CH_4 emissions from manure management due to recalculations

Change	1988	1989	1990	1991	1992	1993
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2012**	**2013**	**2014**	**2015**		
kt	0	0	0	0		
%	0	0	0	0		

Table 5.13. Changes in N_2O emissions from manure management due to recalculations

Change	1988	1989	1990	1991	1992	1993
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2012**	**2013**	**2014**	**2015**		
kt	0	0	-0.06	-0.09		
%	0	0	-0.84	-1.34		

5.3.6. Source-specific planned improvements

Recognition related to data on liquid systems management with differentiation for with/without crust is planned.

5.4. Agricultural Soils (CRF sector 3.D)

5.4.1. Source category description

Nitrous oxide emissions from agricultural soils amounted to 44.1 kt N_2O in 2016 and significantly decreased since base year by about 27% (fig. 5.6). Since 1993 emissions stabilised with few percent changes between years. There are several main driving forces influencing emissions variability during entire inventoried period: nitrogen mineral and organic fertilizers use, livestock and crops production.

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 74% up to 2016 while maize production increased more than 15-fold (table 5.14).

Table 5.14. Main crops production in 1988–2016 in Poland [kt]

Year	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
2014	11629	3275	4468	1459	2793	5247	2922	135	115	352	7689	3276	5607	4189
2015	10958	2961	3156	1220	2013	5339	2250	99	172	543	6314	2701	4795	4100
2016	10828	3441	4343	1358	2200	5102	2415	160	180	458	8872	2219	5610	4644
change [%] 1988-2016	42.8	-9.5	2028.9	-38.9	-60.0	194.8	-28.7	118.5	66.6	0.2	-74.4	85.1	8.3	114.2

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).

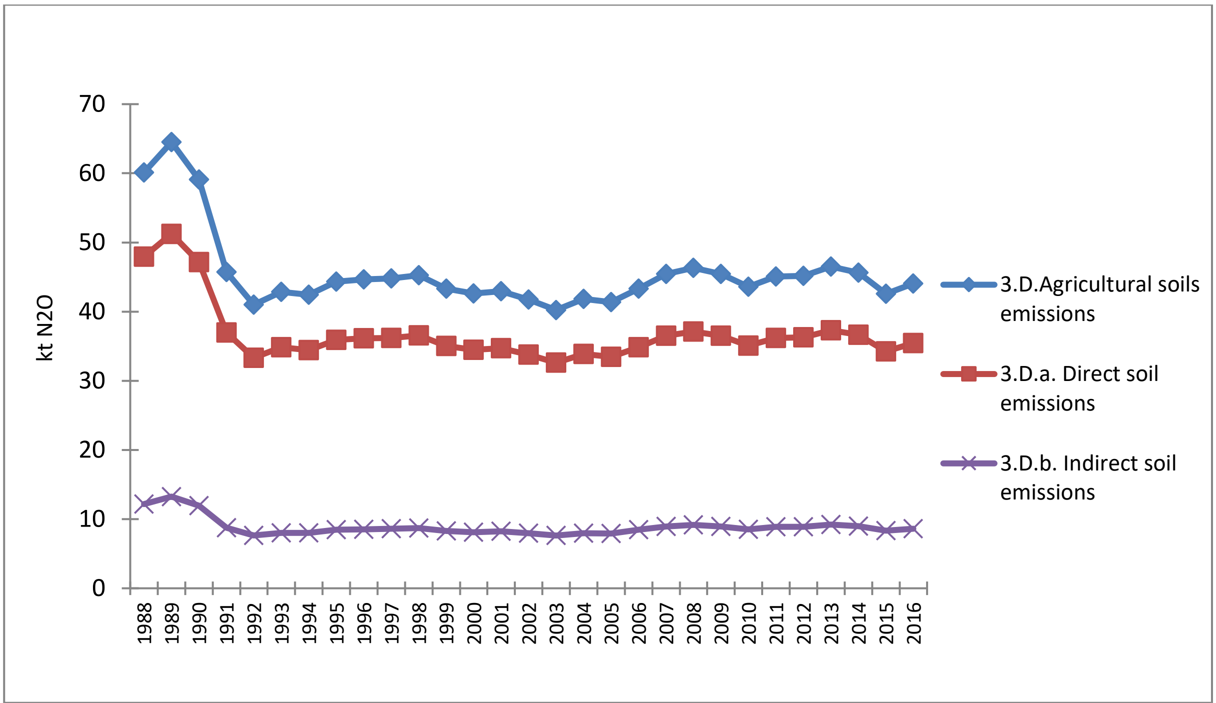

Figure 5.6. N_2O emissions from agricultural soils

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:

$$N_2O_{Direct} - N = (F_{SN} + F_{ON} + F_{CR} + F_{SOM})EF_1 + F_{OS} * EF_2 + F_{PRP} * EF_{3PRP}$$

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 2016 about 46% of direct N_2O emissions comes from the use of synthetic nitrogen fertilizers, about 24% relates to management of organic soils, 13% − to crop residues and to organic fertilizers applied to soils. Only 3% of direct N_2O emissions comes from urine and dung left by grazing animals on pastures (fig. 5.7). As relates to mineralisation of soils as a result of changes of land use or management – these emissions are moved to LULUCF sector.

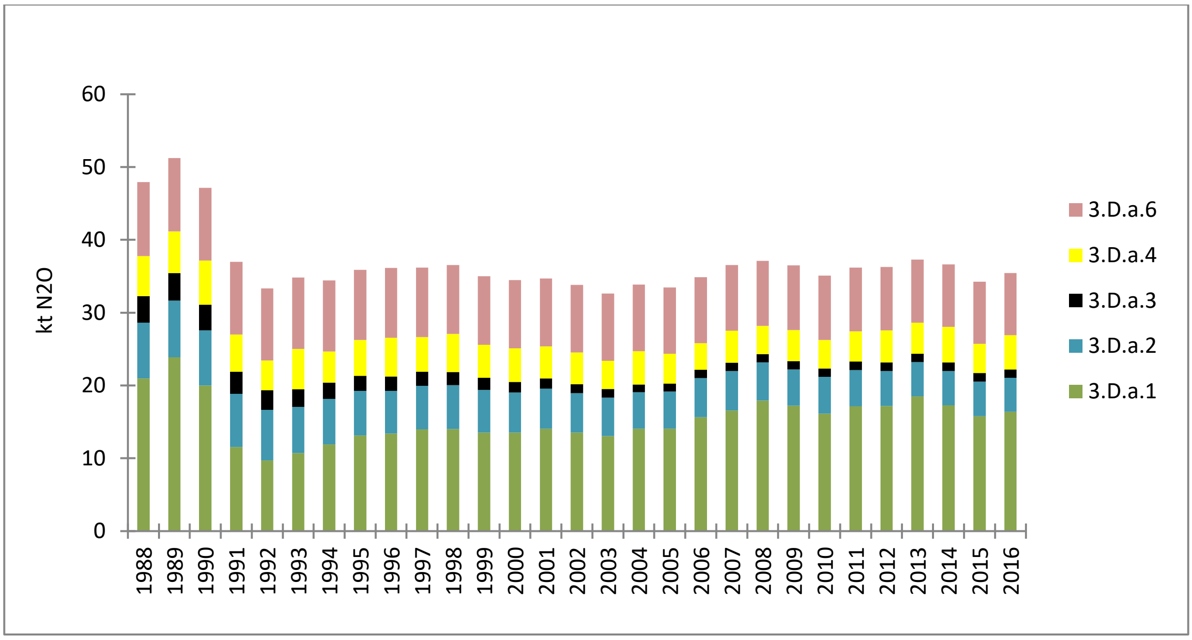

Figure 5.7. Direct N_2O emissions from specific subcategories

Synthetic nitrogen fertilizers (F_{SN}) (CRF sector 3.D.a.1)

N_2O emission from synthetic fertilizers was estimated based on the amount of nitrogen synthetic fertilizer applied to soils published in [GUS R2 2017]. 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). As part of the Act on Fertilisers and Fertilisation, *inter alia*, the following measures are introduced: limitation of the natural fertiliser dose to 170 kg N/ha/year, a ban on the use of natural fertilisers from the end of November to the beginning of March and mandatory training for fertilizer service providers [BR3 POL 2017, chapter 4.6.5.2].

Table 5.15. Nitrogen fertilizers use (F_{SN}) in 1988–2016 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**	**2014**	**2015**	**2016**							
1095	1179	1098	1004	1043							

Nitrous oxide emissions amounted in 2016 about 16.4 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}) (CRF sector 3.D.a.2)

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 taken into account in total Nitrogen applied to soils. Data related to Nitrogen added in straw was calculated in line with Ammonia emissions from manure management for straw based systems and amounts to: dairy cattle; 6 kg N/animal/yr., other cattle 2 kg N/animal/yr., fattening pigs: 0.8 kg N/animal/yr., sows 2.4 kg N/animal/yr., sheep and goats 0.08 kg N/animal/yr., horses 2 kg N/animal/yr. The fractions of animal manure burned for fuel, used for feed and fuel were neglected because these activities do not occur in Poland.

Nitrous oxide emissions from animal manure applied to soils in 2016 was about 4.6 kt N_2O. Trend of emissions is caused by trend of livestock population, mainly cattle and sheep after 1989, and changes in AWMS share.

Activity data on the amount of **sewage sludge applied on the fields** were taken from national statistics [GUS 2016d] 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 2003−2009 where constant increasing trend was noted (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 more than 28 million in 2016 where this number was more than doubled in 1988-2016. Also the number of municipal sewage treatment plants increased from 558 in 1988 up to 1923 in 1998 and 3253 in 2016 [GUS 2017d].

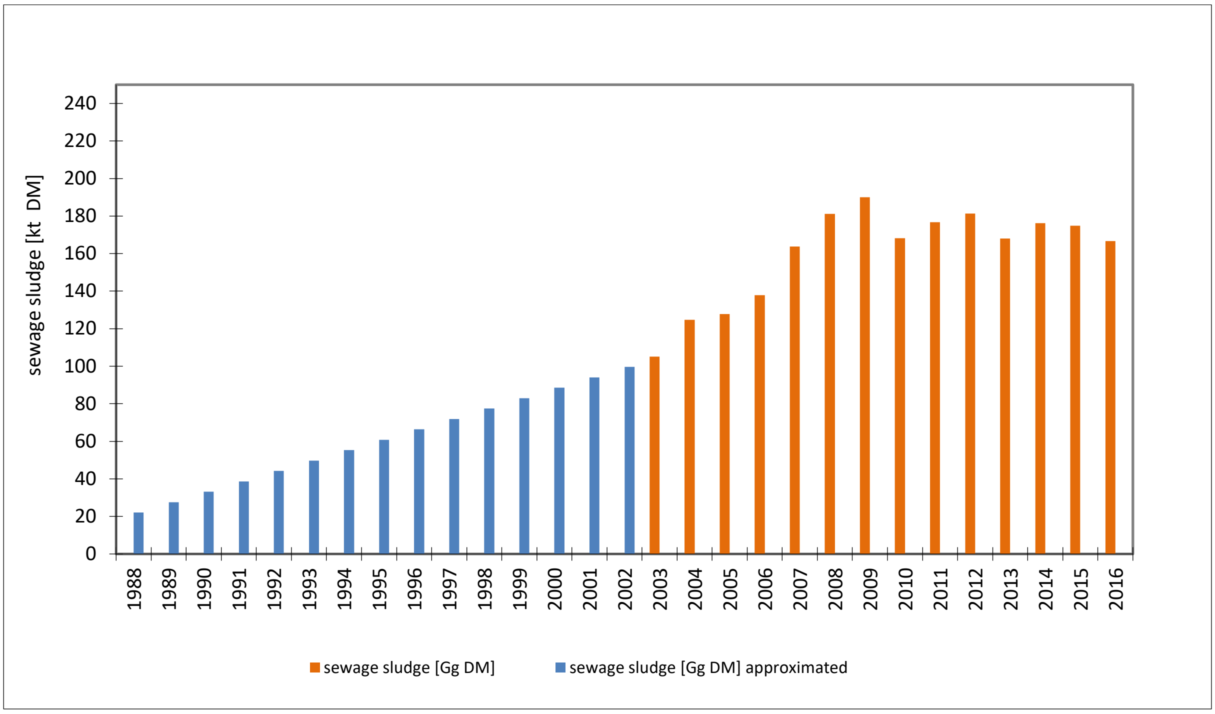

Fig. 5.8. Amounts of sewage sludge applied in agriculture [kt DM]

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 2016.

Urine and dung deposited by grazing animals (F_{PRP}) (CRF sector 3.D.a.3)

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 2016 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.

Crop Residues (F_{CR}) (CRF sector 3.D.a.4)

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]:

$$F_{CR} = \sum_{T} \{Crop_{(T)} * Area_{(T)} * Frac_{Renew(T)} * [R_{AG(T)} * N_{AG(T)} * (1 - Frac_{Burn(T)} - Frac_{Remove(T)}) + R_{BG(T)} * N_{BG(T)}]\}$$

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 (= [($AG_{DM(T)}$ * 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 2017] (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 2016 was 4.7 kt N_2O and is lower by about 14% than in 1988 due to 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}) (CRF sector 3.D.a.5)

The N_2O emission reported in this subcategory in previous NIRs was moved to the category 4.B. related to cropland use change as the indicated emissions were related to N loss due to land management change. For cropland remaining cropland no N_2O emissions are recognised.

Cultivation of organic soils (F_{OS}) (CRF sector 3.D.a.6)

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 2016 for the purpose of GHG emission projections which amounts to 679 thousand ha. Similarly to the previous period interpolation of histosol areas was applied between 1995 and 2015 and further up to 2020 [7RR 2017, chapter 5.1].

Nitrous oxide emissions from cultivated histosols in Poland in 2016 was about 8.5 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.

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]:

$$N_2O_{(ATD)} - N = \left[(F_{SN} * Frac_{GASF}) + \left((F_{ON} + F_{PRP}) * Frac_{GASM}\right)\right] * EF_4$$

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	257.17	2003	158.32
1989	278.15	2004	160.68
1990	248.72	2005	162.09
1991	188.32	2006	175.67
1992	169.04	2007	182.08
1993	165.84	2008	188.51
1994	170.86	2009	180.77
1995	175.79	2010	174.60
1996	173.63	2011	180.28
1997	178.04	2012	178.17
1998	178.26	2013	185.31
1999	172.15	2014	177.80
2000	166.26	2015	168.83
2001	169.43	2016	171.13
2002	163.52		

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	690.79	2003	436.25
1989	753.95	2004	462.36
1990	679.78	2005	455.32
1991	490.27	2006	482.75
1992	424.76	2007	515.38
1993	457.44	2008	527.83
1994	451.37	2009	517.27
1995	482.99	2010	490.66
1996	489.38	2011	513.05
1997	491.42	2012	515.63
1998	500.84	2013	535.90
1999	473.87	2014	524.69
2000	466.80	2015	480.32
2001	472.65	2016	503.21
2002	457.43		

Total indirect emission in 2016 was about 8.6 kt N_2O and the trend since 1992 is rather stable after significant drop in 1989-1992 accompanying serial decrease in mineral fertilisers use as well as in 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

- correction of weighted mean Nex value for other cattle (N_2O)

Table 5.19. Changes in N_2O emissions from agricultural soils resulting from recalculations

Change	1988	1989	1990	1991	1992	1993
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
kt	0	0	0	0	0	0
%	0	0	0	0	0	0
Change	**2012**	**2013**	**2014**	**2015**		
kt	0	0	-0.06	-0.10		
%	0	0	-0.13	-0.24		

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 2016 from field burning of agricultural residues amounted to 0.99 kt CH_4 and 0.04 kt N_2O. 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.

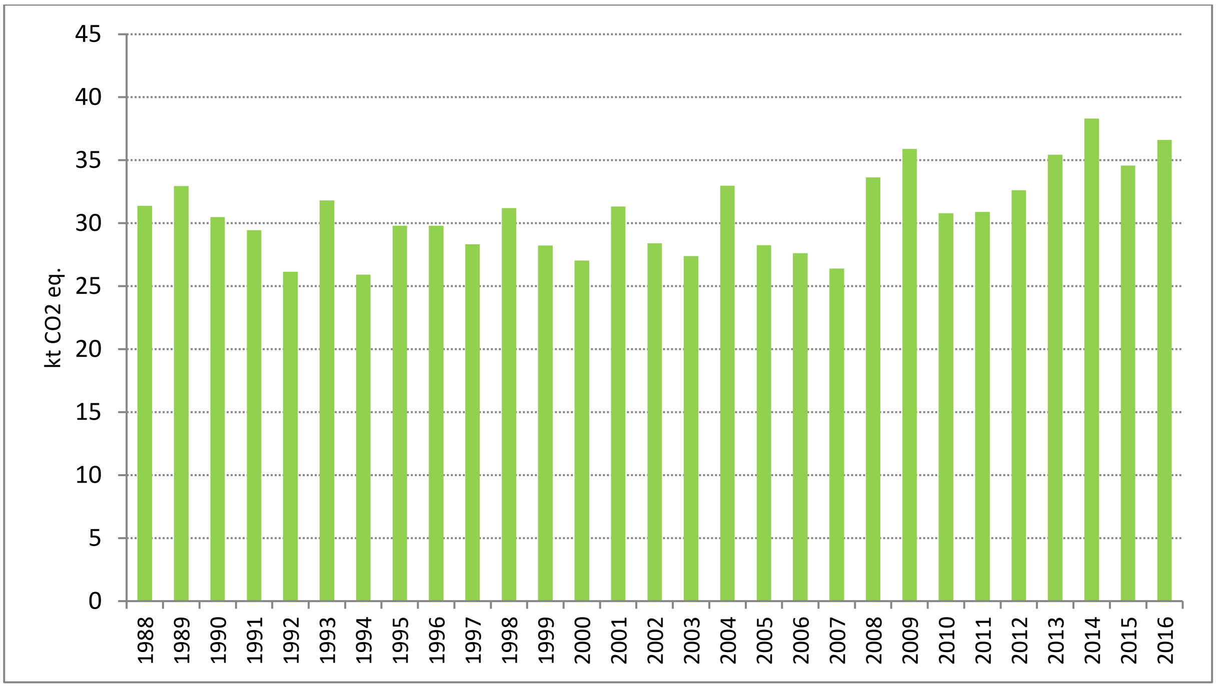

Figure 5.9 CH_4 and N_2O emissions from field burning of agricultural residues presented as CO_2 equivalent

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 still based on the IPCC methodology as published in 1997. This method is more detail and covers specific crops burned, than the method described in IPCC 2006 GLs (Chapters 2.4 and 5.2.4). These parameters and emissions are also consistent with calculations made for category 3.1.a.4 Crop residues retained to soils.

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 2017, GUS R10, 2017]. 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 (3.F) and direct soil emissions related to crop residues returned to soils (3.D.a.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

- recalculation was made in AD for flux straw for 2015 resulting in insignificant change.

5.5.6. Source-specific planned improvements

No improvements are planned presently.

5.6. CO_2 emissions from liming (CRF sector 3.G)

5.6.1. Source category description

Emissions of CO_2 from lime ($CaCO_3$) and dolomite ($CaMg(CO_3)_2$) application to agricultural soils in 2016 amounted to 237 kt and 426 kt respectively and increased in relation to 2015. 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 annual carbon emission from agricultural lime application is calculated Tier 1 method using equation 11.12 and the default emission factors for carbon conversion of 0.12 and 0.13 for limestone and dolomite respectively [IPCC 2006]:

$$CO_2\text{-C } \mathit{Emission} = (M_{limestone} * EF_{limestone}) + (M_{dolomite} * EF_{dolomite})$$

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, in division for calcic limestone and dolomite, is available in national statistics on an annual basis in pure nutrient (CaO, CaO+MgO) [GUS R2 2017]. Based on country study [Radwański 2006b] it was established that application of oxides of lime occurs in Poland in limited amount, carbonate limes dominate (respectively 12% and 88%). As the oxides of lime do not contain inorganic carbon they are not included in calculations for CO_2 estimation from application to soils [Chapter 11.3.1 IPCC 2006].

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 recalculation was made

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 amounted to 377 kt CO_2 in 2016 and drop since 1988 by 15%.

5.7.2. Methodological issues

The annual carbon emission from urea application is calculated Tier 1 method using equation 11.13 [IPCC 2006]:

$$CO_2\text{-}C\ \textit{Emission} = M * EF$$

where:

CO_2-C *Emission* = annual C emissions from urea application (t C / year)
M – annual amount of urea fertilization [t urea / year]
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 R2 2015] 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

- correction of urea content in urea based fertilizers for 2014 and 2015

Table 5.21. Changes in CO_2 emissions from urea application resulting from recalculations

Change	1988	1989	1990	1991	1992	1993
kt	0.00	0.00	0.00	0.00	0.00	0.00
%	0.00	0.00	0.00	0.00	0.00	0.00
Change	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
kt	0.00	0.00	0.00	0.00	0.00	0.00
%	0.00	0.00	0.00	0.00	0.00	0.00
Change	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
kt	0.00	0.00	0.00	0.00	0.00	0.00
%	0.00	0.00	0.00	0.00	0.00	0.00
Change	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
kt	0.00	0.00	0.00	0.00	0.00	0.00
%	0.00	0.00	0.00	0.00	0.00	0.00
Change	**2012**	**2013**	**2014**	**2015**		
kt	0.00	0.00	-39.34	-34.21		
%	0.00	0.00	-9.06	-8.62		

5.7.6. Source-specific planned improvements

No improvements are planned at the moment.

6. LAND USE, LAND USE CHANGE AND FORESTRY (CRF SECTOR 4)

6.1. Overview of sector

The greenhouse gas inventory of the Land Use, Land Use Change and Forestry (LULUCF) sector covers all CO_2 emissions and removals of due to gains and losses in the relevant carbon pools of the predefined six land-use categories, as well as non-CO_2 emissions from biomass burning and disturbance associated with land-use conversions. 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 2006) is based on 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).

Amendments to the regulations introduced changes in land classifications. 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 Head 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. These activities in 2016 altogether resulted in net removals estimated to be equal to 29 219 kt of CO_2 equivalent.

Most removals are generated by biomass gains in the *Forest Land remaining Forest Land* and the *Land converted to Forest Land* categories. The net sink in these category is mainly due to the fact that the forest area has been increasing, and that the total increment of the growing stock in forest lands has always been higher than the annual harvest

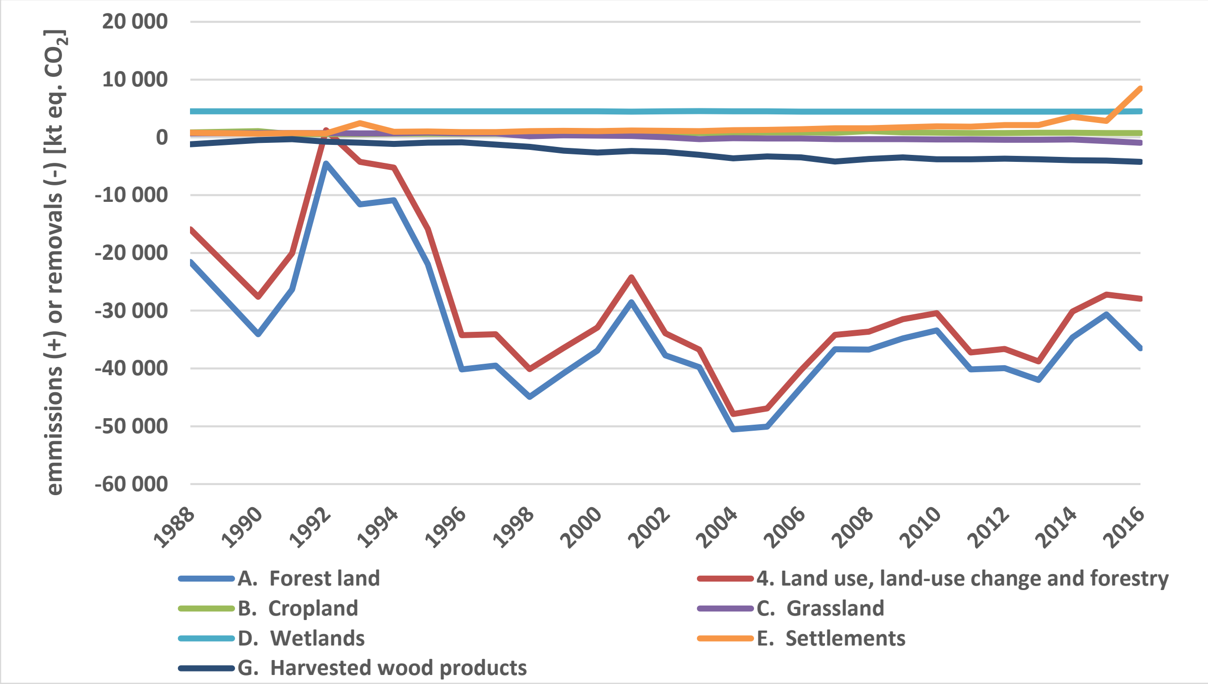

Figure 6.1. Trends in emissions/removals from the LULUCF sector by land-use

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 2016

Table 6.1. Country area balance in 2016

Year	**2016**
Greenhouse gas source and sink categories	Area [ha]
4. Total land-use categories	
4.A. forest land	9 381 979
4.A.1. forest land remaining forest land	8 754 092
4.A.2. land converted to forest land	627 887
total organic soils on forest land, of which:	260 180
on forest land remaining forest land	241 764
on land converted to forest land	18 416
4.B. cropland	
total cropland area	13 979 034
4.B.1. cropland remaining cropland	13 648 912
4.B.2. land converted to cropland	330 123
total organic soils on cropland, of which:	532 880
on cropland remaining cropland	532 880
on land converted to cropland	NO
4.C. grassland	
total grassland area	4 203 034
4.C.1. grassland remaining grassland	3 965 641
4.C.2. land converted to grassland	237 393
total organic soils on grassland, of which:	146 120
on grassland remaining grassland	146 120
on land converted to grassland	NO
4.D. wetlands	
total wetlands area	1 371 364
4.D.1. wetlands remaining wetlands	1 314 339

Year	2016
4.D.2. land converted to wetlands	57 025
total organic soils on wetland, of which:	271 467
on wetlands remaining wetlands	271 467
on land converted to wetlands	NO
4.E. settlements	
total settlements area	2 248 288
4.E.1. settlements remaining settlements	1 908 389
4.E.2. land converted to settlements	339 899
4.F. other Land	84 272
Country area balance	31 267 967

Land-use transition matrices (approach 2) are included in the Annex 6.1 and Annex 6.2. Nonetheless, it shall be noted that the land use change matrices have been resolved to minimise inconsistencies as far as they can with the available datasets. Because several different data sources have been combined it is not possible to reduce all inconsistencies to zero, but the variation is very small (always less than 0.00000015%) difference between the sum of all changes and the overall category totals to ensure that the sum of categories consistently adds up to the total area of Poland

6.1.3. Land uses classification for representing LULUCF areas

For the reporting purposes to the United Nations Framework Convention on Climate Change and Kyoto Protocol it is recommended to assign 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 fulfill the above mentioned recommendations available data were summarized taking into account the assessment provided in the table 6.2.

Table 6.2. Land use classification

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; ecological arable land; wasteland
4.E Settlements	agricultural build-up areas; build-up and urbanized areas;
4.F Other land	miscellaneous land

In general, total country area (total land area) slightly fluctuate over the reported period with the following reason. Central Statistical Office (CSO) in the statistical yearbooks (Environment), indicated that country total area variations are driven mainly by geodesic re-measurements at subsequent surveys. The fact that the country borders are very unstable was considered as the main factor of relative area changes. Polish coastline is constantly changing as a result of water erosion. The same changes in the area are driven by the land boarders movement. A significant part of Polish border runs along the rivers mainstreams, where a large part of these rivers is unregulated, so the frequent changes in the location of the mainstream occurs. Country area fluctuations were reflected in the changes of the area of other 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 2016 is a net CO_2 sink, estimated to be equal to 36 519 kt CO_2.

6.2.1.1. Area of forest land in Poland in year 2016

Forest land reported under subcategory 4.A is classified as a "forest" according 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 in line with internationally adopted standard which takes into account the forest land associated with forest management. Forest land area in Poland, as of 1 January 2017, was equal to 9 381 979 ha *(GUS; Environmental protection 2017)*.

Table 6.3 Forest land area by provinces as of the end of inventory year (1/2)

No	Voivodship	Unit	2008	2009	2010	2011	2012
	Total	[ha]	9 251 404	9 275 786	9 304 762	9 329 174	9 353 731
1.	**Dolnośląskie**	[ha]	606 104	607 327	608 387	609 279	610 583
2.	**Kujawsko-pomorskie**	[ha]	425 207	426 170	427 147	427 843	428 254
3.	**Lubelskie**	[ha]	568 601	572 620	576 420	579 237	581 002
4.	**Lubuskie**	[ha]	706 788	707 583	708 201	709 002	709 881
5.	**Łódzkie**	[ha]	386 172	387 711	388 597	389 350	390 358
6.	**Małopolskie**	[ha]	439 126	438 280	439 765	440 114	440 432
7.	**Mazowieckie**	[ha]	802 158	804 912	808 810	812 973	817 869
8.	**Opolskie**	[ha]	257 858	258 170	258 246	258 399	258 570
9.	**Podkarpackie**	[ha]	671 363	674 450	677 953	680 166	683 371
10.	**Podlaskie**	[ha]	621 718	624 856	626 532	627 235	628 678
11.	**Pomorskie**	[ha]	676 165	677 673	678 226	679 898	681 014
12.	**Śląskie**	[ha]	400 709	399 592	399 954	401 747	402 014
13.	**Świętokrzyskie**	[ha]	331 492	332 089	332 487	332 980	402 364
14.	**Warmińsko-mazurskie**	[ha]	752 146	755 050	760 064	763 567	334 385
15.	**Wielkopolskie**	[ha]	778 863	780 795	783 340	784 649	785 648
16.	**Zachodniopomorskie**	[ha]	826 934	828 508	830 633	832 735	834 009

Table 6.3 Forest land area by provinces as of the end of inventory year (2/2)

No	Voivodship	Unit	2013	2014	2015	2016
	Total	[ha]	9 369 403	9 382 578	9 395 171	9 513 245
1.	**Dolnośląskie**	[ha]	610 968	611 562	611 919	620 518
2.	**Kujawsko-pomorskie**	[ha]	428 491	428 772	429 045	434 722
3.	**Lubelskie**	[ha]	582 307	583 447	584 477	584 740
4.	**Lubuskie**	[ha]	710 350	710 858	711 077	715 648
5.	**Łódzkie**	[ha]	390 950	391 259	391 722	376 730
6.	**Małopolskie**	[ha]	440 664	440 672	440 683	460 815
7.	**Mazowieckie**	[ha]	824 660	828 607	835 112	850 810
8.	**Opolskie**	[ha]	258 846	258 982	259 139	260 549
9.	**Podkarpackie**	[ha]	683 462	685 002	686 848	700 806
10.	**Podlaskie**	[ha]	629 184	630 047	630 622	638 429
11.	**Pomorskie**	[ha]	681 537	682 244	682 783	687 741
12.	**Śląskie**	[ha]	402 307	402 989	403 341	411 635
13.	**Świętokrzyskie**	[ha]	334 796	335 083	335 277	341 142
14.	**Warmińsko-mazurskie**	[ha]	769 824	771 463	774 906	789 637
15.	**Wielkopolskie**	[ha]	785 998	786 497	786 015	792 486
16.	**Zachodniopomorskie**	[ha]	834 760	835 094	833 205	846 840

Difference between the areas reported by Poland under FAO and UNFCCC

Data on the condition and changes in the registered intended use of land, developed on the basis of annual reports on land prepared by the Head Office of Geodesy and Cartography, was applied in the estimations and reported under the UNFCCC. National statistics prepared and published on the basis of those reports, describes areas of all land uses, including forest land, with the consideration of the geodesic area [e.g. "GUS; Environmental Protection 2017"].

In relation to the FAO reports, data collected and reported there was developed on the basis of information obtained from stand-alone statistical surveys in subsequent years. As a result of various methods, which were applied for data collection and processing some notable differences can occur. What needs to be emphasized, statistical approach used in stand-alone statistical surveys do not consider all land use types in the same survey at the same time. Therefore, with regard to the data comparability and accuracy reported under the UNFCCC and KP, information obtained from statistical surveys on land areas, which covers country territory partially, could not be applied.

6.2.1.2. Habitat structure

The diversity of growing conditions for forests in Poland is linked to the natural-forest habitats allocations and is 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 68.5% *(GUS; Leśnictwo 2017)* of the total forest area, while broadleaved habitats cover 31.5% . In both groups, a further distinction of forests area is made between lowland (84.8%), upland (6.5%) and mountain (8.7%) habitats.

Figure 6.2. Natural-forest habitats diversification 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 prevail as the dominant species.

In terms of forest area, coniferous species dominate in Polish forests, accounting for 68.7% 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 58.1% of the area of forests in all ownership categories, for 63.0% in the State Forests and for 55.4% in the privately-owned forests.

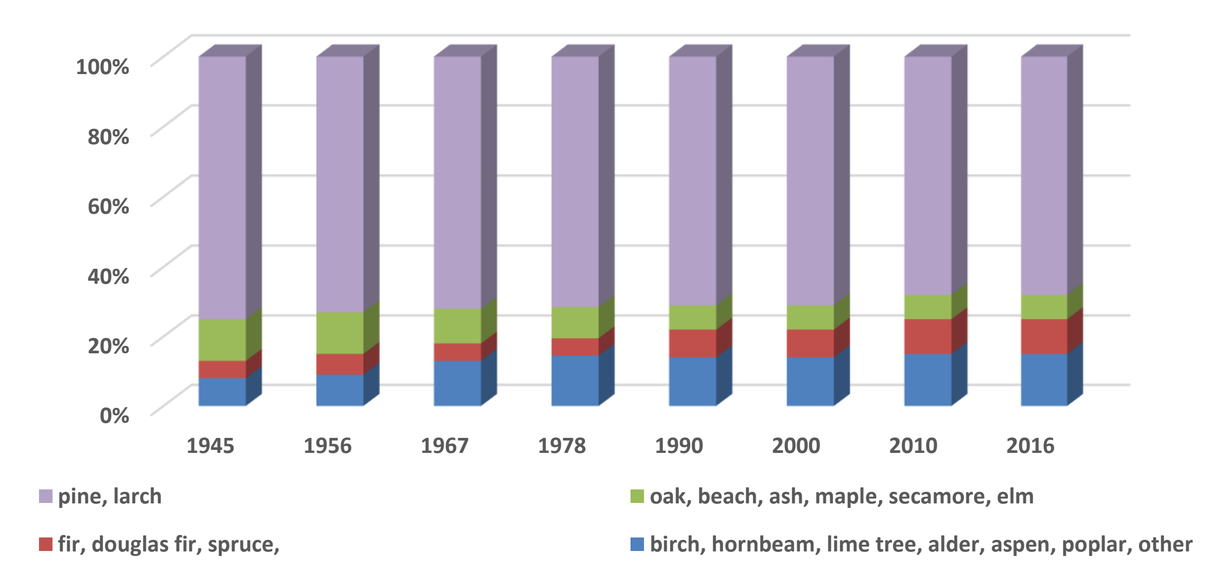

Figure 6.3. Spatial structure of dominant tree species

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 is 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 31.3%. 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 25.5% and 19.1% of the forest area respectively. Moreover, stands aged 41–80 years are dominating in total forests area, with their total share equal to nearly 44.6%. Stands over 80 years old, including stands in the restocking class, account for 22.1% of the total forest area.

6.2.1.5. Structure of timber resources by volume

According to the Statistical Yearbook "Forestry 2017", estimated timber resources, as of the end of 2016 amounted to 2 549 744 m^3 of gross merchantable timber, including 2 126 167 m^3 in the public forests and 429 577 m^3 in forests owned privately.

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 identified 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

According 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 2016 net CO_2 sink was about 34 005 kt CO_2. Methodological assumptions are provided in the 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 change matrix is presented in the annex 6.

According to 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

As stated in the previous NIRs, the carbon stock-change method to estimate emission and removals balance related to the subcategory 4.A.1 *Forest Land remaining Forest land* was applied in Polish GHG Inventory since 2014. CSC in other categories were estimated with the available methods and factors that were possible to be applied to national circumstances.

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 structure.

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, which is 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.

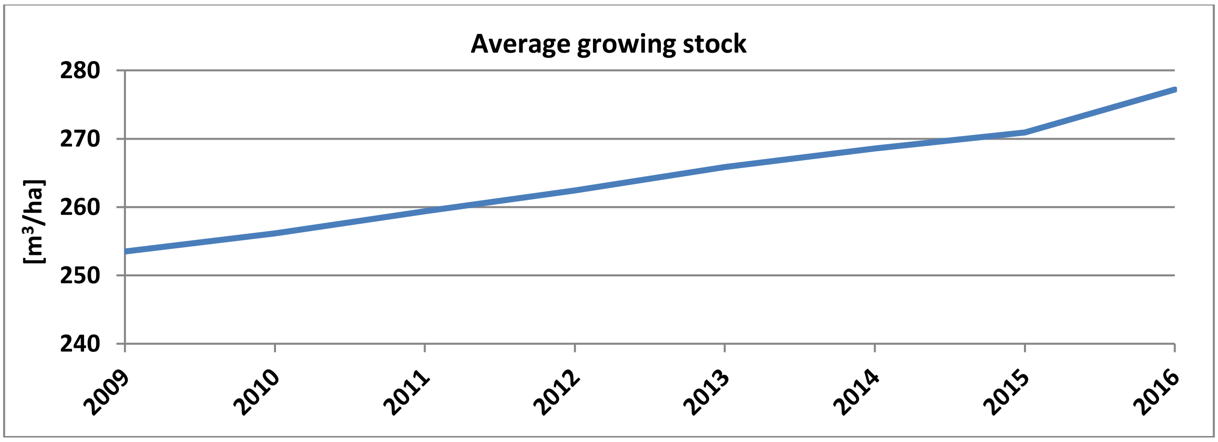

Figure 6.4. Average volume stock of merchantable timber in Polish forests

Data provided on the graph above was prepared on the basis of data collected from the periodical forest inventory surveys by the Forest Management and Geodesy Bureau. Recent result are not fully comparable with data published up to 2009. To eliminate potential overestimations of carbon sinks linear calibration of previous data was applied. The inventory data is stored by stand in a publically available databases, i.e. the Forest Data Bank. 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 as 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

The current form of the equation 2.8 of chapter 4 of the Volume 4 of the IPCC 2006 (p. 2.12) actually triggered the use of a weighted mean of wood density. Basic wood density by species can only be applied when the volume of the average merchantable growing stock by single species is provided. Since the average merchantable growing stock has been applied in the eq. 2.8, the weighted mean of wood density was also applied to adjust the BCEF (as provided in the section 2.3.1.1 of the chapter 2 of the Volume 4 of the IPCC 2006. In the calculation of specific wood density (oven dry) by species, air dry wood density values by species (with the humidity at the level of 15%) and volumetric shrinkage of wood by species were used. Simplified approach for calculation of weighted mean of wood density by major tree species is presented in the table 6.6.

Table 6.4. Air-dry wood density [t/m^3]/ 15% of wood humidity

Species	**Air-dry wood density [t/m^3]**
Pine	0.52
Spruce	0.47
Fir	0.45
Beech	0.73
Oak	0.69
Hornbeam	0.83
Birch	0.65
Alder	0.53
Poplar	0.45
Aspen	0.44

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

Table 6.5. Volumetric wood shrinkage [%]

Species	**Volumetric wood shrinkage [%]**
Pine	12.4
Spruce	12.0
Fir	11.7
Beech	17.6
Oak	12.6
Hornbeam	19.7
Birch	14.2
Alder	12.6
Poplar	14.3
Aspen	11.0

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

Air-dry wood density [t/m^3] was multiplied by the volumetric shrinkage of wood to estimate basic wood density (oven dry) by species. Results are presented in the table below. Almost in all cases country specific dry wood density is lower than value provided by the IPCC in the table 4.14 on p. 4.71 of chapter 4 of the Volume 4 of the IPCC 2006:

$$D = \text{Air-dry wood density } [t/m^3] * (1 - \text{volumetric shrinkage of wood})$$

Table 6.6. Basic wood density by major tree species

Species	**Air-dry wood density [t/m^3]**
	A
Pine	0.43
Spruce	0.38
Fir	0.36
Beech	0.57
Oak	0.57
Hornbeam	0.63
Birch	0.52
Alder	0.43
Poplar	0.35
Aspen	0.36
Other	0.36

6.2.4.5. Biomass conversion and expansion factor

Due to lack of proper country-specific data and in order to be consistent with previous estimate, IPCC default values for the BEF 2 (table 3 A.1.10 of the IPCC 2003 GPG) were used. Recent approach to estimate the BCEF, is consistent with the guideline provided in the section 2.3.1.1 p. 2.13 of chapter 4 of the Volume 4 of the IPCC 2006.

Table 6.7. BEF factors

Climatic zone	**Forest type**	**Minimum dbh (cm)**	**BEF_2 (overbark)**
Temeperate	Spruce, Fir, Other coniferous	0-12.5	1.15
	Pines	0-12.5	1.05
	Broadleaf	0-12.5	1.20

Recent process, related to the possibility of using country-specific values for the BEF is carried out as an independent activity in parallel to subsequent improvements introduced into the inventory preparation. Since the official data is not yet available, Poland has continued its consideration of application of the default values results to obtain a consistent time series in the GHG inventory. With respect to the estimation related to the biomass, data from the forest monitoring system is used, the primary objective of which has been to obtain accurate information on the status and development of all forests in the country. The forest inventory was designed to collect data at the stand level, but provide accurate estimates at aggregated levels.

With respect to net annual CO_2 removals, actual values may deviate from estimated values as the stock volume inventory for the whole country is not able to capture all inter-annual variability of timber growth and harvests, which can be high due to the variability of meteorological conditions. Also noting that the inter-annual variability of the estimated net removals in the Forest Land sector is due to a number of reasons, including the continuously, although slowly, changing structure of the forests by species, site fertility and age, and the variability of annual harvests and mortality. All these effects have rather different delayed effects, and these effects may be rather small relative to the total volume stocks, when applying default factors adjusted to national circumstances

It can be concluded that the carbon stock change estimation based on assumptions described above seem to be reliable and not affects accuracy of the emissions and removals associated with forest land.

6.2.4.6. Root-to-shoot ratio

Root-to-shoot ratio was adjusted based on default values proposed to be used by the IPCC in IPCC 2006 Guidelines of the Volume 4, table 4.4.

Table 6.8. R factors

Ratio of below-ground biomass to above-ground biomass (R)			
Species	Above-ground biomass [tonne root d.m./ha^{-1}]		
	<50	50-100	>100
Pine	0.40	0.29	0.20
Spruce	0.40	0.29	0.20
Fir	0.40	0.29	0.20
Beech	0.46	0.23	0.24
Oak	0.46	0.30	0.30
Hornbeam	0.46	0.23	0.24
Birch	0.46	0.23	0.24
Alder	0.46	0.23	0.24
Poplar	0.46	0.23	0.24
Aspen	0.46	0.23	0.24

The above R (weighted mean) value has been applied in the equation 2.8 of chapter 4 of the Volume 4 of the IPCC 2006 (p. 2.12) for recent estimates of CO_2 removals. As indicated above, process related to the possibility of using country-specific values for the Root-to-shoot ratio is carried out as an independent activity in parallel to subsequent improvements introduced into the inventory preparation. Since the official data is not yet available, Poland has continued its consideration of application of the default values results to obtain a consistent time series in the GHG inventory.

6.2.4.7. Carbon fraction

Estimations are based on the following default factors (table 6.9.).

Table 6.9. CF factors

Species	IPCC
Pine	0.51
Spruce	0.51
Fir	0.51
Beech	0.48
Oak	0.48
Hornbeam	0.48
Birch	0.48
Alder	0.48
Poplar	0.48
Aspen	0.48

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.

Forest carbon accounting guidance from the Intergovernmental Panel on Climate Change (IPCC) has become the primary source of information for methods, accounting equations and parameters. However, IPCC guidance is vast and often difficult to navigate. In response, a number of tools for forest carbon accounting have emerged. These vary in terms of geographical coverage, forestry activities and the carbon pools accounted for, as well as the level of data input required. The DOM wood carbon pool includes all non-living woody biomass and includes standing and fallen trees, roots and stumps with diameter over 7 cm (overbark). The DOM litter carbon pool includes all non-living biomass with a size greater than the limit for soil organic matter (SOM), commonly 2mm, and smaller than that of

DOM wood, 7 cm diameter over bark. This pool comprises biomass in various states of decomposition prior to complete fragmentation and decomposition where it is transformed to SOM.

The relevant assumption for the land converted to forest land (4.A.2), under the the Tier 1 is that dead wood and litter pools increase linearly from zero (in the non-forest land-use category) to the default values for the climate region over a period of T years (the current default applied is 20 years for both litter and dead wood carbon pools).

Accordingly, as stated in the section 2.3.2, the Tier 1 assumption is that only carbon stocks in dead wood and litter pools in non-forest land are zero, and that carbon in dead organic matter pool increases linearly to the value of mature forests over a specified time period (default = 20 years). Additionally, the Tier 1 assumption for the conversion of unmanaged to managed forest land is that the dead organic matter carbon stocks in unmanaged forests are similar to those of managed forests and that no carbon stock changes need to be reported. Nevertheless, the conversions of non-forest land to forest land result, in all probability, in net removals in the DOM & litter pools. However, reporting zero emissions in these pools is considered as the most acceptable approach for L-FL until a more advanced estimation would be developed.

In relation to the category 4.A.1 in Poland, relevant data has not been collected in a representative sample of stands on deadwood and litter. Despite this, based on very limited data that we have, it seems justified to state that these pools continue to sequester carbon, rather than to lose carbon, in the medium-term, and that they are not a source. To demonstrate that the DOM reservoir (DW+Litter) is not a source, the following arguments shall be considered. Until the late 20th century, across all Europe, deadwood in managed forests was removed becasue it was thougt that forests has to be “sanitised” to be healty. Over time this lead to the widespread improvement of woodland biodiversity. It has since been acknoledged that a wide range of plant and animal species depend on dead and dying wood for habitat (e.q. European otter) or as food source (e.g beetles). Generally speaking, the greater the volume of deadwood, the grater the value of forest for biodiversity. The amount of deadwood in forests in now increasingly used as a key international indicator of ecosystem biodiversity. Poland has less deadwood in its forests than most other EU countries. With 5.7 m^3/ha of standing and lying deadwood, Poland ranks fourth lowest among the 20 EU countries for which data are avilable (Forest EUROPE, UNECE, FAO 2013). The volume of deadwood is much higher (up to 35 m^3/ha) in forests of national parks.

Current evidence for the EU forests suggests that, in the long term, deadwood (not including stumps, usually retained after felling) should averge roughtly 20 m^3/ha (Humprey and Bailey, 2012). This does not mean deadwood must be uniformly distributed; efforts to create, maintain and manage deadwood habitats should be directed where they are most needed,especially in areas of high ecological value.

Additionally, progress has been made in reducing deadwood removal related to sanitary thinning. Sanitary thinning primarily consists of removing trees damaged by factors such as wind damage, pests, pollution and severe weather. In some areas it is used as an oportunity to remove old, naturall decaying trees so as to enhance forest productivity. This is the case in Poland, where sanitary thinning has included both damaged trees and deadwood. Nevertheless, except in 2007, deadwood removsal from sanitary thinnings as share of merchantable timber has been halved since 2000 and was down to 15% in 2012.

Another reason of the increase of the amount of deadwood and litter in all forests is that about one-third of all forests are afforestations since 1945, and most of these forests are still in their intensive growing phase, which means that carbon stocks of dead organic matter pools have not saturated yet. These results are based on a small but anyway systematic sampling, and show a varying and slowly increasing tendency of net accumulation of the number of standing dead trees.Finally, no major disturbances or other processes have occurred that could have resulted in substantial emissions from the dead organic matter. Therefore, although no quantitative estimates can be made on the increase, the Tier 1 assumption can safely be made, at least on average in the long run. Therefore, when the Tier 1 method is applied which assumes that the dead wood and litter stocks are at equilibrium, the related carbon stock changes for these pools are not estimated.

Additionally, Poland would like to highlight that since the dead organic matter pool and its carbon stock change is assumed as insignificant amounts and to keep the notations keys use relevant, notation key " NO" is applied in relevant CRF table.

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 6.10. 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 6.11. Percentage share of soil types by land use system (for time t and t–20)

Habitats	2016 (t)	1996 (t-20)
high activity	45.7	34.8
low activity	17.8	19.7
sandy	31.9	41.6
wetland	4.6	3.9
Total	100.0	100.0

The reason of the increase of the amount of soil carbon in all forests is that about one-third of all forests are afforestation's since 1945, and most of these forests are still in their intensive growing phase, which means that carbon stocks of soil organic matter pool have not saturated yet.

Additionally, no major disturbances or other processes have occurred that could have resulted in substantial emissions from the soil organic matter. Therefore, quantitative estimates can be made on the increase. Carbon stock changes in mineral soils were estimated based on 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

Poland made justification for the country specific values for the soil organic carbon contents. Consist with the results of the analysis determining the direction and rate of change in SOC content indicate that the C stock in the 1m layer of mineral soils derived from sand under the coniferous forests is with the range 65-90 Mg C*ha-1, comparable results are obtained for the deciduous. The C stock in the 1m layer of mineral soils derived from soil under the deciduous forests with the range 65-115 Mg C*ha^{-1}. Average C stock in the 1m layer of mineral soils derived from soils under the deciduous forests with high activity clay are with the range 140-250 Mg C*ha^{-1}. Presented results were obtained from the country study "The balance of carbon in the biomass of the main forest-forming species in Poland" Poznań, Kórnik, Warszawa, Kraków, Sękocin 2011. Having stated that, country experts decided to use default SOC ref values provided by the IPCC for the whole time series. Estimation of C stock changes in mineral soil pool in the subcategory forest land remaining forest land is based on changes of areas of forest habitat types. The assumptions made, allow to assign the in-direct impact of forest vegetation, associated with a particular forest habitat, on structure and forest litter decomposition directly related to the CS changes in the upper soil layers. On the basis of annually reported forestry data on area of forest habitat structure, following assignment was made.

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 2016 for the purpose of GHG emission projections which amounts to 679 thousand ha. Similarly to the previous period interpolation of histosol areas was applied between 1995 and 2015 and further up to 2020 [7RR 2017, chapter 5.1]. 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 2016 was estimated for ha with the following split for subcategories: forest land remaining forest land – 241 763 ha land converted to forest land – 18 416 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 6.12. 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 2.27 (IPCC 2006, page 2.42.):

Table 6.13. 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	4.7	default	[IPCC 2006]
CO	107.0	default	[IPCC 2006]
N_2O	0.26	default	[IPCC 2006]
NO_x	3.0	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 2016 net CO_2 sink was approximately 2513 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.

Afforestation of orchards, in terms of planning regulations, is strictly limited, encouraging the conservation of traditional orchards which helps to guarantee the survival of a wide range of trees and fruit varieties that are particular to each region of the country – and supports the growing popularity of locally-produced food. Fruit trees age much more quickly than most other species found in the countryside so they rapidly accumulate the 'veteran' features associated with over-mature trees. Large volumes of standing dead wood in the form of 'stag's heads', whole limbs and rotting heartwood are specific habitats favoured by suites of very specialised organisms that have become increasingly rare in the countryside. The presence of old trees spaced within permanent grassland creates a range of habitats very similar to those found in wood pasture landscapes.The main principles of the planning regulations are covered by the following relevant regulations:

1. Ordinance of the Minister of Agriculture and Rural Development of 18 June 2007 on the detailed conditions and procedures for granting financial assistance under the "Afforestation of agricultural land and afforestation of non-agricultural land" covered by the Rural Development Program 2007-2013 (OJ 2007 No. 114, item 786);
2. Ordinance of the Minister of Agriculture and Rural Development of 21 September 2007 amending the Regulation on detailed conditions and procedures for granting financial assistance under the "Afforestation of agricultural land and afforestation of non-agricultural land" area covered by the RDP 2007-2013 (Official Journal from 2007 No. 185, item 1316);
3. Ordinance of the Minister of Agriculture and Rural Development of 18 July 2008 amending the Regulation on detailed conditions and procedures for granting financial aid under the "Afforestation of agricultural land and afforestation of non-agricultural land" covered by the RDP 2007-2013 (Journal of Laws of 2008, No. 134, item 853);
4. Ordinance of the Minister of Agriculture and Rural Development of 19 March 2009 on detailed conditions and procedure for granting financial aid under the measure "Afforestation of agricultural land and afforestation of non-agricultural land", covered by the RDP 2007-2013 (Journal of Laws of 2009 no. 48, item 390);
5. Ordinance of the Minister of Agriculture and Rural Development of 31 May 2010 amending the Regulation on detailed conditions and procedures for granting financial assistance under the "Afforestation of agricultural land and afforestation of non-agricultural land" covered by the RDP for 2007-2013 (Journal of Laws of 2010 No. 94, item 608).

6.2.5.2. Subcategory area

Land use change 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 6.14. Default biomass increment

Name	Value	Unit
G_{ext}	4	[t d.m./ha/year]

Poland does not have indicated nationally appropriate values of G_{ex} available, yet. National Forest Inventory has not provided annual data related to increment, exclusively from age class I (1–20 years old). Hence, application of the default values results in a consistent time series of both the area and the GHG information. With respect to the estimation related to the biomass, data from the forest monitoring system is used, the primary objective of which has been to obtain accurate information on the status and development of all forests in the country. The forest inventory was designed to collect data at the stand level, but provide accurate estimates at aggregated levels.

However, Poland is exploring the possibility to estimate carbon stock changes in the biomass pool of the newly established forests with an empirical model of growing stock over age on a unit area of afforestation. In order to estimate the volume data, we are analysing available species-specific simplified models for the young forests using a sample of young stands of varying age (known based on the year of the afforestation) for which volume was known. This volume would preferably available either from direct assessment or from yield tables (in this last case, height would be measured). Nevertheless, accuracy cannot always be quantified partly because the error distributions are unknown due to lack of measured data and partly because calculation errors or assumptions cannot be quantified. However, calculation errors during the development of the GHG inventory are highly unlikely due to the double checking of the data processing as described QA/QC section.

For carbon stock changes in biomass, the system of calculations allows for the use of a simple sensitivity analysis. 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 used for the calculation is relatively simple.

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 1993-2016, 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

With respect to the estimation related to the biomass, data from the forest monitoring system is used, the primary objective of which has been to obtain accurate information on the status and development of all forests in the country. The forest inventory was designed to collect data at the stand level, but provide accurate estimates at aggregated levels. Therefore, with respect to net annual CO_2 removals, actual values may deviate from estimated values as the stock volume inventory for the whole country is not able to capture all inter-annual variability of timber growth and harvests, which can be high due to the variability of meteorological conditions. Also noting that the inter-annual variability of the estimated net removals in the Forest Land sector is due to a number of reasons, including the continuously, although slowly, changing structure of the forests by species, site fertility and age, and the variability of annual harvests and mortality. All these effects have rather different delayed effects, and these effects may be rather small relative to the total volume stocks, when applying default factors adjusted to national circumstances. It can be concluded that the carbon stock change estimation based on assumptions described above seem to be reliable and not affects accuracy of the emissions and removals associated with forest land. Further information is contained 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 category was identified as a net CO_2 source. Net CO_2 balance was equal to 670 kt CO_2.

Activity data (i.e. area) for the lands divisions included in this category is provided by the land use change matrix, for both 4.B.1 *Cropland remaining Cropland* and 4.B.2 *Land converted to Cropland* subcategories. Estimation of carbon stock changes corresponds to Tier 1, estimating annual rates of growth and loss for national level data on the major type of crops.

6.3.1.2. Land converted to Cropland (CRF sector 4.B.2)

GHG balance in this category was identified as a net CO_2 source. Net CO_2 balance was equal to 62 kt CO_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 10a, 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 10a, 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 on cropland remaining cropland (4.B.1)

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.

Estimation of C stocks changes was made individually on each of the two different types of land included in the Cropland category and their subcategories: perennial crops (orchards) and non-woody agricultural land (arable).

6.3.4.3. Living organic matter on land converted to croplands (4.B.2.)

Agricultural land here is represented mainly by arable land or management cycles which include arable land. Current data shows there are conversions from all land use categories to cropland, largest area being the conversions from grasslands. Conversion also occur from Settlements and Other land (i.e. industrial dumps and ecologization, reclamation of river deposits and islands along Danube and other rivers).

Estimates are calculated using equation 2.15 from 2006 Guidelines. Initial C stock changes in biomass are calculated under Tier 1 (ΔCconversions), assuming a biomass C stock of 6.1 t dm/ha for grasslands the default value for the warm temperate dry eco-region (Table 6.4 of 2006 Guidelines) and 4.7 t C/ha for annual crops (Table 5.9 of 2006 Guidelines). Entire amount of C stock in biomass in land use category before conversion is assumed to be lost in the moment of conversion to cropland (e.g. usually the technology implies deep soil preparation and removals of any pre-existing vegetation).

6.3.4.4. 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 6.15. 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	0.0	0.0	0.0	0.0	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 6.16. Interporpolated and extrapolated results for the area of cropland under different soil types in a percentage of the total area

Soil type	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
high activity	28.49	28.55	28.60	28.66	28.71	28.77	28.82	28.88	28.93	28.99
low activity	39.15	39.13	39.12	39.11	39.09	39.08	39.07	39.06	39.05	39.05
sandy	20.31	20.29	20.27	20.26	20.25	20.24	20.23	20.22	20.21	20.20
wetland	12.06	12.03	12.01	11.98	11.94	11.91	11.87	11.84	11.81	11.77

Soil type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
high activity	29.04	29.10	29.20	29.20	29.20	29.20	29.20	29.20	29.20	29.20
low activity	39.04	39.03	39.03	39.03	39.03	39.03	39.03	39.03	39.03	39.03
sandy	20.19	20.18	20.13	20.13	20.13	20.13	20.13	20.13	20.13	20.13
wetland	11.74	11.70	11.64	11.64	11.64	11.64	11.64	11.64	11.64	11.64

Soil type	2008	2009	2010	2011	2012	2013	2014	2015	2016
high activity	29.20	29.20	29.20	29.20	29.20	29.20	29.20	29.20	29.20
low activity	39.03	39.03	39.03	39.03	39.03	39.03	39.03	39.03	39.03
sandy	20.13	20.13	20.13	20.13	20.13	20.13	20.13	20.13	20.13
wetland	11.64	11.64	11.64	11.64	11.64	11.64	11.64	11.64	11.64

Table 6.17. 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 6.18. 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. 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. 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. 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. 5.5 page 5.17].
- Stock change factor for management regime in current inventory year –F_{MG}(0)=1.00 [IPCC 2006 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. 5.5 page 5.17].

6.3.4.5. 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 2016 for the purpose of GHG emission projections which amounts to 679 thousand ha. Similarly to the previous period interpolation of histosol areas was applied between 1995 and 2015 and further up to 2020 [7RR 2017, chapter 5.1].

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].

6.3.4.6. CH_4, N_2O, CO and NO_x emissions from fires

CH_4, N_2O, CO and NO_x emissions from wildfires fires on croplands are reported in subcategory 4.C.1.

6.3.4.7. 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 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:

- 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

With ongoing project to derive new activity data for all land categories the uncertainty is not yet estimated. Estimates for the uncertainty of the activity data would be derived as soon as data processing will be finalized. The advantage of the new land classification and area estimation method is that it provides sampling error for the area estimates for each land category and subcategory.

6.3.6. Category-specific QA/QC and verification

For the estimation of C stock changes in soils of land "remaining croplands" there is an improvement plan available, related to the development of national system to respond accounting requirements set in decision 529/2013UE. According to this decision a reporting to European Commission on the national estimating system for cropland management and grazing land management is due annually for 2016-2018 while provide preliminary estimates before 2022 and final estimates in the final deadline in 2022.

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.

Activity data used to calculate GHG emissions for the land included in the *Grassland* category is provided by the land use change matrix, both for the 4.C.1 – *Grassland remaining Grassland* and 4.C.2 *Land converted to Grassland* category. Estimation of carbon stock change in the *Grassland* category corresponds to Tier 1, with country specific data on reference C stock in soils.

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 357 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 1298 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.
- 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.

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 change matrix is provided in the annex 6.

6.4.4.2. Living organic matter

Estimates of the change of C stocks vary by type of land included in this land category:

- *Land remaining under the same use.* In the case of grasslands where there are no changes in usage it was considered that there are no changes in the C stocks of any pool (aboveground, belowground).
- *Land in conversion to grassland*. A default biomass value for the cold temperate dry eco-region (Table 6.4 of 2006 Guidelines) of 6.5 tC/ha was used in calculations. Estimates are calculated using equation 2.15 from 2006 Guidelines. Initial C stock changes in biomass are calculated under Tier 1 (ΔCconversions), assuming a biomass C stock of 1.8 tC/ha for annual crops (Table 5.9 of 2006 Guidelines).

6.4.4.3. Change of C stock in dead organic matter and soil

For the estimation of C stock changes in dead organic matter of land "remaining grasslands" there is an improvement plan available, related to the development of national system to respond accounting requirements set in decision 529/2013/UE. Current approach is that there no change in dead organic matter C pool since there is no management change (reference soil C stock and values of C stock change factors would practically no change in time).

For the estimation of C stock changes in soil organic matter in land remaining the same category following assumptions were applied. 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 6.19. 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	2.0	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	0.0	0.0	0.0	0.0	5.0

Due to limited data availability, linear interpolation was applied between the subsequent years. Since 2000, estimations are based on the latest available data sets.

Table 6.20. Interporpolated and extrapolated results for the area of grassland under different soil types in a percentage of the total area

Soil type	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
high activity	15.00	14.97	14.92	14.89	14.86	14.84	14.82	14.80	14.78	14.76
low activity	42.32	42.38	42.46	42.53	42.61	42.68	42.75	42.83	42.90	42.97
sandy	31.31	31.31	31.32	31.34	31.37	31.39	31.41	31.43	31.45	31.47
wetland	11.37	11.34	11.31	11.23	11.16	11.09	11.02	10.94	10.87	10.80

Soil type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
high activity	14.74	14.73	14.73	14.73	14.73	14.73	14.73	14.73	14.73	14.73
low activity	43.04	43.11	43.14	43.14	43.14	43.14	43.14	43.14	43.14	43.14
sandy	31.49	31.51	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55
wetland	10.72	10.65	10.58	10.58	10.58	10.58	10.58	10.58	10.58	10.58

Soil type	2008	2009	2010	2011	2012	2013	2014	2015	2016
high activity	14.73	14.73	14.73	14.73	14.73	14.73	14.73	14.73	14.73
low activity	43.14	43.14	43.14	43.14	43.14	43.14	43.14	43.14	43.14
sandy	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55
wetland	10.58	10.58	10.58	10.58	10.58	10.58	10.58	10.58	10.58

Table 6.21. 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 6.22. 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-T) = 1.00 [IPCC 2006 tab. 6.2 page 6.16]
- stock change factor for management regime in the beginning of inventory year – F_{MG}(0-T)=1.14 [IPCC 2006 tab. 6.2 page 6.16]
- Stock change factor for input of organic matter in the beginning of inventory year – F_{I}(0-T)=1.11 [IPCC 2006 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. 6.2 page 6.16]
- Stock change factor for management regime in current inventory year –F_{MG}(0)=1.14 [IPCC 2006 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. 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. 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.

Estimated non-CO_2 emissions include those from burning of slash on-site and, for more than a decade, those from wildfires. Non-CO_2 emissions from the mentioned sources are not significant, and are only reported for the sake of completeness and that of time series consistency with previous years. Note that CO_2 emissions from these sources are accounted for in the biomass pool, because we apply the stock-change method. Non-CO_2 emissions include the carbon of CO and CH_4, however, these gases are nevertheless reported because of their high global warming potential, because the double counting of the carbon is negligible, and also in order to comply with the IPCC 2006 GL.

Table 6.23. 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	default	[IPCC 2006]
N_2O	0.06	default	[IPCC 2006]
NO_x	1.1	default	[IPCC 2006]

The estimation of the amount of emissions is done according to section 6.2.4.11. Although, the default amount of biomass burned was applied based on country research (Cenowski, 1996) with its amount equal to 3.6 [t d.m.]. Relevant data became possible based on additional capacity to improve accuracy. Although the new estimates are also based on expert solicitation, they are considered more accurate than the expert judgment applied before.

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

For the estimation of C stock changes in soils of land "remaining grasslands" there is an improvement plan available, related to the development of national system to respond accounting requirements set in decision 529/2013UE. According to this decision a reporting to European Commission on the national estimating system for cropland management and grazing land management is due annually for 2016-2018 while provide preliminary estimates before 2022 and final estimates in the final deadline in 2022.

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 4475 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 19.5 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 2016 was 3 485 ha and area of flooded land was 1312 kha.

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 6.24. Area of organic soils managed for peat extraction in period 1999-2016

Year	Unit	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
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	3312.0	3360.0	3485
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	2837.4	2885.4	2992
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	474.6	474.6	493

Data source: Central Statistical Office - Environmental Protection 2000-2017

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 6.25. 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 6.26. Emission factors for N_2O 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 4. For calculations default emission factors for cold climate were used as presented below:

Table 6.27. 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 d.m./ha [IPCC 2006, page 6.8], living biomass immediately following conversion to flooded land B_{After} = 0 t d.m./ha [IPCC 2006, page 7.20].

Table 6.28. 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 7247 kt of CO_2.

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:
  1. 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;
  2. railway grounds;
  3. 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 2016 Environmental Protection). Carbon stock changes in living biomass were calculated based on equation 8.2. page 8.7 [IPCC 2006]. Default accumulation rate C_{RF}=2.9 t C/ha was used for calculations [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 7533 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.

To estimate LB carbon stock change in Forest Land converted to Settlements, we have considered instant oxidation of carbon stock in living biomass and litter and dead wood.

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 6.29. 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

The reference dataset is actually a combination of heterogeneous underlying sources offering indirect guarantee for complete and consistent land use capturing in time and space. Land registry is a major source of data, usually locally implemented cadastral database as ownership information, complemented by operational data in forestry, both backed by ground measurements. Additional information is provided by sectorial statistics in agriculture mostly based on municipality or owners/farmers' declarations. Notably, for the agricultural lands reported under agricultural statistics, errors can be particularly high when "activity area" is taken as a proxy for "land use", or when subjective methods are involved (e.g. non-rigorous implementation of land definition on owner declaration) or lack of rigorous checks and quality assurance/control procedures. Using such data for emissions reduction commitments on land is further strongly limited by non-spatially explicit nature of information and impossibility to be processed as a unique national database. The most significant weakness of reference dataset related to forest land is that it implements an exclusive forest definition, which is 'land administration oriented' thus focusing on forest administrated by the State Forests Holding, instead of one based on quantitative thresholds which would be able to capture all forests and change no matter of their cadastral status.

Uncertainty of inventory annual estimate is dominated by forest sink, and apparently influenced by uncertainties of C pool changes. Our sensitivity analysis did not reveal uncertainty of land areas as a significant input, nor for stable land uses and for conversions.

For estimating the contribution of land datasets uncertainty to the overall uncertainty of the CO_2 emissions and removals, a Approach 1 (IPCC 2006) was applied to the inputs for year 2016 within the LUM spreadsheet. An input was defined as the mean value and its relative standard deviation of the mean CSC. Where data was available, standard error of the mean was used (e.g. C stock change in litter or biomass on lands in conversion to forests), otherwise a probability range of the mean as defined by the reference or based on expert assumption (assuming mean is normally distributed).

Uncertainty analysis for the year 2016 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. In this submission 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 1988-2015 ensured consistency for whole time-series.

Table 6.30. Results of the sectoral uncertainty analysis in 2016

2016	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	**-29219.16**	**1.79**	**4.10**	49.9%	71.2%	100.3%
A. Forest Land	-36519.30	1.57	0.01	31.6%	80.6%	100.5%
B. Cropland	733.07			75.2%		
C. Grassland	-940.65	0.22	0.00	75.2%	80.2%	100.1%
D. Wetlands	4495.22	0.00	0.00	75.2%	0.0%	0.0%
E. Settlements	7247.04			31.6%		
F. Other Land						
G. Other	-4234.53			50.2%		

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

It has be noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO_2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before. Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows:

- comprehensive implementation of methods and factors provided in IPCC 2006 guidelines;
- factors related adjustment of carbon stocks calculation in category 4.A;
- Inherited emissions were considered when calculating the initial carbon stock at the beginning of the commitment period (flux data method) in order to subsequently estimate net-emissions based on pool changes;
- accounting of HWP in solid waste disposal sites (on the basis of pool changes) was excluded;
- the apparent consumption of e.g. industrial roundwood is assumed to equal the feedstock used to manufacture e.g. sawnwood;
- HWP estimates were calculated by means of flux data methods (annual carbon inflow based on annual statistical data on production and trade) allowing estimating C pool change (i.e. net-emissions) on annual basis.

Net effect of recalculations on CO_2 emissions/removals is provided in the tables 6.30; 6.31; 6.32.

Table 6.31. Recalculation of CO_2 for entire time series made in CRF 2018 comparing to CRF 2017

CRF	Unit	1988	1990	1991	1992	1993	1994	1995	1996
4.A	[kt]	33.47	52.27	24.46	-11.73	-28.26	-16.78	11.46	137.08
	[%]	-0.15	-0.15	-0.09	0.25	0.24	0.15	-0.05	-0.34
4.B	[kt]	0.00	-32.23	-48.51	-65.24	-81.10	-97.54	-113.87	-126.54
	[%]	0.00	-3.14	-9.58	-12.78	-15.74	-18.83	-21.75	-23.94
4.C	[kt]	-0.02	-2.37	-3.50	-4.52	-5.75	-6.86	-7.99	-8.91
	[%]	0.00	-0.33	-0.46	-0.63	-0.86	-1.02	-1.00	-1.27
4.D	[kt]	0.00	0.13	0.41	0.49	0.51	0.64	0.78	2.37
	[%]	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.05
4.E	[kt]	-193.61	-100.25	-89.98	-52.70	-543.99	-83.81	-98.93	-58.95
	[%]	-41.83	-26.59	-20.03	-11.52	-40.24	-14.10	-16.08	-11.43
4.G	[kt]	-719.61	1955.75	2210.95	3042.03	3080.11	1884.97	1441.89	1075.89
	[%]	37.25	129.87	116.50	133.28	140.59	249.13	279.05	470.81

CRF	Unit	1997	1998	1999	2000	2001	2002	2003	2004
4.A	[kt]	100.84	226.30	-11333.45	61.91	-14.90	169.18	225.67	371.36
	[%]	-0.26	-0.51	21.71	-0.17	0.05	-0.45	-0.57	-0.74
4.B	[kt]	-139.54	-154.48	-167.25	-179.93	-190.80	-205.20	-217.55	-229.31
	[%]	-26.66	-29.65	-32.06	-33.51	-36.21	-39.19	-43.23	-45.75
4.C	[kt]	-9.74	-10.06	-10.88	-11.87	-13.17	-13.70	-14.69	-15.85
	[%]	-1.50	-5.61	-3.14	-4.50	-5.25	-139.47	4.83	8.82
4.D	[kt]	7.29	7.97	8.31	10.82	24.09	27.67	31.38	34.26
	[%]	0.16	0.18	0.18	0.24	0.53	0.61	0.68	0.76
4.E	[kt]	-61.18	-85.11	-71.22	-58.85	-105.39	-77.07	-61.10	-101.18
	[%]	-11.71	-13.26	-10.37	-8.71	-15.42	-11.87	-9.71	-14.33
4.G	[kt]	908.78	308.47	1514.05	1624.82	2353.98	2288.89	1768.87	1466.30
	[%]	-254.69	-23.70	-195.11	-160.54	62962.25	-946.21	-143.74	-67.49

CRF	Unit	2005	2006	2007	2008	2009	2010	2011	2012
4.A	[kt]	201.51	-10.54	176.52	40.23	18.46	26.64	24.31	19.70
	[%]	-0.40	0.02	-0.48	-0.11	-0.05	-0.08	-0.06	-0.05
4.B	[kt]	-240.37	-250.85	-260.63	-271.52	-282.94	-295.43	-307.98	-320.69
	[%]	-40.66	-43.34	-46.80	-33.36	-49.98	-58.11	-66.39	-71.49
4.C	[kt]	-17.15	-18.51	-20.22	-21.38	-22.48	-23.48	-24.41	-25.31
	[%]	8.38	8.22	6.48	6.36	7.19	6.11	5.91	5.88
4.D	[kt]	38.35	46.00	51.42	52.05	51.17	50.14	45.37	45.60
	[%]	0.85	1.02	1.13	1.15	1.13	1.11	1.00	1.01
4.E	[kt]	-95.77	-69.22	-87.60	-87.60	-91.20	-94.30	-80.89	-88.66

CRF	Unit	2005	2006	2007	2008	2009	2010	2011	2012
	[%]	-12.57	-7.88	-8.74	-9.30	-8.24	-7.87	-7.00	-6.69
4.G	[kt]	1381.28	472.43	-410.56	56.54	-132.06	9.54	-352.65	-700.02
	[%]	-72.24	-15.75	8.99	-1.55	3.66	-0.25	8.47	16.01

CRF	Unit	2013	2014	2015
4.A	[kt]	-19.52	-46.85	65.43
	[%]	0.05	0.13	-0.21
4.B	[kt]	-332.73	-347.03	-358.89
	[%]	-73.92	-80.95	-99.11
4.C	[kt]	-26.38	-26.89	53.83
	[%]	6.20	7.32	-9.48
4.D	[kt]	40.24	55.33	46.10
	[%]	0.89	1.23	1.02
4.E	[kt]	-72.49	-113.80	-108.33
	[%]	-5.57	-4.78	-6.58
4.G	[kt]	-1290.53	-1540.57	-1332.12
	[%]	25.52	27.89	24.94

Table 6.32. Recalculation of CH_4 for entire time series made in CRF 2018 comparing to CRF 2017

CRF	Unit	1988	1990	1991	1992	1993	1994	1995	1996
4.A	[kt]	0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.02
	[%]	-0.09	-0.42	-0.57	-0.72	-0.72	-0.84	-1.04	-1.48
4.B	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.C	[kt]	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
4.D	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.E	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.G	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	NA	NA	NA	NA	NA	NA	NA	NA

CRF	Unit	1997	1998	1999	2000	2001	2002	2003	2004
4.A	[kt]	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05	-0.06
	[%]	-1.84	-2.46	-2.64	-2.95	-3.09	-3.72	-4.47	-5.36
4.B	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.C	[kt]	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
4.D	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.E	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.G	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	NA	NA	NA	NA	NA	NA	NA	NA

CRF	Unit	2005	2006	2007	2008	2009	2010	2011	2012
4.A	[kt]	-0.07	-0.07	-0.08	-0.08	-0.08	-0.08	-0.08	-0.09
	[%]	-5.89	-6.00	-6.74	-6.94	-6.96	-7.01	-7.14	-7.33
4.B	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.C	[kt]	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
4.D	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.E	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.G	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	NA	NA	NA	NA	NA	NA	NA	NA

CRF	Unit	2013	2014	2015
4.A	[kt]	-0.11	-0.09	-0.09
	[%]	-7.64	-7.34	-7.04
4.B	[kt]	NA	NA	NA
	[%]	NA	NA	NA
4.C	[kt]	0.00	0.00	NA
	[%]	0.00	0.00	NA
4.D	[kt]	NA	NA	NA
	[%]	NA	NA	NA
4.E	[kt]	NA	NA	NA
	[%]	NA	NA	NA
4.G	[kt]	0.00	0.00	0.00
	[%]	NA	NA	NA

Table 6.33. Recalculation of N_2O for entire time series made in CRF 2018 comparing to CRF 2017

CRF	Unit	1988	1990	1991	1992	1993	1994	1995	1996
4.A	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
4.B	[kt]	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.C	[kt]	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
4.D	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.E	[kt]	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
4.G	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	NA	NA	NA	NA	NA	NA	NA	NA

CRF	Unit	1997	1998	1999	2000	2001	2002	2003	2004
4.A	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	0.02	0.01	0.03	0.03	0.03	0.02	0.05	0.02
4.B	[kt]	0.00	0.00	NA	0.00	NA	0.00	0.00	0.00
	[%]	0.00	0.00	NA	0.00	NA	0.00	0.00	0.00
4.C	[kt]	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
4.D	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.E	[kt]	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
4.G	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	NA	NA	NA	NA	NA	NA	NA	NA

CRF	Unit	2005	2006	2007	2008	2009	2010	2011	2012
4.A	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	0.04	0.08	0.03	0.04	0.10	0.09	0.12	0.16
4.B	[kt]	0.00	NA	0.00	0.00	NA	NA	NA	NA
	[%]	0.00	NA	0.00	0.00	NA	NA	NA	NA
4.C	[kt]	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
4.D	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.E	[kt]	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
4.G	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	NA	NA	NA	NA	NA	NA	NA	NA

CRF	Unit	2013	2014	2015
4.A	[kt]	0.00	0.00	-0.01
	[%]	0.05	0.23	-39.72
4.B	[kt]	NA	NA	0.00
	[%]	NA	NA	0.00

CRF	Unit	2013	2014	2015
4.C	[kt]	0.00	0.00	NA
	[%]	0.00	23.41	NA
4.D	[kt]	NA	NA	NA
	[%]	NA	NA	NA
4.E	[kt]	0.00	0.00	0.00
	[%]	0.00	0.00	0.00
4.G	[kt]	0.00	0.00	0.00
	[%]	NA	NA	NA

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 continuously 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. Poland 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.

6.8. Harvested wood products (CRF sector 4.G)

Following coefficients from Table 12.4 of 2006 Guidelines (default factors to convert from product units to carbon) were adapted to the conditions of our country, resulting the following factors for conversion to carbon:

Table 6.34. Factors for conversion to carbon

Item	Value
Solid wood	0.285
Sawn wood	0.268
Wood panel	0.294
Paper ansd paper board	0.45
Wood charcoal	0.765
Bark	1.120

The half-live time parameters

According to the 2006 Guidelines, the half-live time parameters are: 35 years – sawn wood (decay rate k=0.020), 25 years – wood panels (decay rate k=0.028) and 2 years- paper products (decay rate k=0.347).

Data sources (FAO database)

When determining CO_2 emission balance, we resorted to consulting the FAO database (available at the following address: http://faostat.fao.org). Based on FAO classification, we retrieved data regarding the production and export of the following wood products: roundwood, sawnwood, wood-based panels, paper and paperboard, wood pulp and recovered paper, industrial roundwood, chips and particles, wood charcoal and wood residues.

Estimating data for the period between 1900 and 1960

Due to the fact that FAO only supplies data beginning with 1961, we resorted to estimate production and export of wood products between 1900 and 1960 by equation 12.6, which takes into account the production and exports values for 1961 and U (the exchange rate in Europe, which amounts to 0.0151).

The variables (1.A, 1.B, 2.A, 2.B, 3, 4, 5) were determined in conformity with the provisions of the *IPCC Guidelines for National Greenhouse Gas Inventories Volume 4. Agriculture, Forestry and Other Land Use, chapter 12 Harvested Wood Products 2006*. Calculation runs through all of the mentioned stages, and also by using the I*nventory Software ver 2.12*, available at http://www.ipcc-nggip.iges.or.jp/software/index.html.

Calculation

Step 1: Calculating variable 1.A (i.e. Annual change in carbon stock in "products in use"). It was calculated using formulas 12.1 and 12.2, for each product category (solid wood or paper products), inflow, k (decay rate), and the carbon stock at the beginning of the year (C(i)).

Step 2: Calculating variable 2.A (Annual change in carbon stock in "products in use" where wood came from harvest in the reporting country (includes exports)). It was calculated using formulas 12.1 and 12.3, accounting for the product category (solid wood or paper products), inflow, k (decay rate) and the stock of carbon at the beginning of the year (C(i)).

Step 3: Calculating variable 1.B (Annual Change in stock of HWP in SWDS from consumption) and 2.B (annual Change in stock of HWP in SWDS produced from domestic harvest). When calculating the 1.B and 2.B variables, we took into account the Waste Sector Tier 1 estimates, as laid out in the IPCC 2006 Guidelines.

6.8.1 Uncertainties and time series consistency

Estimation of C stock change in HWP is under further refining. Estimate of uncertainty is going to be done with future submissions.

6.8.2 Category-specific QA/QC and verification, if applicable

Comparable order of magnitude of currently submitted estimates with those submitted by Poland in the past (TAR for forest management reference level).

6.8.3 Category-specific recalculations, if applicable, including changes made in response to the review process and impact on emission trend

No recalculations were performed in relation to the HWP estimates.

6.8.4 Category-specific planned improvements, if applicable (e.g. methodologies, activity data, emission factors, etc.), including those in response to the review process

Current approach is to build capacity to cover HWP, to better understand the estimation methodologies and requirements, as well as available data.

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 subcategories from sector 5. have been identified as key source (excluding LULUCF):

IPCC Source Categories	GHG	Identification criteria (Level, Trend, Qualitative)		
5.A Solid Waste Disposal	CH_4	L	T	
5.D Wastewater Treatment and Discharge	CH_4		T	

Share of these subcategories in total Poland's GHG emissions amounts ca. 2.38%.

Total emission of GHG amounted to 11 433.43 kt of CO_2 equivalent in 2016 and decreased since 1988 by 33.32% (figure 7.1).

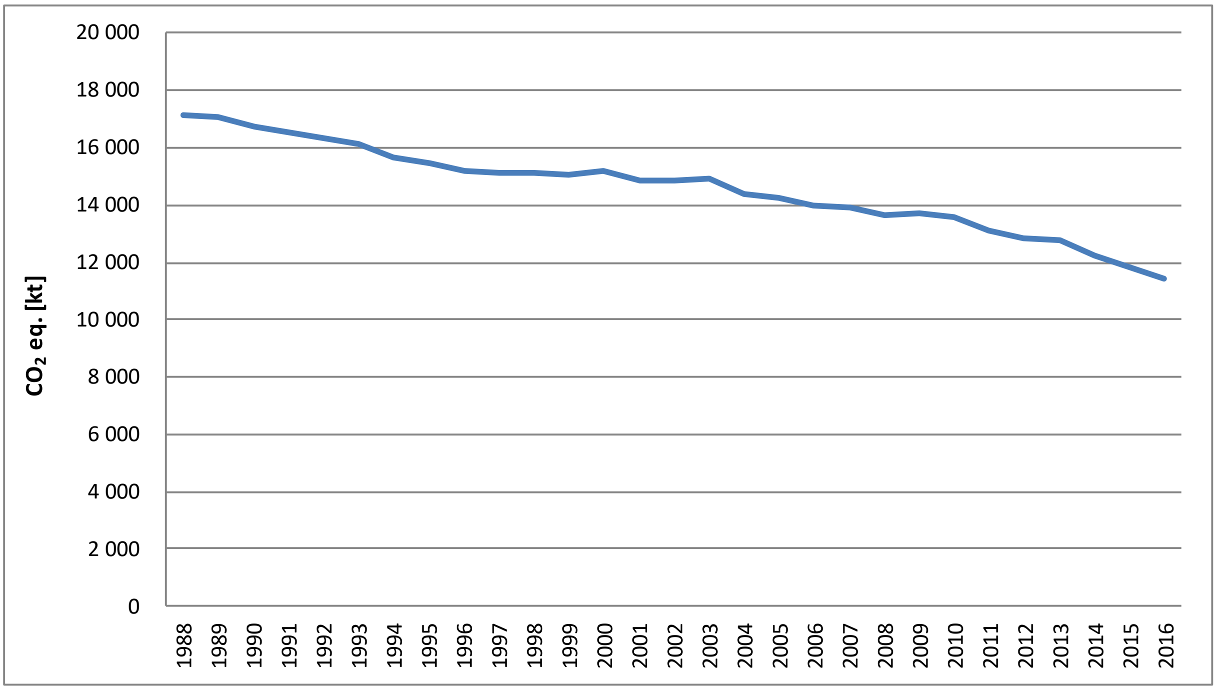

Figure 7.1. GHG emissions from waste sector in 1988-2016

Between years 1988 and 2016 decrease of GHG emissions appeared in subcategory 5.A (by 23.9 %) and 5.D (by 74.8 %) while emissions from sources gathered in subcategories 5.B and 5.C increased since 1988 by 6 100.0 % (5.B) and 86.7 % (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 (78.7% and 10.8% of emission respectively) contributors to emission from *Waste* sector.

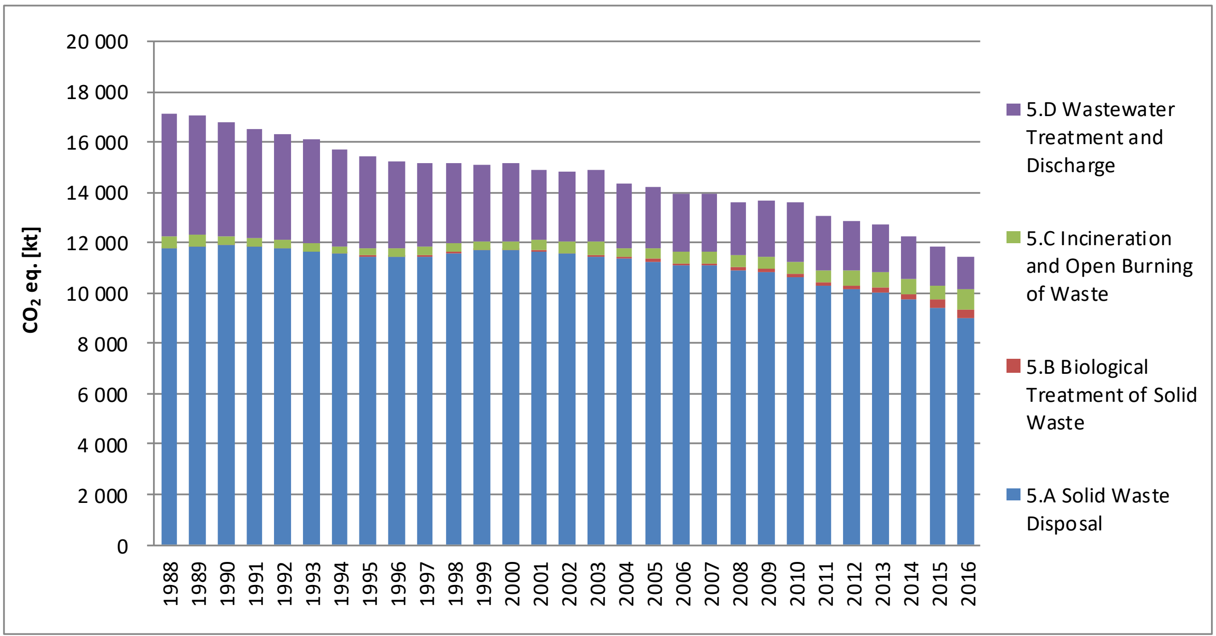

Figure 7.2. GHG emissions from waste sector divided to subsectors

According to statistical data [GUS (2016d)] in 2016 collected municipal solid wastes go to four different pathways: incineration (4.1%), biological treatment (16.2%), recycling (43.2%) and landfilling (36.5%).

The changes in shares of municipal solid waste treatment pathways since 2007 are presented below (figure 7.3).

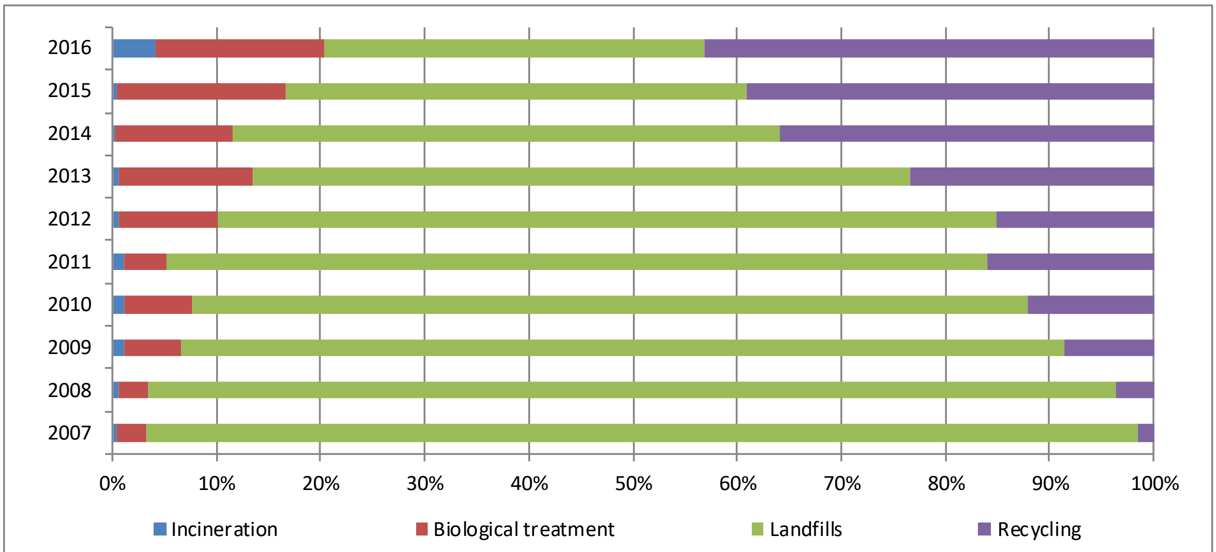

Figure 7.3. Municipal solid waste treatment pathways

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 amounts ca. 78.7% and it involves methane emissions from Managed Waste Disposal on Land (46.4% share of 5.A), Unmanaged Waste Disposal on Land deep (23.1% share of 5.A) and Uncategorized MSW Disposal on Land (9.2% share of 5.A). Managed Waste Disposal on Land includes methane emissions from disposal of sewage sludge (described in chapter 7.2.2.1) and industrial solid waste (described in chapter 7.2.2.2).

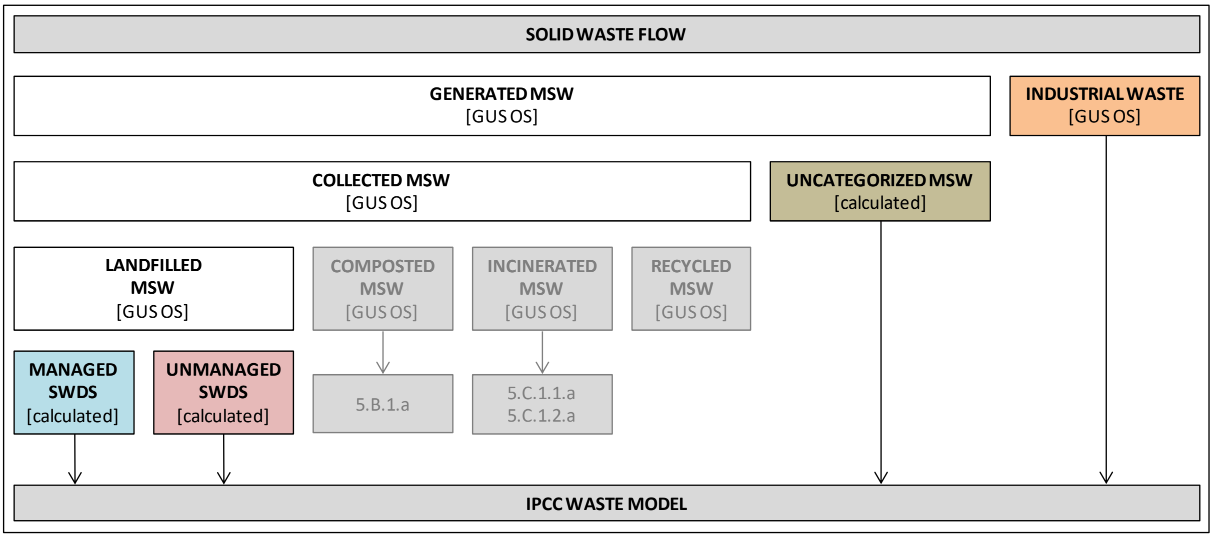

Figure 7.4. Solid waste flow scheme

The trend of emissions from sector 5.A is mostly conditioned by activity data – amounts of waste generated, collected and landfilled – which reached highest values around the year 1990 and the year 1999. The first peak in the trend (Fig. 7.5) 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, the most common way of treatment was landfilling, and the significant amount of disposal sites were 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 coinsiding with the highest peak in collected MSW trend.

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.

Basic legal regulatory

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.

Imported waste

Poland is importing solid waste but according to information from Chief Inspectorate of Environmental Protection it is mostly hazardous waste for incineration (no municipal waste is imported) and it's amount is included in data on incinerated waste used by Party for estimates from subsector 5.C.

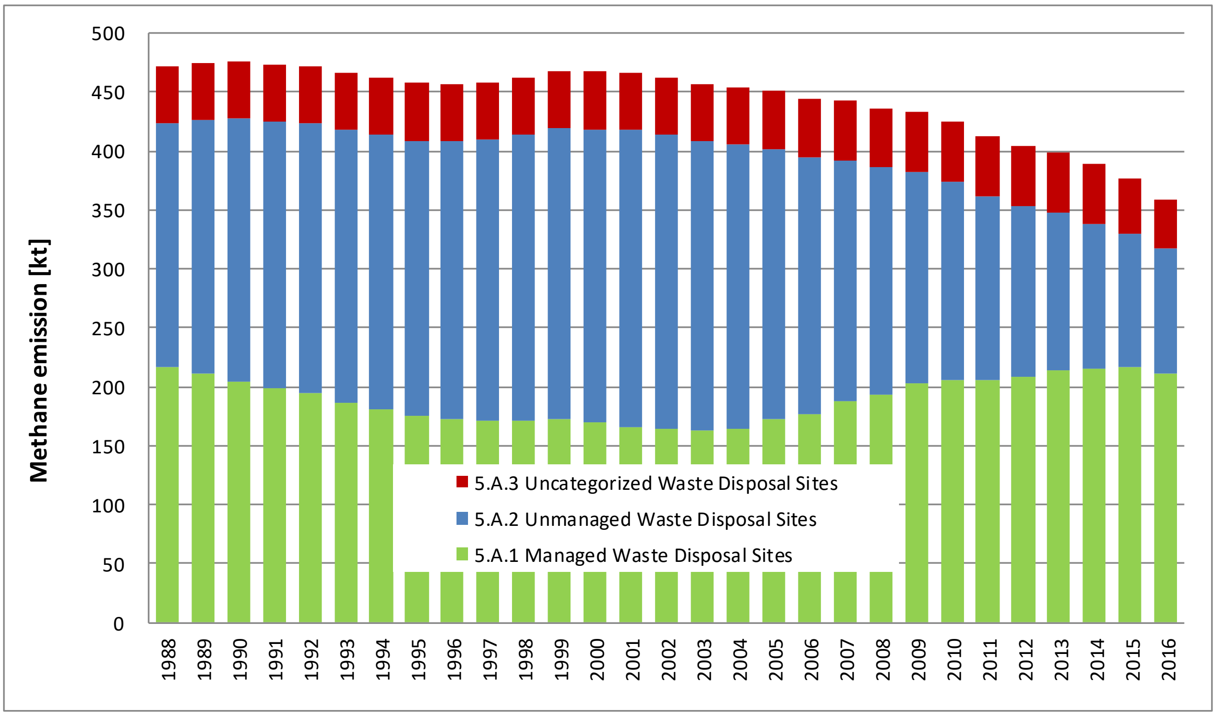

Figure 7.5. Methane emission from 5.A subsector divided to subcategories

7.2.2. Methodological issues

7.2.2.1 Method and factors applied

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 provided by 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 following factors were used for estimation of CH_4 emissions:
DOC – degradable organic carbon in the year of deposition,
DOC_f – fraction of DOC that can decompose,
MCF – CH_4 correction factor for aerobic decomposition in the year of deposition,
k – reaction constant,
F – fraction of CH_4 by volume, in generated landfill gas.
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 7.1. 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

Party assummed on the basis of the expert judgement that all unmanaged landfills are considered to be „deep". This is more restrictive approach that could lead to overestimation of the emission, but there is no available statistical historical and present data on the share of „shallow" and „deep" landfills.

Table 7.2. DOC and DOC_f indicators

DOC	Municipal Waste			Industrial Waste	
	Range	Default	Adopted Value	Default	Adopted Value
Food	0.08-0.20	0.15	0.15	0.15	0.15
Garden	0.18-0.22	0.2	0.2	NO	NO
Paper	0.36-0.45	0.4	0.4	0.4	0.4
Wood and straw	0.39-0.46	0.43	0.43	0.43	0.43
Textiles	0.20-0.40	0.24	0.24	0.24	0.24
Nappies	0.18-0.32	0.24	IE	NO	NO
Rubber (and leather)	0.39	0.39	IE	0.39	0.39
DOC_f	0.5	0.5	0.5	0.5	0.5

Table 7.3. Methane generation rate (k) assumed for calculations

Methane generation rate constant (k)	Municipal Waste			Industrial Waste		
	Range	Default	Adopted Value	Range	Default	Adopted Value
Food waste	0.1–0.2	0.185	0.185	0.1–0.2	0.185	0.185
Garden	0.06–0.1	0.1	0.1	NO	NO	NO
Paper	0.05–0.07	0.06	0.06	0.05–0.07	0.06	0.06
Wood and straw	0.02–0.04	0.03	0.03	0.02–0.04	0.03	0.03
Textiles	0.05–0.07	0.06	0.06	0.05–0.07	0.06	0.06
Nappies	0.06-0.1	0.1	IE	0.06-0.1	0.1	NO
Rubber	IE	IE	IE	0.02–0.04	0.03	0.03

No data on shares of nappies, rubber and leather in municipal solid waste are available - reported under "textile" category.

Table 7.4. Factors F, OX and delay time assumed for calculations

Factor	Municipal Waste		Industrial Waste	
	Default	Value	Default	Value
Delay time (months)	6	6	6	6
Fraction of methane in developed gas (F)	0.5	0.55	0.5	0.5
Oxidation factor (OX)	0	0-0.1*	0	0

* 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

Fraction of degradable organic carbon in bulk waste (DOC) was calculated with application of default IPCC 2006 method and country specific data on waste composition.

Fraction of methane in developed gas

Fraction of methane (F) in generated landfill gas in municipal SWDSs was calculated on basis of country specific studies performed on data from thirteen solid waste disposal sites. Measured shares of CH_4 in generated biogas are presented in table 7.6. The value of obtained factor F applied in inventory is an arithmetical average of measured fractions and equals 55%.

Table 7.5. Calculation of factor F for municipal waste

No.	SWDS	Measured CH_4 fraction in landfill gas [%]	Data source
1.	Sierakowo	65.8	Grzybek (2005)
2.	Kłoda	33.8	
3.	Lipówka I	50.6	Ocieczek (2010)
4.	Kraków-Barycz	56.2	Dudek (2013)
5.	Myślenice-Borzęta	62.1	
6.	Brzesko-Jadowniki	71.9	
7.	Choszczno-Stradzewo	48.7	
8.	Nowy Sącz	54.0	Ciuła (2013)
9.	Łódź-Nowosolna	63.0	Czurejno (2006)
10.	Warszawa-Radiowo	59.3	
11.	Bydgoszcz	31.6	
12.	Gdańsk-Szadłówki	69.0	
13.	Toruń	47.5	Grzesik (2006)
	calculated F value:	**55.0**	-

Sewage sludge

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 on 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

Climatic zone

Party is applying IPCC 2006 values of methane generation rate (k) and half-life ($t_{1/2}$) default for cold temperate wet climatic zone, according to IPCC Good Practice Guidance for LULUCF, Chapter 3 (IPCC 2003).

7.2.2.2 Activity data

Activity data applied in IPCC Waste Model to estimate emissions of CH_4 from solid waste disposal are calculated on basis of following data:

- **generated MSW** – data for the years 1950 - 2004 extrapolated according to amount of collected MSW, since 2005 – data published in [GUS (2006-2016d)] (table 7.7.).
- **collected MSW** – data for the years 1970 - 2015 was taken from National Statistics, data for the years 1950 - 1970 was extrapolated according to amount of landfilled MSW. Data for 1971-1973 and 1976 were interpolated (table 7.7).

- **landfilled MSW** – data for the years 1970 – 2015 was taken from National Statistics, data for the years 1950 – 1970 was extrapolated according to data on average monthly salary per capita published in National Statistics (table 7.7).
- **managed SWDS** – data prvided by Waste Management Department of Ministry of the Environment – MSW deposited on landfills fulfilling requirements of Landfill Directive 1999/31/EC (table 7.8.).
- **landfilled sewage sludge** – data for the years 1995 - 2015 published in [GUS (1996d-2016d)] (table 7.10).
- **landfilled industrial waste** – data for the years 1975 - 2015 published in [GUS (1976d-2016d)] (table 7.12).
- **composition of MSW** – data calculataed on basis of National Waste Management Plans (table 7.9.).
- **composition of industrial waste** – calculated on basis of data on landfilled waste in industries published in [GUS (1976d-2016d)] (table 7.13).
- **methane recovery** – calculated on basis of data on amounts of recovered landfill gas published in [GUS OZE (2001-2016)] (table 7.11).

Municipal Waste

Table 7.7. Generated, collected and landfilled municipal solid waste

Years	Generated MSW [kt]	Data source	Collected MSW [kt]	Data source	Landfilled MSW [kt]	Data source
1950	3 403.63	extrapolation	1 151.67	extrapolation	973.50	extrapolation
1951	3 488.43	extrapolation	1 236.48	extrapolation	1 058.30	extrapolation
1952	3 582.07	extrapolation	1 330.12	extrapolation	1 151.94	extrapolation
1953	4 055.57	extrapolation	1 803.62	extrapolation	1 625.44	extrapolation
1954	4 152.74	extrapolation	1 900.79	extrapolation	1 722.61	extrapolation
1955	4 211.05	extrapolation	1 959.10	extrapolation	1 780.92	extrapolation
1956	4 405.39	extrapolation	2 153.44	extrapolation	1 975.27	extrapolation
1957	4 689.86	extrapolation	2 437.90	extrapolation	2 259.72	extrapolation
1958	4 811.75	extrapolation	2 559.80	extrapolation	2 381.63	extrapolation
1959	4 997.24	extrapolation	2 745.29	extrapolation	2 567.14	extrapolation
1960	5 186.37	extrapolation	2 934.42	extrapolation	2 756.18	extrapolation
1961	5 301.11	extrapolation	3 049.16	extrapolation	2 871.02	extrapolation
1962	5 398.23	extrapolation	3 146.28	extrapolation	2 968.20	extrapolation
1963	5 545.28	extrapolation	3 293.33	extrapolation	3 114.84	extrapolation
1964	5 638.27	extrapolation	3 386.32	extrapolation	3 208.48	extrapolation
1965	5 728.46	extrapolation	3 476.51	extrapolation	3 298.59	extrapolation
1966	5 848.60	extrapolation	3 596.65	extrapolation	3 416.96	extrapolation
1967	5 989.70	extrapolation	3 737.74	extrapolation	3 561.84	extrapolation
1968	6 150.98	extrapolation	3 899.03	extrapolation	3 720.85	extrapolation
1969	6 277.93	extrapolation	4 025.98	extrapolation	3 840.99	extrapolation
1970	6 365.93	extrapolation	4 113.98	GUS (1987)	3 949.42	GUS (1987)
1971	6 876.60	extrapolation	4 624.65	interpolation	4 439.66	interpolation
1972	7 387.26	extrapolation	5 135.31	interpolation	4 929.90	interpolation
1973	7 897.93	extrapolation	5 645.98	interpolation	5 420.14	interpolation
1974	8 408.60	extrapolation	6 156.64	GUS (1974d)	5 910.38	GUS (1974d)
1975	9 040.92	extrapolation	6 788.96	GUS (1986d)	6 517.41	GUS (1986d)
1976	9 649.95	extrapolation	7 397.99	interpolation	7 102.07	interpolation
1977	10 258.98	extrapolation	8 007.03	GUS (1981d)	7 686.74	GUS (1981d)
1978	10 954.78	extrapolation	8 702.83	GUS (1981d)	8 676.72	GUS (1981d)
1979	11 304.58	extrapolation	9 052.63	GUS (1981d)	9 044.52	GUS (1981d)

Years	Generated MSW [kt]	Data source	Collected MSW [kt]	Data source	Landfilled MSW [kt]	Data source
1980	12 120.67	extrapolation	9 868.72	GUS (1986d)	9 861.54	GUS (1986d)
1981	12 266.37	extrapolation	10 014.42	GUS (1986d)	10 004.41	GUS (1986d)
1982	12 581.02	extrapolation	10 329.07	GUS (1986d)	10 318.74	GUS (1986d)
1983	12 793.86	extrapolation	10 541.91	GUS (1986d)	10 531.37	GUS (1986d)
1984	13 116.49	extrapolation	10 864.54	GUS (1986d)	10 853.68	GUS (1986d)
1985	13 338.90	extrapolation	11 086.95	GUS (1986d)	11 075.86	GUS (1986d)
1986	13 798.81	extrapolation	11 546.86	GUS (1987)	11 535.31	GUS (1987)
1987	14 129.40	extrapolation	11 877.45	GUS (1989d)	11 865.57	GUS (1989d)
1988	14 336.13	extrapolation	12 084.18	GUS (1989d)	12 072.09	GUS (1989d)
1989	14 252.90	extrapolation	12 000.95	GUS (1990d)	11 988.95	GUS (1990d)
1990	13 350.23	extrapolation	11 098.28	GUS (1996)	11 087.18	GUS (1996)
1991	12 889.93	extrapolation	10 637.98	GUS (1996)	10 627.34	GUS (1996)
1992	12 872.95	extrapolation	10 621.00	GUS (1996)	10 610.38	GUS (1996)
1993	12 896.61	extrapolation	10 644.66	GUS (1996)	10 551.85	GUS (1996)
1994	13 266.59	extrapolation	11 014.64	GUS (1996)	10 899.98	GUS (1996)
1995	13 236.95	extrapolation	10 985.00	GUS (2005d)	10 783.84	GUS (2005d)
1996	13 873.17	extrapolation	11 621.22	GUS (1997d)	11 402.00	GUS (1997d)
1997	14 435.40	extrapolation	12 183.44	GUS (1998d)	11 964.00	GUS (1998d)
1998	14 527.72	extrapolation	12 275.77	GUS (1999d)	11 988.00	GUS (1999d)
1999	14 568.85	extrapolation	12 316.90	GUS (2000d)	12 035.00	GUS (2000d)
2000	14 477.95	extrapolation	12 226.00	GUS (2005d)	11 888.04	GUS (2005d)
2001	13 360.95	extrapolation	11 109.00	GUS (2005d)	10 637.57	GUS (2005d)
2002	12 760.65	extrapolation	10 508.70	GUS (2005d)	10 161.93	GUS (2005d)
2003	12 176.56	extrapolation	9 924.61	GUS (2005d)	9 609.10	GUS (2005d)
2004	12 011.26	extrapolation	9 759.31	GUS (2005d)	9 193.60	GUS (2005d)
2005	12 169.00	GUS (2012d)	9 352.12	GUS (2006d)	8 623.10	GUS (2006d)
2006	12 235.00	GUS (2009d)	9 876.59	GUS (2007d)	8 987.00	GUS (2007d)
2007	12 264.00	GUS (2010d)	10 082.58	GUS (2011d)	9 098.00	GUS (2011d)
2008	12 194.00	GUS (2011d)	10 036.41	GUS (2011d)	8 693.00	GUS (2011d)
2009	12 053.00	GUS (2012d)	10 053.50	GUS (2012d)	7 859.00	GUS (2012d)
2010	12 038.00	GUS (2012d)	10 040.11	GUS (2012d)	7 369.00	GUS (2012d)
2011	12 128.80	GUS (2012d)	9 827.64	GUS (2012d)	6 967.10	GUS (2012d)
2012	12 085.00	GUS (2013d)	9 580.87	GUS (2013d)	7 158.20	GUS (2013d)
2013	11 295.00	GUS (2014d)	9 473.83	GUS (2014d)	5 978.70	GUS (2014d)
2014	10 330.40	GUS (2015d)	10 330.40	GUS (2015d)	5 437.00	GUS (2015d)
2015	10 863.50	GUS (2016d)	10 863.50	GUS (2016d)	4 808.00	GUS (2016d)
2016	11 654.00	GUS (2017d)	11 654.00	GUS (2017d)	4 255.00	GUS (2017d)

Data on landfilled municipal solid waste for the years 1950 – 1970 was extrapolated according to data on average monthly salary per capita published in National Statistics [GUS W (2016)]. Correlation of those factors is acknowledged by many researches and described in papers, eg. Gellynck (2011).

Shares of managed and unmanaged SWDSs for years 1970-2001 was calculated in accordance to elaboration [Gworek (2003)]. Since 2001, Poland was implementing the Landfill Directive (1999/31/EC), and gathering data on amounts of SDWSs which are fullfilling its requirements and are considered to be managed solid waste disposal sites. For years 2003 – 2011, it was provided for inventory purposes by Waste Management Department of Ministry of Environment. Since 2012 all solid waste disposal sites in Poland fulfill requirements of the Directive.

Tabela 7.8. Amount and share of waste landfilled on managed SWDS

Year	Landfilled MSW [kt]	MSW landfilled on managed SWDS [kt]	Share of managed SDWS
2001	data unavailable	data unavailable	20%*
2002	data unavailable	data unavailable	26%*
2003	10 753.0	3 414.0	32%
2004	9 029.3	5 207.5	58%
2005	8 623.1	5 210.0	60%
2006	7 824.4	5 903.3	75%
2007	9 227.8	7 411.4	80%
2008	8 947.2	7 584.8	85%
2009	8 543.6	7 379.9	86%
2010	8 577.6	7 885.3	92%
2011	7 649.8	6 979.1	91%
2012	7 158.2	7 158.2	100%
2013	5 978.7	5 978.7	100%
2014	5 437.0	5 437.0	100%
2015	4 808.0	4 808.0	100%
2016	4 255.0	4 255.0	100%

* interpolated values

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 7.10). Data for 2001-2003 are based on National Waste Management Plan 2003 [KPGO 2003], for 2004-2008 on [KPGO 2010], for 2008-2013 on [KPGO 2014] and for the year 2016 [KPGO 2022].

The data on recovered methane are plant specific, based on responses to questionnaires of Central Statistical Office on energy combustion. Recovered gas is combusted for energy purposes or flared (no data on amounts available).

Table 7.9. Composition of municipal solid waste

Year	Food	Garden	Paper	Wood	Textile	Plastics, and other inert
1970	31.50%	4.70%	15.50%	6.30%	3.50%	38.48%
1971	31.15%	4.63%	15.56%	6.09%	3.49%	39.07%
1972	30.80%	4.56%	15.63%	5.88%	3.47%	39.67%
1973	30.44%	4.49%	15.69%	5.67%	3.45%	40.26%
1974	30.09%	4.41%	15.75%	5.46%	3.44%	40.85%
1975	29.73%	4.34%	15.81%	5.25%	3.42%	41.44%
1976	29.38%	4.27%	15.87%	5.04%	3.41%	42.04%
1977	29.02%	4.20%	15.93%	4.83%	3.39%	42.63%
1978	28.67%	4.12%	15.99%	4.62%	3.37%	43.22%
1979	28.31%	4.05%	16.05%	4.41%	3.36%	43.81%
1980	27.96%	3.98%	16.11%	4.20%	3.34%	44.40%
1981	27.61%	3.91%	16.17%	3.99%	3.32%	45.00%
1982	27.25%	3.83%	16.24%	3.78%	3.31%	45.59%
1983	26.90%	3.76%	16.30%	3.57%	3.29%	46.18%
1984	26.54%	3.69%	16.36%	3.36%	3.27%	46.77%
1985	26.19%	3.62%	16.42%	3.15%	3.26%	47.37%
1986	25.83%	3.54%	16.48%	2.94%	3.24%	47.96%
1987	25.48%	3.47%	16.54%	2.73%	3.23%	48.55%
1988	25.13%	3.40%	16.60%	2.52%	3.21%	49.14%
1989	24.77%	3.33%	16.66%	2.31%	3.19%	49.74%

Year	Food	Garden	Paper	Wood	Textile	Plastics, and other inert
1990	24.42%	3.25%	16.72%	2.10%	3.18%	50.33%
1991	24.06%	3.18%	16.78%	1.89%	3.16%	50.92%
1992	23.71%	3.11%	16.85%	1.68%	3.14%	51.51%
1993	23.35%	3.04%	16.91%	1.47%	3.13%	52.11%
1994	23.00%	2.96%	16.97%	1.26%	3.11%	52.70%
1995	22.65%	2.89%	17.03%	1.05%	3.09%	53.29%
1996	22.29%	2.82%	17.09%	0.84%	3.08%	53.88%
1997	21.94%	2.75%	17.15%	0.63%	3.06%	54.48%
1998	21.58%	2.67%	17.21%	0.42%	3.05%	55.07%
1999	21.23%	2.60%	17.27%	0.21%	3.03%	55.66%
2000	20.87%	2.53%	17.33%	0.00%	3.01%	56.25%
2001	21.44%	3.12%	17.48%	0.41%	2.60%	54.96%
2002	22.00%	3.70%	17.62%	0.81%	2.18%	53.68%
2003	22.56%	4.29%	17.77%	1.22%	1.77%	52.39%
2004	23.12%	4.88%	17.91%	1.63%	1.36%	51.10%
2005	26.01%	4.80%	16.58%	1.31%	1.69%	49.61%
2006	28.91%	4.71%	15.24%	1.00%	2.02%	48.12%
2007	31.80%	4.63%	13.90%	0.68%	2.36%	46.63%
2008	34.69%	4.54%	12.56%	0.37%	2.69%	45.14%
2009	34.83%	3.93%	12.86%	0.40%	2.86%	45.11%
2010	34.97%	3.33%	13.15%	0.44%	3.04%	45.08%
2011	35.11%	2.72%	13.44%	0.47%	3.21%	45.05%
2012	35.26%	2.12%	13.73%	0.50%	3.38%	45.02%
2013	35.40%	1.51%	14.02%	0.53%	3.55%	44.98%
2014	35.54%	0.91%	14.31%	0.57%	3.73%	44.95%
2015	35.68%	0.30%	14.60%	0.60%	3.90%	44.92%
2016	35.86%	0.30%	14.67%	0.60%	3.73%	44.84%

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.

Sewage sludge

The data on amounts of landfilled sewage sludge for the years 1995-2016 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.

No data for period prior to 1995 are available in Polish statistics.

Table 7.10. Sewage sludge activity data

Year	Amount of sewage sludge disposed on landfills [kt]	Data source
1995	1 471	GUS (1996d)
1996	1 419	GUS (1997d)
1997	2 184	GUS (1998d)
1998	1 983	interpolation
1999	1 783	interpolation
2000	1 582	GUS (2005d)
2001	1573	interpolation
2002	1 565	GUS (2005d)
2003	1 510	GUS (2005d)
2004	1 511	GUS (2005d)
2005	1 330	GUS (2006d)
2006	1 271	GUS (2007d)
2007	991	GUS (2011d)
2008	696	GUS (2011d)

Year	Amount of sewage sludge disposed on landfills [kt]	Data source
2009	605	GUS (2012d)
2010	553	GUS (2012d)
2011	534	GUS (2012d)
2012	559	GUS (2013d)
2013	458	GUS (2014d)
2014	451	GUS (2015d)
2015	438	GUS (2016d)
2016	325	GUS (2017d)

Methane recovery

Data on amounts of recovered landfill gas are published in elaboration *Energy from renewable sources* [GUS OZE (2001-2016)]. Amount of recovered methane is calculated with application of [IPCC (2006)] default net calorific value (50.4 MJ/m^3) and country specific fraction of methane in landfill gas (55%).

Table 7.11. Methane recovery data

Year	Recovered landfill gas [TJ]	Data source	Recovered methane [kt]	Data source
2000	423.00	GUS OZE (2001)	4.62	calculation
2001	544.00	GUS OZE (2002)	5.94	calculation
2002	628.00	GUS OZE (2003)	6.85	calculation
2003	704.00	GUS OZE (2004)	7.68	calculation
2004	636.00	GUS OZE (2005)	6.94	calculation
2005	649.10	GUS OZE (2006)	7.08	calculation
2006	791.32	GUS OZE (2007)	8.64	calculation
2007	879.00	GUS OZE (2008)	9.59	calculation
2008	1 432.00	GUS OZE (2009)	15.63	calculation
2009	1 487.00	GUS OZE (2010)	16.23	calculation
2010	1 811.00	GUS OZE (2011)	19.76	calculation
2011	2 323.00	GUS OZE (2012)	25.35	calculation
2012	2 249.00	GUS OZE (2013)	24.54	calculation
2013	2 157.00	GUS OZE (2014)	23.54	calculation
2014	2 051.00	GUS OZE (2015)	22.38	calculation
2015	2 125.00	GUS OZE (2016)	23.19	calculation
2016	2 412.00	GUS OZE (2017)	26.32	calculation

Industrial Waste

Activity data on landfilled industrial waste for the years 1975 - 2016 were taken from Central Statistical Office annuals – Environment Protection. Before year 1975 there were no data on industrial waste.

Table 7.12. Landfilled industrial waste

Years	Landfilled industrial waste [kt]	Data source
1975	3 042.50	GUS (1986d)
1976	3 695.30	GUS (1981d)
1977	4 660.54	GUS (1981d)
1978	5 292.84	GUS (1981d)
1979	4 898.40	GUS (1981d)
1980	4 106.70	GUS (1986d)
1981	4 626.30	GUS (1986d)
1982	4 145.50	GUS (1986d)
1983	4 026.70	GUS (1986d)
1984	3 821.80	GUS (1986d)
1985	3 922.80	GUS (1986d)

Years	Landfilled industrial waste [kt]	Data source
1986	1 867.60	GUS (1987d)
1987	1 851.40	GUS (1989d)
1988	2 151.30	GUS (1989d)
1989	1 906.90	GUS (1990d)
1990	1 752.80	GUS (1996d)
1991	1 897.80	GUS (1996d)
1992	1 472.30	GUS (1996d)
1993	1 498.70	GUS (1996d)
1994	1 204.70	GUS (1996d)
1995	1 043.40	GUS (2005d)
1996	1 149.60	GUS (1997d)
1997	961.00	GUS (1998d)
1998	1 155.10	GUS (1999d)
1999	1 268.90	GUS (2000d)
2000	940.50	GUS (2005d)
2001	736.40	GUS (2005d)
2002	686.40	GUS (2005d)
2003	584.40	GUS (2005d)
2004	493.90	GUS (2005d)
2005	472.30	GUS (2006d)
2006	371.60	GUS (2007d)
2007	330.80	GUS (2011d)
2008	228.90	GUS (2011d)
2009	192.20	GUS (2012d)
2010	263.80	GUS (2012d)
2011	191.00	GUS (2012d)
2012	167.80	GUS (2013d)
2013	140.90	GUS (2014d)
2014	111.70	GUS (2015d)
2015	76.60	GUS (2016d)
2016	111.70	GUS (2017d)

According to IPCC Guidelines [IPCC (2006)] only following types of industrial waste generate CH_4 emission:

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

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.

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	Source of activity data
1975	87.80%	7.43%	2.56%	2.21%	0.00%	0.00%	GUS (1975d)
1976	91.76%	4.70%	2.15%	1.39%	0.00%	0.00%	GUS (1976d)
1977	90.68%	4.65%	2.30%	2.37%	0.00%	0.00%	GUS (1977d)
1978	91.47%	3.08%	1.65%	3.80%	0.00%	0.00%	GUS (1978d)
1979	92.91%	3.37%	1.94%	1.79%	0.00%	0.00%	GUS (1979d)
1980	90.75%	4.83%	2.15%	2.27%	0.00%	0.00%	GUS (1981d)
1981	93.76%	3.49%	1.04%	1.71%	0.00%	0.00%	GUS (1982d)
1982	90.26%	6.60%	1.15%	1.99%	0.00%	0.00%	GUS (1983d)
1983	87.41%	9.44%	1.51%	1.65%	0.00%	0.00%	GUS (1984d)
1984	88.26%	8.35%	1.33%	2.06%	0.00%	0.00%	GUS (1985d)
1985	88.81%	7.54%	1.57%	2.08%	0.00%	0.00%	GUS (1986d)
1986	68.18%	18.59%	5.47%	7.76%	0.00%	0.00%	GUS (1987d)
1987	68.00%	20.60%	6.68%	4.73%	0.00%	0.00%	GUS (1988d)
1988	69.65%	19.02%	4.93%	6.41%	0.00%	0.00%	GUS (1989d)
1989	64.78%	25.85%	5.69%	3.68%	0.00%	0.00%	GUS (1990d)
1990	69.12%	23.29%	5.19%	2.41%	0.00%	0.00%	GUS (1991d)
1991	72.98%	21.45%	3.46%	2.11%	0.00%	0.00%	GUS (1992d)
1992	63.77%	24.67%	1.62%	3.63%	5.53%	0.78%	GUS (1993d)
1993	70.65%	22.62%	1.17%	2.27%	2.41%	0.87%	GUS (1994d)
1994	71.00%	23.00%	1.59%	1.79%	1.76%	0.86%	GUS (1995d)
1995	67.60%	23.03%	3.37%	2.48%	1.84%	1.68%	GUS (1996d)
1996	68.81%	23.22%	2.69%	2.54%	1.70%	1.05%	GUS (1997d)
1997	64.96%	26.87%	2.39%	2.57%	1.82%	1.38%	GUS (1998d)
1998	53.01%	40.21%	1.81%	1.84%	0.71%	2.42%	GUS (1999d)
1999	36.84%	57.46%	1.93%	0.99%	0.41%	2.37%	GUS (2000d)
2000	45.78%	47.45%	2.31%	0.73%	0.35%	3.37%	GUS (2001d)
2001	44.93%	49.29%	1.83%	0.38%	0.38%	3.18%	GUS (2002d)
2002	43.08%	51.94%	2.23%	0.25%	0.13%	2.37%	GUS (2003d)
2003	47.16%	47.09%	2.33%	0.21%	0.10%	3.11%	GUS (2004d)
2004	59.59%	37.70%	2.04%	0.38%	0.14%	0.14%	GUS (2005d)
2005	66.57%	30.59%	1.61%	0.95%	0.15%	0.13%	GUS (2006d)
2006	65.69%	32.13%	1.05%	0.54%	0.08%	0.51%	GUS (2007d)
2007	66.38%	31.89%	1.06%	0.09%	0.03%	0.54%	GUS (2008d)
2008	66.36%	31.50%	1.35%	0.13%	0.00%	0.66%	GUS (2009d)
2009	45.94%	52.19%	1.04%	0.00%	0.00%	0.83%	GUS (2010d)
2010	32.30%	66.34%	0.53%	0.00%	0.00%	0.83%	GUS (2011d)
2011	31.99%	65.92%	0.79%	0.00%	0.05%	1.26%	GUS (2012d)
2012	31.64%	66.45%	0.83%	0.00%	0.00%	1.07%	GUS (2013d)
2013	25.98%	70.33%	0.92%	0.00%	0.00%	2.77%	GUS (2014d)
2014	16.20%	77.53%	1.43%	0.00%	0.00%	4.83%	GUS (2015d)
2015	31.98%	57.83%	5.61%	0.00%	0.00%	4.57%	GUS (2016d)
2016	22.56%	64.55%	2.86%	0.00%	0.00%	10.03%	GUS (2017d)

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.

7.2.2.3 Unmanaged Solid Waste Disposal Sites

In the inventory Party estimates emissions from unmanaged SWDSs. Emission factors and activity data are described in the NIR in chapters 7.2.2.1 and 7.2.2.2. Since 2012 all solid waste disposal sites in Poland fulfill requirements of the Landfill Directive 1999/31/EC and are considered to be managed. Therefore Party still estimates emissions from waste landfilled in unmanaged SWDSs before 2012. This is more restrictive approach that could lead to overestimation of the emissions but also the best available. There is no available way of determining wheather and which Unmanaged Solid Waste Disposal Sites finally became upgraded to managed SWDSs or closed.

7.2.2.4 Uncategorized Solid Waste Disposal Sites

In the inventory Party estimates emissions from unmanaged SWDSs. Emission factors are described in the NIR in chapters 7.2.2.1. Amount of municipal solid waste landfilled in Uncategorized SWDSs is calculated by subtracting amount of collected MSW from amount of generated MSW (fig. 7.4).

In Poland, disposal of waste outside Waste Management System (in Uncategorized Solid Waste Disposal Sites) is strictly prohibited by law and it is assumed that since 2014 no new waste is being landfilled in Uncategorized SWDSs. Still no data on treatment of waste disposed illegally before 2014 are available, therefore assumption that methane emissions from this source stopped is unjustifiable. For this reason emission of methane from waste landfilled before 2014 in Uncategorized Waste Disposal Sites is still estimated.

7.2.3. Uncertainties and time-series consistency

Uncertainty analysis for the revised year 2016 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 1988-2015 ensured consistency for whole time-series.

2016	CO_2 [kt]	CH_4 [kt]	N_2O [kt]	CO_2 Emission uncertainty [%]	CH_4 Emission uncertainty [%]	N_2O Emission uncertainty [%]
5. Waste	**788.15**	**387.07**	**3.25**	33.5%	63.8%	120.6%
A. Solid Waste Disposal on Land		359.11			68.6%	
B. Biological treatment of solid waste		7.94	0.48		104.4%	153.0%
C. Waste Incineration	788.15	0.00	0.22	33.5%	101.1%	150.7%
D. Wastewater treatment and discharge		20.02	2.55		71.1%	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

Table 7.14. Change in methane emissions in result of recalculations in sector 5.A

Change	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
kt CH_4	31.1	30.3	29.3	28.2	27.3	26.1	24.9	23.7	22.3	21.1
%	7.1%	6.8%	6.6%	6.3%	6.2%	5.9%	5.7%	5.5%	5.1%	4.8%

Change	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
kt CH_4	19.7	18.5	17.5	16.2	15.8	16.1	16.7	17.1	17.3	17.2
%	4.4%	4.1%	3.9%	3.6%	3.5%	3.6%	3.8%	3.9%	4.1%	4.0%

Change	2008	2009	2010	2011	2012	2013	2014	2015
kt CH_4	16.8	16.3	15.8	15.1	14.6	13.9	13.1	12.0
%	4.0%	3.9%	3.9%	3.8%	3.7%	3.6%	3.5%	3.3%

Recalculations details:
- corrected value of F factor for industrial, unmanaged and uncategorized waste disposal was applied.

7.2.6. Source-specific planned improvements

Study on extrapolation of amount of landfilled industrial waste for the years 1950-1975 is planned.

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 3.0%.

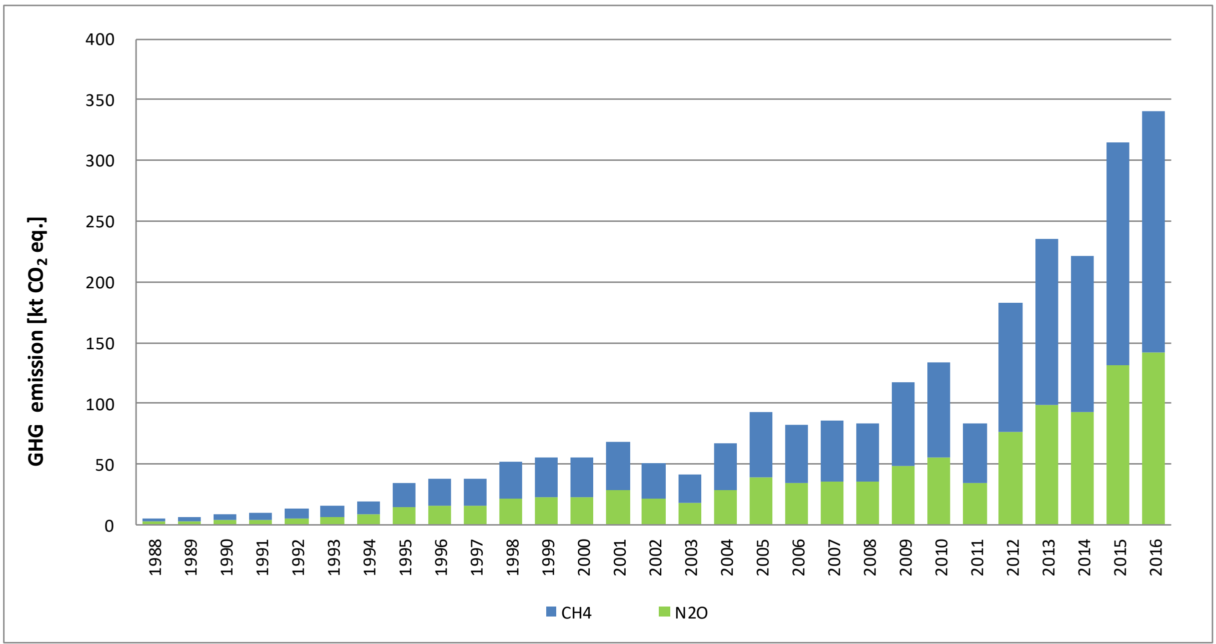

Figure 7.6. GHG emission from 5.B subsector

7.3.2. Methodological issues

7.3.2.1 Method and factors applied

Calculations are based on IPCC 2006 Guidelines [IPCC (2006)] methodology, *Tier 1*, choice of which justifies lack of country-specific method of estimation and research.

Default emission factors applied by Party are: 4 g CH_4/kg treated waste and 0.24 g N_2O/kg treated waste (composting, wet weight basis).

7.3.2.2 Activity data

Activity data and its sources are presented in table 7.15. Data on amounts of municipal waste composted in years 1993-2016 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 1998-2016 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 7.15. 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	1 230.5	GUS (2014d)	142.3	GUS (2014d)
2014	1 154.0	GUS (2015d)	138.8	GUS (2015d)
2015	1 750.0	GUS (2016d)	85.6	GUS (2016d)
2016	1 890.0	GUS (2017d)	94.3	GUS (2017d)

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

Table 7.16. Change in GHG emissions in result of recalculations in sector 5.B

Change	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
kt CO_2 eq.	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%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Change	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
kt CO_2 eq.	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%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Change	2008	2009	2010	2011	2012	2013	2014	2015
kt CO_2 eq.	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%	0.0%	0.0%	0.0%

Recalculations details:
- no recalculations were performed.

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 7.5% 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 (173.20 kt in 2016) is not included in total emission.

Polish law strictly prohibits open burning of waste. Therefore no data on open burning are present in national statistics and no estimation of emissions of GHG from this subsector is calculated.

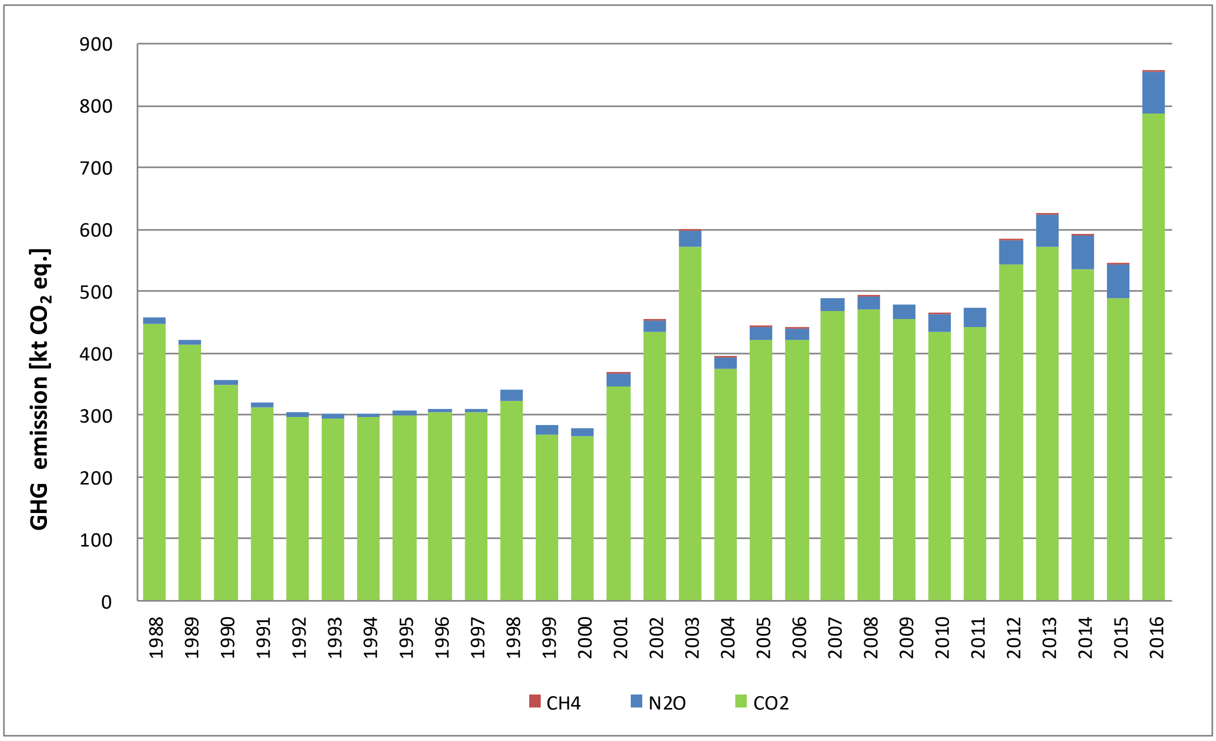

Figure 7.7. GHG emission from 5.C subsector

7.4.2. Methodological issues

7.4.2.1 Method and factors applied

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	Data source
municipal	composition of waste	CS - see table 7.20
	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 of 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 of 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 of 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 fractions was taken from [IPCC (2006)] – municipal solid waste, and [IPCC 2000] – industrial and medical waste and sewage sludge and are presented in table 7.18.

Table 7.18. Biogenic and non-biogenic content of waste in 2016

Type of waste	Biogenic waste fraction	Non-biogenic waste fraction
municipal	0.43	0.57
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 (2016d)]. Data on incinerated medical waste is taken from Central Waste System database.

7.4.2.2 Activity data

Data on amounts of incinerated municipal and medical waste are plant specific and provided by Waste Management Department of The Ministry of The Environment. Data on incineration of industrial waste and sewage sludge are provided by National Statistics [GUS (2016d)].

Table 7.19. Activity data in 2016 [kt]

Type of waste	Amount of waste incinerated	Data source
municipal	479.36	CSO
industrial	430.50	GUS (2016d)
medical	48.97	CSO
sewage sludge	194.70	GUS (2016d)

National Waste Management Plans are source of data on composition of municipal waste. Data for 2001-2003 are based on National Waste Management Plan 2003 [KPGO 2003], for 2004-2008 on [KPGO 2010], for 2008-2013 on [KPGO 2014] and for the year 2016 [KPGO 2022]. Country specific composition of incinerated municipal solid waste is presented in table 7.20.

Table 7.20. Composition of incinerated municipal solid waste

Year	Paper	Textiles	Food waste	Wood	Garden and park waste	Nappies	Rubber and leather	Plastics	Metal	Glass	Other inert waste
2000	17.33%	3.01%	20.87%	0.00%	2.53%	0.00%	0.00%	16.29%	4.59%	8.54%	26.84%
2001	17.48%	2.60%	20.92%	0.41%	3.12%	0.00%	0.00%	15.45%	4.54%	8.29%	27.20%
2002	17.62%	2.18%	20.97%	0.81%	3.70%	0.00%	0.00%	14.62%	4.50%	8.03%	27.55%
2003	17.77%	1.77%	21.02%	1.22%	4.29%	0.00%	0.00%	13.79%	4.46%	7.78%	27.90%
2004	17.91%	1.36%	21.06%	1.63%	4.88%	0.00%	0.00%	12.96%	4.41%	7.53%	28.26%
2005	16.58%	1.69%	23.83%	1.31%	4.80%	0.00%	0.00%	12.88%	3.89%	8.16%	26.86%
2006	15.24%	2.02%	26.60%	1.00%	4.71%	0.00%	0.00%	12.81%	3.36%	8.79%	25.46%
2007	13.90%	2.36%	29.37%	0.68%	4.63%	0.00%	0.00%	12.74%	2.83%	9.42%	24.07%
2008	12.56%	2.69%	32.13%	0.37%	4.54%	0.00%	0.00%	12.67%	2.31%	10.05%	22.67%
2009	12.86%	2.86%	31.13%	0.40%	3.93%	0.00%	0.00%	12.88%	2.26%	9.84%	23.83%
2010	13.15%	3.04%	30.12%	0.44%	3.33%	0.00%	0.00%	13.08%	2.22%	9.64%	24.99%
2011	13.44%	3.21%	29.12%	0.47%	2.72%	0.00%	0.00%	13.28%	2.17%	9.43%	26.15%
2012	13.73%	3.38%	28.11%	0.50%	2.12%	0.00%	0.00%	13.49%	2.13%	9.22%	27.32%
2013	14.02%	3.55%	27.11%	0.53%	1.51%	0.00%	0.00%	13.69%	2.09%	9.01%	28.48%
2014	14.31%	3.73%	26.10%	0.57%	0.91%	0.00%	0.00%	13.90%	2.04%	8.81%	29.64%
2015	14.60%	3.90%	25.10%	0.60%	0.30%	0.00%	0.00%	14.10%	2.00%	8.60%	30.80%
2016	14.67%	3.73%	25.23%	0.60%	0.30%	0.00%	0.00%	13.90%	2.04%	8.81%	30.72%

Table 7.21 presents composition of incinerated waste. Before the year 2000, when first municipal waste incineration installation was launched, no municipal waste was incinerated in Poland. Between December 2015 and the end of year 2016 five new municipal waste incineration plants were commissioned. As a result amount of incinerated municipal solid waste increased almost by ca. 940% in year 2016.

Data on incineration of sewage sludge before 1998 are not available and lack of distinguishable trend indisposes extrapolation.

Table 7.21. 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

Year	Municipal		Medical		Industrial (incl. hazardous)		Sewage sludge
	nonbiogenic	biogenic	nonbiogenic	biogenic	nonbiogenic	biogenic	biogenic
2000	1.2	1.7	20.4	30.6	168.2	18.7	34.1
2001	11.3	14.7	10.8	16.1	220.8	24.5	46.6
2002	16.0	20.0	7.3	10.9	278.7	31.0	31.5
2003	18.9	22.7	8.2	12.3	370.5	41.2	47.0
2004	19.9	23.1	10.7	16.1	236.7	26.3	39.9
2005	21.1	23.3	11.8	17.7	267.6	29.7	37.4
2006	20.1	21.1	8.8	13.3	268.6	29.8	39.3
2007	21.9	21.9	10.1	15.2	300.1	33.3	33.7
2008	20.9	19.9	9.8	14.7	301.9	33.5	44.5
2009	20.2	20.1	11.4	17.2	290.8	32.3	50.4
2010	20.0	20.9	11.1	16.6	277.7	30.9	66.4
2011	18.8	20.6	13.3	20.0	280.9	31.2	85.2
2012	17.9	20.6	13.7	20.5	349.9	38.9	101.1
2013	22.7	27.4	14.0	20.9	364.4	40.5	148.8
2014	13.9	17.7	16.7	25.0	344.5	38.3	164.4
2015	19.6	26.0	16.8	25.2	307.9	34.2	165.4
2016	273.1	206.3	19.6	29.4	387.5	43.1	194.7

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

Table 7.22. Change in GHG emissions in result of recalculations in sector 5.C

Change	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
kt CO_2 eq.	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%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Change	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
kt CO_2 eq.	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%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Change	2008	2009	2010	2011	2012	2013	2014	2015
kt CO_2 eq.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%

Recalculations details:
- update of amount of incinerated municipal waste in 2015 in Central Waste System database was performed.

7.4.6. Source-specific planned improvements

Continuation of research on usage of activity data from Central Waste System for emissions estimation is planned.

7.5. Waste Water Handling (CRF sector 5.D)

7.5.1. Source category description

The 5.D category share in emission of GHG from waste sector is 10.8% and it involves methane emission from industrial wastewater (20.8% share of 5.D), methane emission from domestic wastewater (19.8% share of 5.D) and N_2O emission from human sewage (59.4% share of 5.D).

The emission from sector 5.D decreased ca. 74.8 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. 79.2% of emission of GHG from sector 5.D in 2016.

Emission of methane from subsector 5.D.2 *Industrial Wastewater* is ca. 20.8% of emission of GHG from sector 5.D in 2016 and it is constantly decreasing due to reduction of wastewater production by industries.

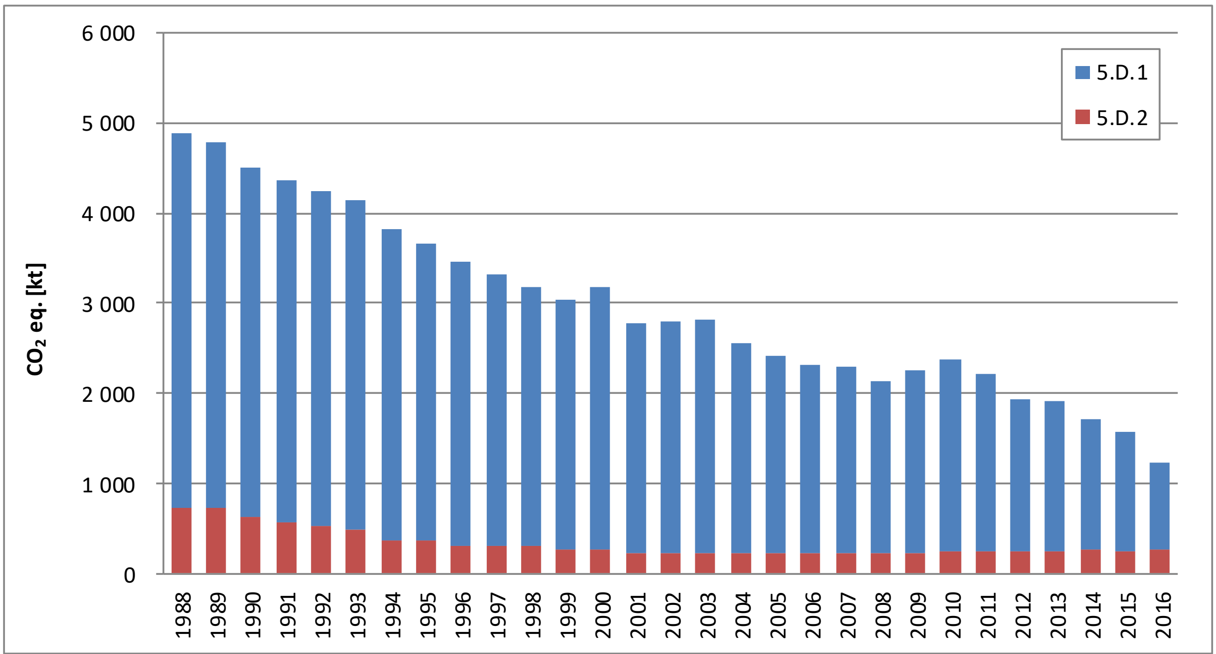

Figure 7.6. GHG emission from 5.D subsector

7.5.2. Methodological issues

7.5.2.1. Domestic Wastewater (CRF sector 5.D.1)

Methane emission

Estimation of CH_4 emissions from sector 5.D.1 *Domestic Wastewater* was based on methodology IPCC 2006 Guidelines [IPCC (2006)], *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 [GUS 2016)], and rural and urban population using different sewage treatment pathways [GUS (2016d)]. Activity data are presented in table 7.23.

Table 7.23. Rural and urban population using given 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	septic tanks	mechanical treatment plant	biological treatment plant	high nutrient removal	not connected	septic tanks
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
2014	0.06	19.70	17.62	0.00	62.62	0.04	9.06	81.11	0.00	9.80
2015	0.05	20.20	19.36	0.00	60.38	0.04	8.65	81.98	0.00	9.34
2016	0.06	20.26	20.59	0.00	58.73	0.04	8.39	82.48	0.00	9.09

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.

Methane Correction Factors (MCF) for various treatment pathways are taken from [IPCC (2006)] and domestic study [Bernacka (2005)]. Their values are listed in table 7.24.

Table 7.24. MCF values

Treatment pathway	mechanical treatment plant	biological treatment plant	high nutrient removal plant	not connected	septic tanks
MCF	0.05	0.05	0.05	0.1	0.5
Data source	Bernacka (2005)	Bernacka (2005)	Bernacka (2005)	default IPCC 2006	default IPCC 2006

Fraction of methane in recovered biogas

Fraction of methane in generated gas was calculated on basis of four country specific studies performed on data measured in wastewater treatment plants. Obtained shares of CH_4 in generated biogas are presented in table 7.25. The final share applied in inventory is an arithmetical average of measured fractions and equals 65%. Recovered gas is combusted for energy purposes.

Table 7.25. Calculation of fraction of methane in recovered biogas

No.	Measured CH_4 fraction in generated gas [%]	Data source
1.	65.0	Grzybek (2005)
2.	65.6	Kołodziejak (2012)
3.	65.0	Błaszczyk-Pasteczka (2007)
4.	63.0	Jędrczak (2007)
-	**65.0**	**calculated fraction**

Amounts of recovered landfill gas (TJ) for the years 1990-2000 are provided by Agency of Energy Market (ARE), and for 2001-2016 are taken from national statistics [GUS OZE]. Values for years 1988-1989 are not available in Polish statistics and were calculated using extrapolation method.

Methane recovery

Data on amounts of recovered biogas are published in elaboration *Energy from renewable sources* [GUS OZE (2001-2016)]. Amount of recovered methane is calculated with application of [IPCC (2006)] default net calorific value (50.4 MJ/m^3) and country specific fraction of methane in wastewater treatment gas (65%).

Table 7.26. Methane recovery data

Year	Recovered landfill gas [TJ]	Data source	Recovered methane [kt]	Data source
1988	no data	-	3.50	extrapolation
1989	no data	-	3.50	extrapolation
1990	393.00	ARE database	5.07	calculation
1991	190.00	ARE database	2.45	calculation
1992	230.00	ARE database	2.97	calculation
1993	62.00	ARE database	0.80	calculation
1994	255.00	ARE database	3.29	calculation
1995	433.00	ARE database	5.58	calculation
1996	587.00	ARE database	7.57	calculation
1997	580.00	ARE database	7.48	calculation
1998	689.00	ARE database	8.89	calculation
1999	732.00	ARE database	9.44	calculation
2000	788.00	ARE database	10.16	calculation
2001	933.00	GUS OZE (2002)	12.03	calculation
2002	725.00	GUS OZE (2003)	9.35	calculation
2003	896.00	GUS OZE (2004)	11.56	calculation
2004	1 297.00	GUS OZE (2005)	16.73	calculation
2005	1 586.00	GUS OZE (2006)	20.45	calculation
2006	1 803.00	GUS OZE (2007)	23.25	calculation
2007	1 802.00	GUS OZE (2008)	23.24	calculation
2008	2 486.00	GUS OZE (2009)	32.06	calculation
2009	2 429.00	GUS OZE (2010)	31.33	calculation
2010	2 652.00	GUS OZE (2011)	34.20	calculation
2011	2 775.00	GUS OZE (2012)	35.79	calculation
2012	3 321.00	GUS OZE (2013)	42.83	calculation
2013	3 572.00	GUS OZE (2014)	46.07	calculation
2014	3 810.00	GUS OZE (2015)	49.14	calculation
2015	4 043.00	GUS OZE (2016)	52.14	calculation
2016	5 014.00	GUS OZE (2017)	64.66	calculation

Organic component removed as sludge

Amounts of organic component removed as sludge are calculated on basis of statistical data on amounts of sewage sludge applied in agriculture, composting, incinerated and landfilled [GUS (2016d)] and factor supplied by ATV Germany which equals to 0.8 kg dry matter/kg BOD.

Data on sludge incinerated, landfilled, used in agriculture and recultivation for the years 1998-2016 are provided by [GUS (1999-2016d)]. For the 1988-1998 period amount of removed sludge was calculated with application extrapolation method.

Table 7.27. Removed sludge

Year	Removed sludge [kt]	Data source	Year	Removed sludge [kt]	Data source
1988	173.44	extrapolation	2003	354.50	GUS (2004d)
1989	190.10	extrapolation	2004	371.40	GUS (2005d)
1990	206.76	extrapolation	2005	370.90	GUS (2006d)
1991	223.42	extrapolation	2006	370.00	GUS (2007d)
1992	240.08	extrapolation	2007	368.40	GUS (2008d)
1993	256.74	extrapolation	2008	343.20	GUS (2009d)
1994	273.40	extrapolation	2009	314.90	GUS (2010d)
1995	290.06	extrapolation	2010	273.20	GUS (2011d)
1996	306.72	extrapolation	2011	294.60	GUS (2012d)
1997	323.38	extrapolation	2012	302.00	GUS (2013d)
1998	340.04	GUS (1999d)	2013	271.70	GUS (2014d)
1999	354.40	GUS (2000d)	2014	291.22	GUS (2015d)
2000	311.50	GUS (2001d)	2015	293.54	GUS (2016d)
2001	373.36	GUS (2002d)	2016	289.73	GUS (2017d)
2002	377.90	GUS (2003d)			

N_2O emission

N_2O emission from human sewage was calculated according to default method [IPCC (2006)]. Population of Poland was provided by Central Statistical Office [GUS (2016)] (table 7.29). Amounts of animal and vegetal protein consumption per capita per year was taken from FAO database. For years 2014-2016 protein consumption was assumed on the level of 2013 data, what is a result of 2-3 years delay in presenting data in FAO database.

Values and sources of emission factors are provided in table 7.28.

Table 7.28. Emission factors

Emission factor	F_{npr}	$EF_{effluent}$	EF_{plant}	$F_{non\text{-}con}$	$F_{ind\text{-}com}$
Value	0.16	0.005	3.2	1.1	1.25
Data source	default IPCC 2006				

Additionaly, estimation of N_2O emissions from advanced wastewater treatment plants was performed. Degree of utilization of modern, centralized WWT plants (T_{plant}) is presented in table 7.29. Amount of nitrogen associated with these emissions (N_{WWT}) was subtracted from the $N_{EFFLUENT}$.

Table 7.29. Consumption of proteins, T_{plant} and population of Poland

Year	Protein consumption [kg/person]	Population [in 1000s]	T_{plant}
1988	38.57	37 885	0.0%
1989	38.19	37 988	0.0%
1990	36.85	38 073	0.0%
1991	37.37	38 144	0.0%
1992	37.28	38 203	0.0%
1993	36.78	38 239	0.0%
1994	35.51	38 265	0.0%
1995	35.91	38 284	3.0%
1996	36.02	38 294	4.8%
1997	35.45	38 290	8.3%
1998	36.26	38 277	13.1%
1999	36.39	38 263	15.4%
2000	36.43	38 254	20.1%
2001	36.36	38 242	22.9%
2002	36.72	38 219	26.8%
2003	36.88	38 191	30.5%
2004	36.17	38 174	33.5%
2005	36.03	38 157	37.3%
2006	36.03	38 125	39.0%
2007	36.35	38 116	41.1%
2008	35.76	38 136	46.6%
2009	36.74	38 167	48.6%
2010	36.96	38 530	49.6%
2011	37.34	38 538	52.2%
2012	37.06	38 533	54.6%
2013	37.04	38 496	56.0%
2014	37.04	38 479	57.6%
2015	37.04	38 437	58.9%
2016	37.04	38 433	59.7%

7.5.2.2. Industrial Wastewater (CRF sector 5.D.2)

Estimates of emissions of methane from industrial wastewater treatment sector are based on IPCC 2006 Guidelines [IPCC (2006)] *Tier 1* method and domestic case study [Przewłocki (2007)]. In the inventory COD default emission factors were applied. For branches, where 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)]. Recovered gas is combusted for energy purposes.

Data on amount of industrial wastewater from separate branches and on biological treatment of organic wastewater were taken from national statistics [GUS (2016d)]. Data on employment and production from some branches were taken from national statistics [GUS (1989-2016)].

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 7.30. 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/m³		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
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 7.31. Amount of industrial wastewater by industry [million m^3]

Year	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

Year	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
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
2014	312.1	12.2	128.6	52.0	7.6	0.0	7.3	0.8	14.8	3.5	3.3	1.3	42.5	0.0	0.3	71.1	22.5	38.8	2.5	40.4	2.1	160.8
2015	247.7	13.8	124.5	84.6	8.2	0.0	7.3	0.8	15.8	4.5	4.1	0.0	43.1	0.1	0.2	73.3	22.1	1.6	2.3	38.5	1.9	229.5
2016	320.0	15.9	115.4	80.0	9.3	0.0	7.5	0.6	16.4	4.2	4.3	0.0	45.4	0.3	0.2	77.4	21.0	1.7	3.3	47.5	1.8	152.2

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 7.32. Change in emissions in result of recalculations in sector 5.D

Change	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
kt eq. CO_2	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%	0%	0%	0%	0%

Change	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
kt eq. CO_2	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%	0%	0%	0%	0%

Change	2008	2009	2010	2011	2012	2013	2014	2015
kt eq. CO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%	0%	0%	0%	0%	0%	0%	0%	0%

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 N_2O emissions in the Agriculture sector can be found in Chapter 5.

10. RECALCULATIONS AND IMPROVEMENTS

10.1. Explanations and justifications for recalculations

10.1.1. GHG inventory

Recalculations made in 2018 consists mostly of further improvements in calculation methods based on the 2006 IPCC Guidelines and country specific ones. Detail sectoral information on recalculations made are given in Chapters 3-7 dedicated to source/sink categories and in CRF table 8. Also information on planned improvements is included in sectoral Chapters 3-7.

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 1988−2015 inventory submitted in NIR 2018)
PS = Previous Submission (for 1988−2015 inventory submitted in NIR 2017)

10.1.2. KP-LULUCF inventory

Main reasons leading to recalculations in the LULUCF sector for the whole time-series are as follows:

- Inherited emissions were considered when calculating the initial carbon stock at the beginning of the commitment period (flux data method) in order to subsequently estimate net-emissions based on pool changes;
- Accounting of HWP in solid waste disposal sites (on the basis of pool changes) was excluded;
- The apparent consumption of e.g. industrial roundwood is assumed to equal the feedstock used to manufacture e.g. sawnwood;
- HWP estimates were calculated by means of flux data methods (annual carbon inflow based on annual statistical data on production and trade) allowing estimating C pool change (i.e. net-emissions) on annual basis.

Net effect of recalculations on CO_2 emissions/removals is provided in Table 7.6.1; 7.6.2 and 7.6.3.

10.2. Implications for emission levels and trends

10.2.1. GHG inventory

Recalculations of CO_2 emissions are generally insignificant, oscilating around -0.1% to +0.6%, except 1999 where the change reached +3.1% what was related to *LULUCF* sector (Fig. 10.1). The apparent level of recalculation for the year 1999 was triggered by the application of updated data on sawn wood production and trade as provided by the Wood Techniology Institute.

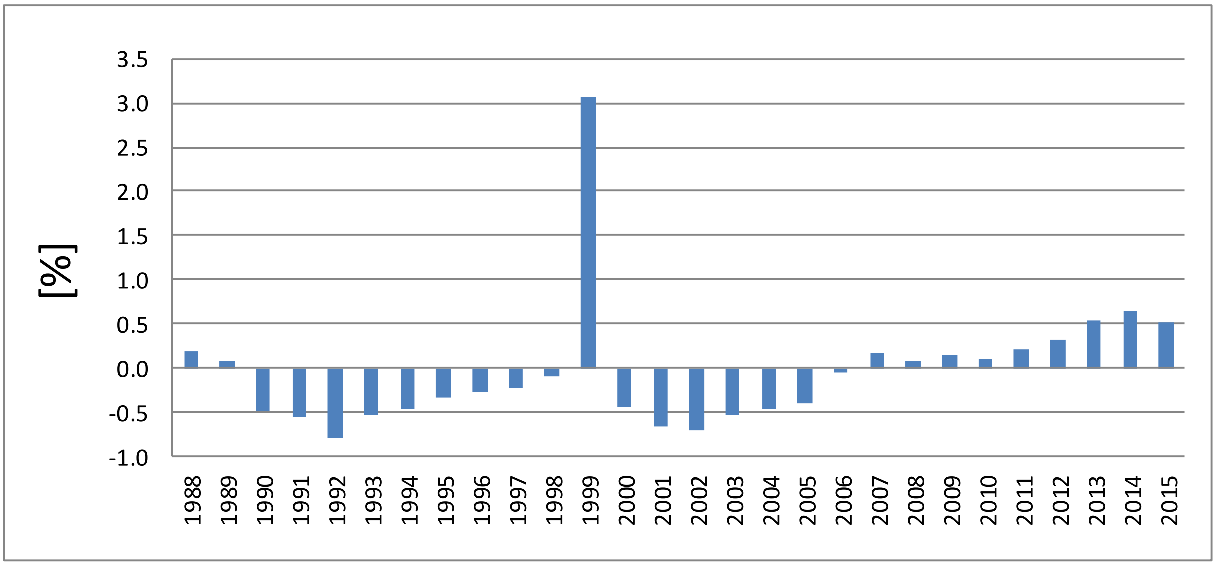

Figure 10.1. Recalculation of CO_2 for entire time series made in CRF 2018 comparing to CRF 2017

In the case of CH_4 the most significant recalculations were made in *Waste* sector and are a result of implementation of new value of F factor for industrial, unmanaged and uncategorized waste disposal (Fig. 10.2).

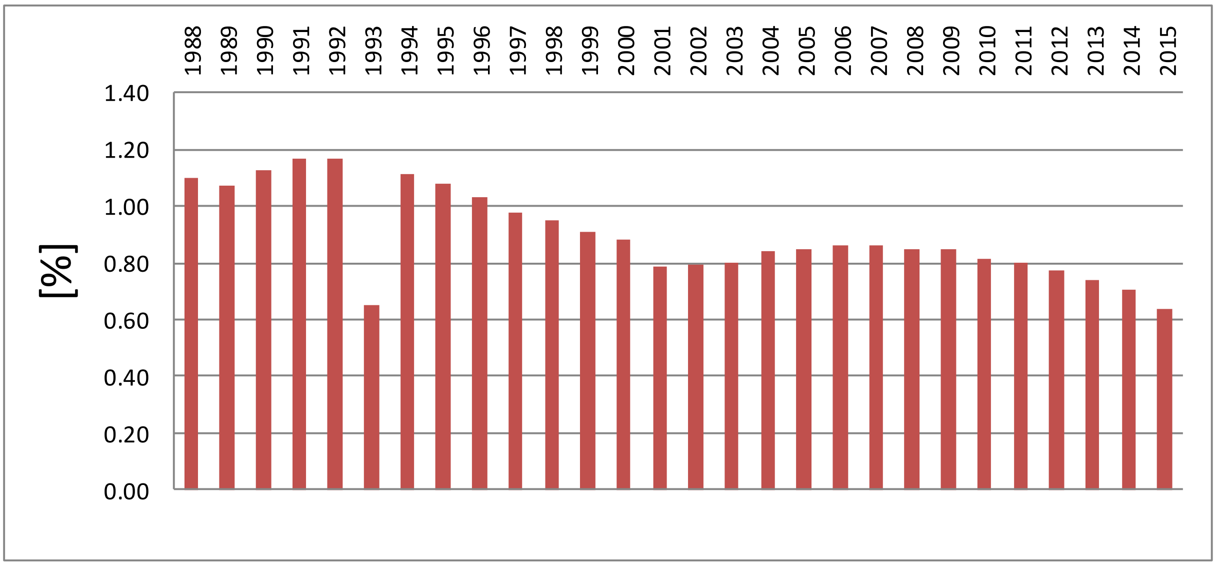

Figure 10.2. Recalculation of CH_4 for entire time series made in CRF 2018 comparing to CRF 2017

Changes in N_2O emissions between Submissions 2018 and 2017 are genrally insignificant (Fig. 10.3). Increase in emissions in 1993 is realted to recalculations made in road transport while decrease in 2014-2015 – by recalculations in *Agriculture* where Nex correction was made for other cattle.

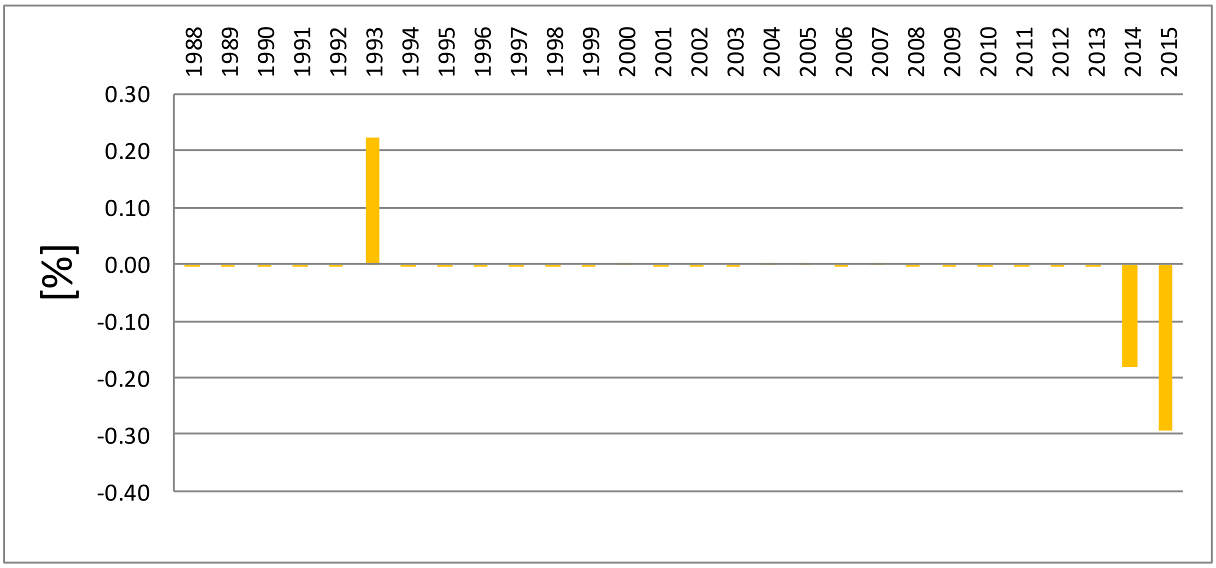

Figure 10.3. Recalculation of N_2O for entire time series made in CRF 2018 comparing to CRF 2017

10.2.2. KP-LULUCF inventory

Main reasons leading to recalculations in the *LULUCF* sector for the whole time-series are as follows:

- comprehensive implementation of methods and factors provided in IPCC 2006 guidelines;
- factors related adjustment of carbon stocks calculation in category 4.A;
- inherited emissions were considered when calculating the initial carbon stock at the beginning of the commitment period in order to subsequently estimate net-emissions based on HWP pool changes;
- application of updated data on sawn wood production and trade as provided by the Wood Technology Institute.

As a result of recalculations for KP–LULUCF sector increase in net removals for 2008–2014 was observed. The main reason for recalculations was the revision of HWP estimates, assigned to forest management. Net emissions of CO_2 related to more detailed estimations resulted in removals increase 6.64% comparing to Submission 2017.

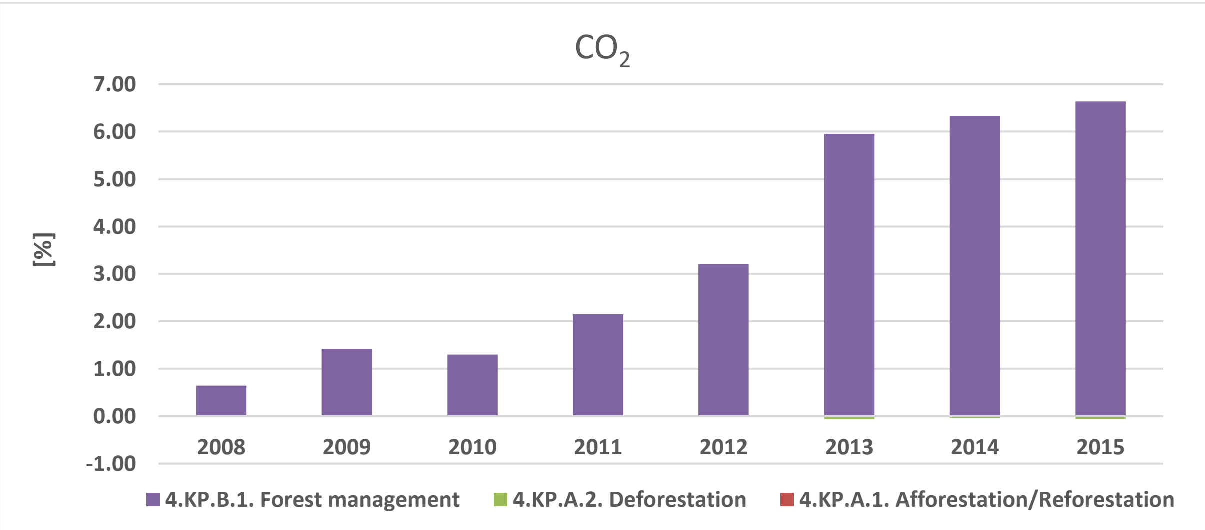

Figure 10.4. Recalculation of CO_2 for 2008–2015 for KP-LULUCF activities made in CRF 2018 comparing to CRF 2017

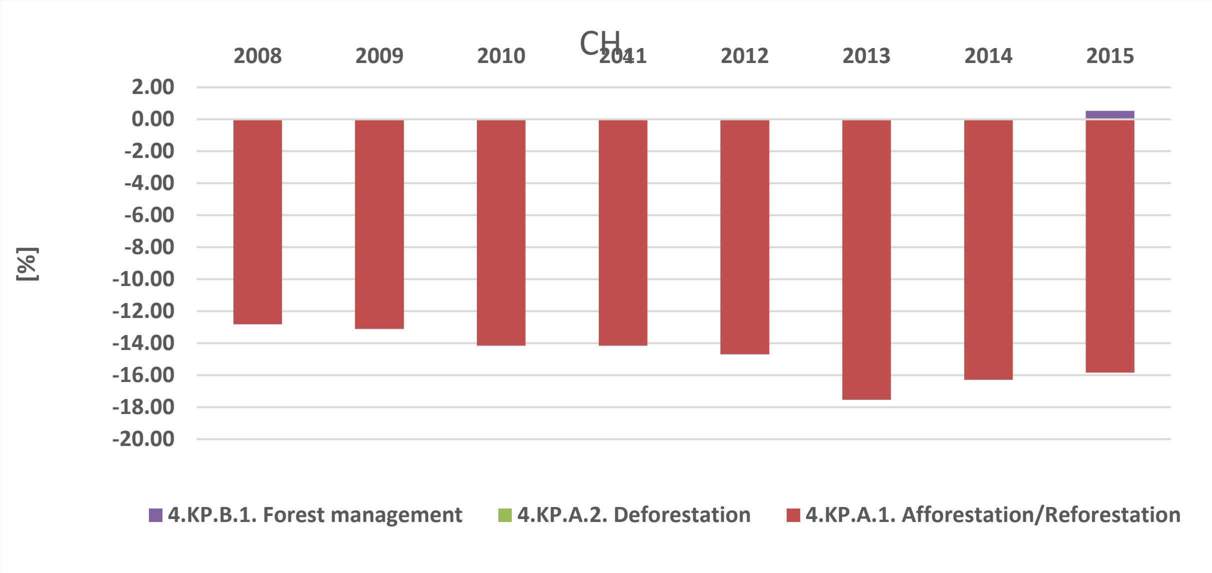

Figure 10.5. Recalculation of CH_4 for 2008–2015 for KP-LULUCF activities made in CRF 2018 comparing to CRF 2017

As a result of internal QC procedure, CH_4 emissions from biomass burning were recalculated due to applying the updated AD.

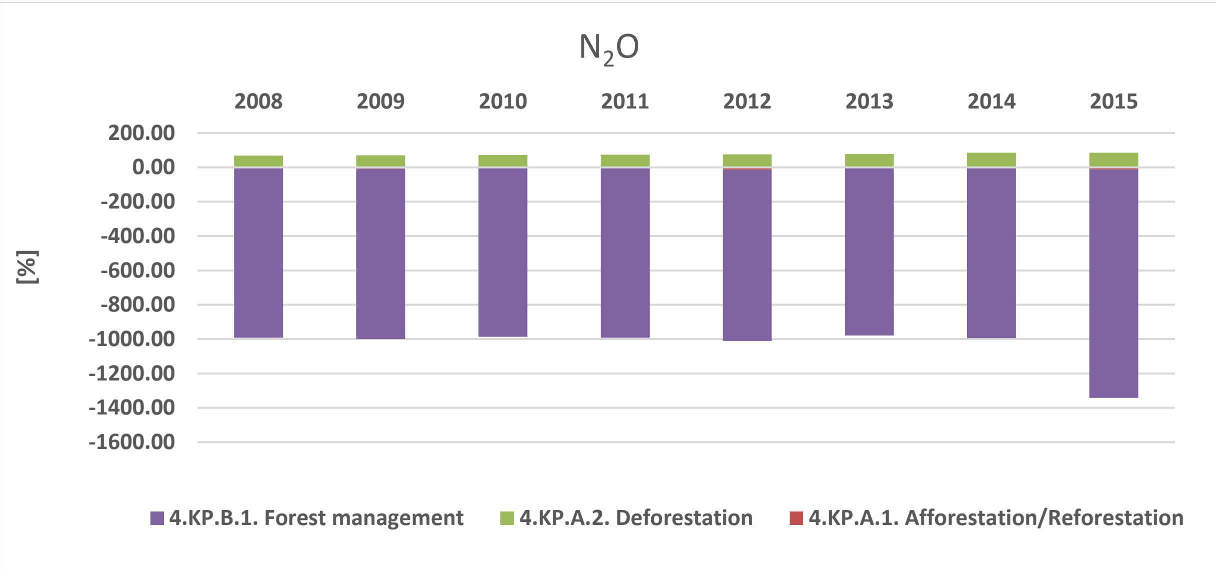

Figure 10.6. Recalculation of N_2O for 2008–2016 for KP-LULUCF activities made in CRF 2018 comparing to CRF 2017

As a result of internal QC procedure, N_2O emissions from biomass burning were recalculated due to applying the updated AD.

10.3. Implications for emission trends

10.3.1. GHG inventory

Changes in GHG emissions made in 2018 in relation to previous Submission 2017 for period 1988-2015 vary insignificantly, ranging between 0.14% in 1988 up to 0.06% in 2015 (Fig. 10.7) thus not influencing the emission trend.

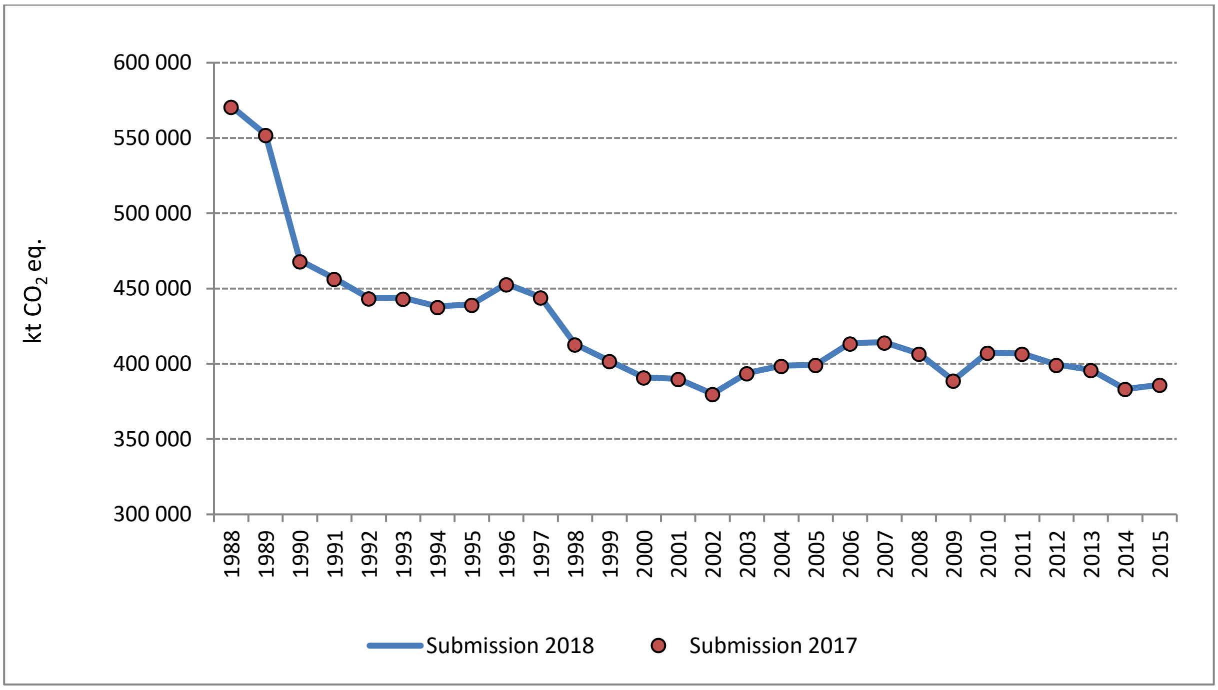

Figure 10.7. GHG emission trends according to Submissions made in 2018 and 2017

10.3.2. KP-LULUCF inventory

Net CO_2 emissions/removals related to elaborating the calculations in more detail, decreased overall by 5.44 % comparing to Submission 2016. Net emissions of other gases did not change significantly.

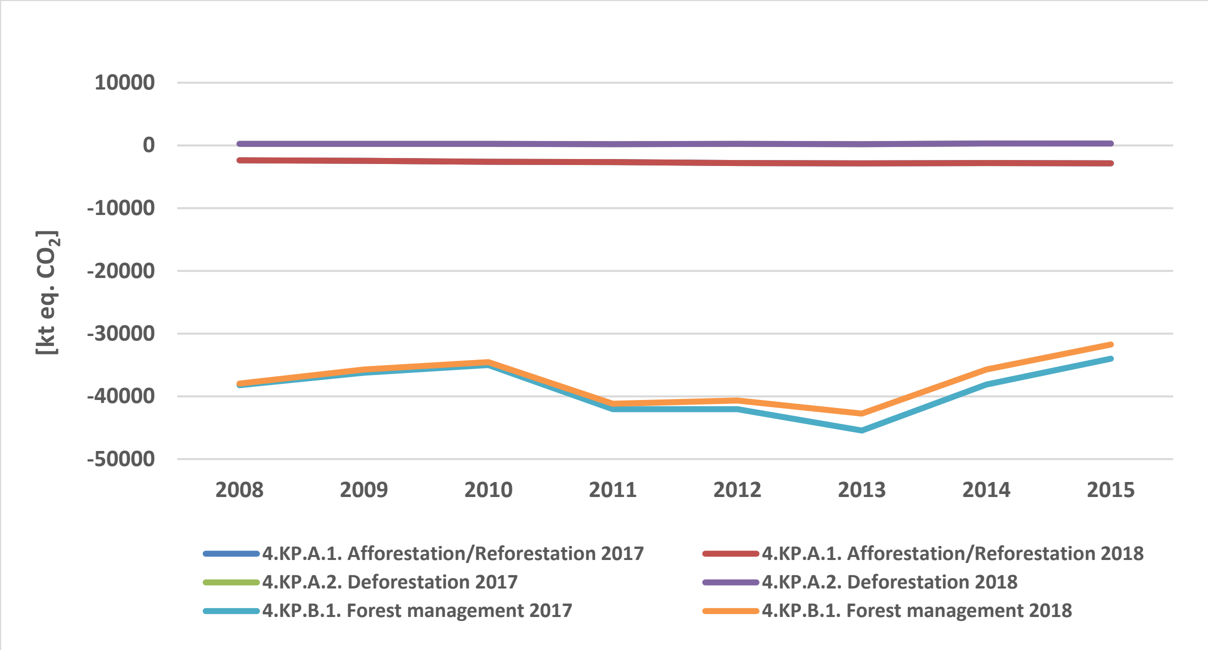

Figure 10.8. KP LULUCF GHG emission trends according to Submissions made in 2018 and 2017

10.4. Recalculations, including in response to the review process, and planned improvements to the inventory

10.4.1. GHG inventory

Table 10.1. The following list of recommendations (and its implementation status) comes from the individual review of the annual submission of Poland submitted in 2016 (FCCC/ARR/2016/POL)

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
General				
ARR Table 3				
Methods	Continue to improve the transparency of the NIR by including in the sectoral chapters more detailed information on the sources of AD and EFs, recalculations applied, and QA/QC and verification procedures	G.1	Resolved. The ERT commends Poland for its efforts to improve transparency. Areas in which the Party can further enhance the transparency of information reported in the NIR and CRF tables are identified in this table and in table 5	-
QA/QC and verification	Enhance the QA/QC and verification procedures so as to avoid inconsistencies between the information in the NIR and in the CRF tables and errors in the input of data	G.2	Resolved. The ERT identified inconsistencies between the NIR and the CRF tables (see table 5). During the review Poland explained that these were due to CRF Reporter problems	-
Inventory planning	Further elaborate the description of the institutional arrangements in chapter 1.2 of the NIR	G.3	Resolved. Poland included in the NIR a detailed description of its institutional arrangements	-
Uncertainty analysis	Provide overall uncertainty for the trend	G.4	Resolved. Poland reported this information in the NIR	Annex 8
Uncertainty analysis	Include the uncertainty for the KP-LULUCF activities	G.5	Resolved. Uncertainty estimates for KP-LULUCF activities were included in the analysis in present submission and were reported in Annex 8	Annex 8
Uncertainty analysis	Include a description of how the uncertainty assessment results were used to prioritize the inventory improvements	G.6	Resolved. Poland reported in the NIR how the uncertainty (and key category) analysis is used to prioritize improvement in the GHG inventory	Annex 8
Uncertainty analysis	Improve the uncertainty data for F-gases, distinguishing between the AD and EFs	G.7	Resolved. Uncertainty model for F-gases was revised and extended to calculate results on the basis of assumptions made separately for AD and EFs.	Annex 8
National registry	Report in the annual submission any change(s) in the national registry	G.8	Resolved. Poland included in its NIR changes in its national registry	-
Energy				
ARR Table 3				
General	Improve the transparency of the description of the methods used to estimate fugitive emissions	E.1	Resolved. Methods for estimating fugitive emissions from coal, oil and gas are sufficiently described in the NIR	-
General	Elaborate on the description of how the Party maintains time-series consistency while using different sources of AD	E.2	Addressing. During the review Poland explained that the large variation in emissions from 1989 to 1990 is mainly due to a dramatic decrease in fuel consumption triggered by significant economic changes related to political transformation rather than to the use of different AD sources. Poland will include this information in its next NIR submission	Addressed in Chapter 3.2.6.4
General	Improve the reporting of the details of the annual QA/QC measures implemented in the energy sector and provide information on the cross-checks made among the national	E.3	Not resolved. The description of QA/QC measures is still not fully transparent and it is difficult to	Addressed in Chapter 3.2.6.4

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	statistics data, the Eurostat data and the EU ETS data, as well as information on any validations of EFs by comparison with the EU ETS data		determine how data from various sources are harmonized	
Fuel combustion – reference approach	When the difference between the sectoral and reference approaches is greater than 2 per cent, include an explanation for this in the documentation box of CRF table 1.A(c) and in the NIR	E.4	When the difference between the sectoral and reference approaches is greater than 2 per cent, include an explanation for this in the documentation box of CRF table 1.A(c) and in the NIR	Addressed in Chapter 3.2.1
International aviation	Document any recalculations of the emissions from international aviation for the years 1988 to 2011 undertaken to ensure time-series consistency in accordance with the IPCC good practice guidance	E.5	Addressing. The ERT accepts the reasoning behind Poland's split of international and domestic aviation using Eurocontrol data on the share of jet kerosene used for international aviation in the country	Addressed in Chapter 3.2.2.1
International navigation	Include in the NIR information on the split between domestic and international navigation and provide details of the trend in international and domestic bunker fuel use across the time series	E.6	Addressing. The ERT accepts the information provided by Poland during the review on the data source for international navigation and the time series of these data. The Party will include this information in the next NIR	Addressed in Chapter 3.2.2.2
Feedstocks, reductants and other NEU of fuels	Further clarify the reporting of feedstocks and NEU of fuels in CRF table 1.A(d) and in the NIR, and provide detailed information on the allocation of the associated emissions in the inventory	E.7	Addressing. The ERT accepts the information provided by Poland during the review on how the emissions from lubricants are allocated. The Party indicated that the missing AD would be included in the next NIR	Addressed in Chapter 4.5.2.1
1.A.1 Energy industries – all fuels – CO_2	Complete and report on the planned development of country-specific CO_2 EFs for the significant fuels in the energy sector, and consider applying the country-specific CO_2 EF for gasoline used in road transportation to stationary combustion	E.8	Addressing. The ERT commends Poland for prioritizing this improvement in its GHG inventory, but also notes that the Party continues to use default EFs for key categories. During the review Poland explained that budget constraints limit the development of countryspecific EFs such as CO_2 EFs for natural gas combustion	The development of country specific CO_2 emission factors for natural gas combustion in the energy sector is ongoing. The CS factors for natural gas have already been used in the estimation of emissions from the use of gas in the ammonia production process (in 2.B.1 IPCC category).
1.A.1 Energy industries – solid fuels, biomass – CH_4	Apply a tier 2 method to estimate CH4 emissions from stationary combustion (solid fuels and biomass)	E.9	Addressing. The ERT commends Poland for prioritizing improvement in its GHG inventory, but also notes that the Party continues to use default EFs for key categories. During the review Poland explained that budget constraints limit the development of countryspecific EFs such as CH4 EFs for stationary combustion	The development of country specific emission factors for CH4 from combustion of solid fuels and biomass is under consideration. Due to financial constraints, the analysis and development of national CO2 emission factors from natural gas combustion was

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
				considered as a higher priority than CH4 emission factor.
1.A.3.e.i Pipeline transport – liquid and gaseous fuels – CO2, CH4 and N2O	Ensure the consistency of the time series for CO2, CH4 and N2O emissions from pipeline transport	E.10	Resolved. The ERT accepted Poland's reasoning behind the time-series consistency issue, and acknowledged the Party's efforts to locate other sources for these data so as to verify that there was no fuel consumption before 1994	-
1.A.3.e.i Pipeline transport – liquid and gaseous fuels – CO2, CH4 and N2O	Follow the guidance set out in the IPCC good practice guidance for the extrapolation of the volumes of fuel used in pipeline transport and recalculate the emissions for both the category other transportation and the category manufacture of solid fuels and other energy industries and explain these recalculations in the NIR	E.11	Resolved. The ERT accepted Poland's explanation on the extrapolation of the volumes of fuel used in pipeline transport and the explanation for the subsequent recalculation	-
1.B.2 Oil and natural gas and other – gaseous and liquid fuels – CO2, CH4 and N2O	Use the correct notation key for other leakages in the residential and commercial sectors and provide in the NIR and documentation box of CRF table 1.B.2 an adequate explanation for the key used	E.12	Not resolved. During the review Poland indicated that it would correct the reporting of notation keys in the next NIR and also enhance the explanation for the use of the notation keys in both the NIR and the documentation box of CRF table 1.B.2	Addressed in CRF Table 1.B.2 and Chapter 3.3.2.2.2
1.B.2.a Oil – liquid fuels – CO2 and CH4	Reconsider the reporting of "NA" for CO2 and CH4 emissions from the distribution of oil products	E.13	Resolved. Poland indicated during the review that it would use notation key "NE" (not estimated) instead of "NA" (not applicable) in the NIR and CRF tables for CO2 and CH4 emissions from this subcategory	-
ARR Table 5				
Feedstocks, reductants and other NEU of fuels – Liquid – CO2	Poland explained in the NIR (Page 57) that emissions related to feedstocks and non-energy use of fuels were calculated and reported under 2D (Non-energy products from fuels and solvent use). However, the ERT noted that in the related section there is only emissions data which was also shown in CRF table 2(I)A-G-category other and it's difficult to track AD/EF. In response to a question raised by the ERT during the review, Party explained that the script filling the import CRF tables has not imported activity data and this will be corrected in the next submission. The ERT recommends that Poland include the information regarding AD/EF of the non-energy use with correct data and more detailed information in the next submission to increase the tranparency of the NIR.	E.14	issue resolved in Submission 2017	Chapter 4.5
1.A.3.b Road transportation –	The ERT noted that the notation key "NO" is used for gaseous fuels of road transportation. However, there are several LNG/CNG stations in Poland for urban buses use (http://www.lngworldnews.com/lng-buses-hit-the-streets-of-warsaw/). In response to the question raised by the ERT during the review, Poland explained that the number of urban buses is still relatively small (384 in 2014) and statistical information on LNG/CNG consumption is still not available. Nevertheless it is expected that the number of such buses will systematically grow and Poland is going to include these activities in the national inventory as soon as data become	E.16	issue resolved. LNG/CNG used for urban buses is available in statistic for the year 2015 and emission from LNG/CNG consumption is presented in Submission 2017	Chapter 3.2.8.2.2

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
Liquid – CO2	available. In this case, Poland agrees to use "NE" instead of "NO" till then, taking into account the number of the LNG/CNG buses it can be assumed that GHG emission is rather insignificant. The ERT recommends that Poland include this information in the next submission to increase the tranparency of the NIR and change the notation key for the gaseous fuel for road transportation. Poland is further encouraged to check the data availability of the LNG/CNG used for urban buses.			
1.A.3.d Domestic navigation Liquid fuels – CO2, CH4 and N2O	The ERT commends Poland for its efforts to split international and domestic navigation and to provide the time-series emission trend. During the review, the Party explained that domestic navigation is calculated on the basis of a questionnaire and that the share of cargo activity is used for the estimation of emissions. However, the NIR lacks information on how cargo activity is related to fuel consumption and on what cross-checking is done when both cargo activity and Eurostat data are used for estimating emissions from navigation The ERT recommends that Poland provide detailed information on the correlation between cargo activity and emissions from navigation and on the cross-checks between emissions estimated using cargo activity and emissions estimated using Eurostat data	E.17	issue resolved in Submission 2018	Chapter 3.2.8.2.4
1.B.1.a Coal mining and handling – Solid – CH4	The ERT noted that the EF for abandoned coal mines [IPCC, page 4.25, table 4.1.6] is from 0.4 to 0.6, but the IEF provided by the Party is 0.09. In a response to the question raised by the ERT during the review, Poland explained that the script filling the import CRF tables has imported wrong activity data and this will be corrected in the next submission. And in a response to the further inquiry from the ERT, Poland provided the detailed datasheet for the number of abandoned coal mines in each inventory year. The ERT recommends Poland to use the correct AD in the next NIR. In addition, Poland did not apply specific EFs according to the time when mines closed in different years. Currently, Poland is using the EF in column "1976-2000" for all 13 mines which is not adhereing to the IPCC guidelines. For the 10 mines closed before 2000, the EF in column "1976-2000" should be applied; while for the 3 mines closed after 2000, column "2001-Present" should be applied.	E.20	Issue resolved in Submission 2017	Chapter 3.3.1.2.1
1.B.1.a Coal mining and handling solid fuels – CH4	For CH4 emission estimates from coal mining and handling, Poland's CH4 IEF (4.556 kg/t) for the entire time series is below the lowest value in the range of IPCC default values (6.7–16.75 kg/t). During the review, the Party explained that a tier 1 method is used for the calculation of fugitive emissions from underground mines, and a country-specific EF. Poland explained that the country-specific EF is from a study on which the defaults from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories were based. The ERT expressed concern that the country-specific EF used by Poland is not fully	E.19	The revised methodology of estimating domestic methane emission from coal mining (1.B.1.a.i. Coal mining and handling, Underground mines, Mining activities) was implemented. Issue resolved in Submission 2017	Chapter 3.3.1.2.1

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	justified or transparently described, and is potentially outdated, having been replaced with a more recent default range in the 2006 IPCC Guidelines. Although the ERT accepted the Party's reporting as the EF used by the Party is 32 per cent lower than the lowest value in the default range from the 2006 IPCC Guidelines, the ERT believes that this issue should be considered further in future reviews to confirm that there is not an underestimate of CH_4 emissions from coal mining and handling. The ERT recommends that Poland either justify that the CH_4 EF applied appropriately reflects the CH_4 content of coal in Poland or use the default EF from the 2006 IPCC Guidelines (12.06 kg/t for average CH_4 emissions) to calculate CH_4 emissions from underground mines for the entire time series			
International aviation liquid fuels – CO_2, CH_4 and N_2O	The ERT commends Poland for its efforts to split domestic and international aviation across the time series for the first time using data for the share of international aviation from the Eurocontrol database. Because of a lack of Eurocontrol data for the years before 2005, the share for the years 1988 to 2004 was assumed by the Party as a five-year average of the years 2005 to 2009. During the review, Poland provided information on the rationale for using Eurocontrol data for 2005–2009 to represent the percentage of the domestic share of aviation before 2005 The ERT recommends that Poland improve the transparency of the NIR by including the information on the source of data used to calculate the share of international aviation from national statistics provided to the ERT during the review, as well as the rationale for applying 2005–2009 average data from Eurocontrol to the years 1988 to 2004	E.21	issue resolved in Submission 2017	Chapter 3.2.2.1
Industrial processes and other product use				
ARR Table 3				
General	Transparently document in the NIR the impact of each change on the overall recalculation and the emission trend for a given category and its impact across the inventory in cases of cross-sectoral categories	I.1	Resolved. The ERT commends Poland for its efforts to enhance the documentation of recalculations in the NIR	-
General	Improve the transparency of the NIR for cement production, nitric acid production, consumption of F-gases (particularly the emissions from fire extinguishers), adipic acid production for the years 1988-1993 and primary aluminium production to prove that the Party has applied the relevant IPCC methodologies	I.2	Resolved. Poland improved the transparency of information in the NIR	-
2.A.1 Cement production – CO_2	Provide detailed information on the estimation method used under the EU ETS, and the comparison of the Central Statistical Office of Poland (GUS) data with the EU ETS data on clinker production provided during the review	I.3	Resolved. The NIR includes some background information on the estimation methods used under the EU ETS. The ERT considers that the information provided by Poland during the review on the verification of data by a comparison of GUS and EU ETS data for clinker production should be included in the NIR	-

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
2.A.2 Lime production	Collect the necessary data so as to be able to consistently use a tier 2 method for the years before 200	I.4	Resolved. Poland used a tier 2 method from the 2006 IPCC Guidelines consistently	-
2.A.4 Other process uses of carbonates	Increase the transparency of the recalculations for the category limestone and dolomite use made in response to the review process	I.5	No longer relevant. The ERT accepts that this recommendation is no longer relevant as a result of the new methodology introduced by the 2006 IPCC Guidelines for this category that is described in the NIR	-
2.B.2 Nitric acid production – N2O	Clarify in the NIR that for the years 2005 to 2011, plant-specific production data are available, and include in the NIR the supplementary information provided during the review	I.6	Resolved. The ERT received this information from Poland during the review as confidential data	-
2.B.3 Adipic acid production – N2O	Provide, in a category-specific subchapter of the NIR, a description of the method and data source used for the calculation of N2O emissions from adipic acid production	I.7	Resolved. Information on the method and data sources for N2O emissions from adipic acid production was provided in the NIR	-
2.C Metal industry – SF6	Implement the new data from the Polish Geological Institute and ensure the consistent reporting of SF6 used in aluminium and magnesium foundries across the time series	I.8	Addressing. The ERT commends Poland for its efforts to locate a new data source for this category. The Party advised the ERT during the review that this source has been validated, but use of its data in the GHG inventory is still being investigated	Adressing
2.C.3 Aluminium production –CO2	Improve the transparency of the NIR by including a trend description for primary aluminium production	I.9	Resolved. The NIR provides the required information	-
2.F.1 Refrigeration and air conditioning	Further enhance the explanation of the recalculations for F-gases from refrigeration and air conditioning, including by specifying the impact of each change on the estimates and providing information on the impact of the recalculations over the entire time series, and ensure the consistency of information provided in different sections of the NIR	I.10	Resolved. Poland provided an explanation of the recalculations and time series consistency for F-gases in the NIR	-
2.F.1 Refrigeration and air conditioning – HFCs	Change the notation key used for HFC-23 and HFC-152a under the subcategory refrigeration and air-conditioning equipment in CRF table 2(II), and include in the NIR a relevant analysis of the national F-gas market and an explanation for the lack of HFC-23 and HFC-152a emissions from refrigeration and air-conditioning equipment	I.11	Addressing. During the review Poland advised the ERT that difficulties with the CRF Reporter resulted in blank cells for these gases. The Party also explained during the review that there was a domestic law prohibiting the import of HFC-23 and HFC-152a, and that F-gas importers and distributors confirmed that blends are restricted. It indicated that this information would be included in the next NIR	Adressing
2.F.1 Refrigeration and air conditioning – HFCs	Include the information provided to the ERT during the review on the data QC checks undertaken for the subcategory transport refrigeration	I.12	Not resolved. Information on QC checks and verification for F-gases other than HFC134a was not provided in the NIR for the subcategory transport refrigeration	Adressing
2.F.1 Refrigeration and air conditioning – HFCs	Justify in the NIR the 15-year lifetime used by the Party for transport refrigeration	I.13	Not resolved. Poland did not provide in the NIR a justification of the lifetime used for transport refrigeration equipment	Adressing
ARR Table 5				
2.A.1 Cement production – CO2	Previous ERTs have made recommendations that Poland provide the EU ETS data, countryspecific methods, EFs and other background information used in the calculation of CO2 emissions from cement production, together with information on data verification activities, and Poland has	I.14	issue resolved	Chapter 4.2.2.1

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	previously responded that the information would be included in the next annual submission. However, little information on the calculation of these emissions was provided in the 2016 submission. Poland provided some information on the methods applied for CO2 emissions estimation from clinker production under the EU ETS, as described in annex VII to Commission Decision 2007/589/EC, but no information on the verification process. During the review, Poland provided information on the verification process, which includes on-site visits and checking that reports are in line with the installation monitoring plan (approved by a competent authority) and with monitoring and reporting guidelines from Commission Decision 2007/589/EC. The Party also explained its emission report verifier checks, which include checks on the monitoring plan, emission sources, calibration activities, data management and technology. The ERT commends Poland for providing information on the verification process. The ERT encourages Poland to include the information on the verification process provided to the ERT during the review in the next NIR.			
2.A.1 Cement production – CO2	Poland reported CO2 emissions from clinker production for the years 2005 to 2014 from installations that participate in the EU ETS. For the years 1988 to 2000, emissions were estimated based on clinker production and an average EF of 529 kg CO2/t of clinker, with this average EF based on country-specific EFs used for the years 2001 to 2004. In response to a question raised by the ERT, the Party clarified the source of the country-specific EFs used for the years 2001 to 2004, and explained why country-specific EFs could not be obtained for the earlier years 1988 to 2000. The CO2 EF for the years before 2005 were based on a Polish study. Poland further explained that the study contains an analysis of CO2 emissions from cement production in Poland for the period 1988–2004 but only emissions calculations for the period 2001–2004 were based on country-specific data (for chemical analysis of clinker, kiln input, etc.). The CO2 emissions for the period 1988–2000 were estimated from published reports based on a default calcination factor (525 kg CO2/t clinker) because of a lack of adequate country-specific data, and it is for this reason that Poland uses in the inventory an average EF value for the period 2001–2004 and countryspecific EFs for the years before 2001 The ERT recommends that Poland include the information clarifying the calculation of CO2 emissions from clinker production, including the derivation of the CO2 EF. It also recommends that Poland make an effort to collect data so as to be able to calculate country-specific EFs for the period 1988–2000	I.15	issue resolved	Chapter 4.2.2.1

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
Agriculture				
ARR Table 3				
General	Document the main findings of the sector-specific QA/QC activities, particularly the reasons for any discrepancies between EFs applied in Poland and those applied in other countries and international literature, in the category-specific subchapters of the NIR	A.1	Not resolved. Poland continues to report in the NIR that EFs and methodologies are compared with the international literature and that EFs and methods from other countries are applied, but there is no information on the main findings of this QA/QC comparison, particularly on whether any discrepancies were identified	Addressed in Chapters: 5.2.2, 5.3.2
General	Provide a transparent explanation for the use of specific livestock census statistics, including the additional information provided during the review indicating that reference date population data from the summer census (June, July) are chosen mainly because there are no consistent time series for other census data and that the summer census data also correspond to the data reported to FAO	A.2	Not resolved. The explanation provided to the previous ERT was not included in the NIR. Instead, Poland justifies the summertime livestock population as representative of the average population in a year	Addressed in Chapter 5.2.2
3.A Enteric fermentation – CH4	Include additional information on the methods and assumptions used to derive the gross energy intake values by livestock subcategory	A.3	Not resolved. During the review Poland explained that this additional information could not be provided in the CRF tables owing to difficulties with the CRF Reporter	Addressed in Chapter 5.2.2
3.A Enteric fermentation – CH4	Provide data justifying the lower body weight of dairy cattle used in the inventory	A.4	Not resolved. Poland did not include in the NIR (or in CRF table 3.As2) a justification for the reported body weight of dairy cattle used to estimate the enteric CH4 EF using a tier 2 method, and therefore has not justified the lower body weight of dairy cattle used in the GHG inventory	Addressed in Chapter 5.2.2
3.A Enteric fermentation – CH4	Report a weighted Ym for sheep in the CRF tables and provide a corresponding explanation in the NIR	A.5	Resolved. The ERT accepts the rationale provided by Poland during the review for using a tier 1 method to estimate CH4 emissions from sheep. The relative contribution of CH4 emissions from sheep is minor (0.4 per cent) toward total GHG emissions from enteric fermentation	-
3.B Manure management – CH4, N2O	Provide additional information that justifies the distribution of animal waste management systems used (including, for example, information on general agricultural structures and policies)	A.6	Not resolved. Poland did not provide in the NIR the required information on the assumptions (based on, for example, general agricultural structures and policies) that support the approach to determine the distribution of manure management systems used in the country	Addressed in Chapter 5.3.2
3.B Manure management – CH4, N2O	Report the correct values for the allocation of animal waste management systems in CRF table 4.B(a)s2	A.7	Resolved. The values reported in CRF table 3.B(a) for the allocation of manure management systems are correct	-
3.B Manure management – N2O	Separately report CH4 emissions from anaerobic digesters	A.8	Not resolved. Poland did not report in the NIR CH4 emissions from anaerobic digesters. During the review the Party explained that comprehensive data from anaerobic digesters are not currently available	Adressing
3.B Manure management – N2O	Include in the NIR additional information on the Nex rate of swine	A.9	Resolved. Poland updated values for the Nex rate of swine in table 10.1 of the NIR (p.250), following weight aggregation as in national statistics	-

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
3.D Direct and indirect N2O emissions from agricultural soils- N2O	Revise the uncertainty of the N2O emissions from agricultural soils	A.10	Resolved. Annex 8 to the NIR includes revised uncertainties for direct and indirect N2O emissions from agricultural soils	Annex 8
3.D Direct and indirect N2O emissions from agricultural soils - N2O	Report the assumptions and methods used to estimate the uncertainty and apply methods, as provided in the IPCC good practice guidance, to combine uncertainties	A.11	Not resolved. Poland included general information in the NIR and in annex 8 on uncertainties for AD and EFs. The ERT identified that information on the assumptions supporting the approach to determine uncertainties for AD and EFs (i.e. rationale, scientific evidence, references) could be improved. The ERT also noted the advice provided by Poland during the review that the required information is readily available	Addressing. Information about approach and methods used in combining uncertainty for that category was provided in Annex 8. Assumption for determining uncertainty for AD (5% for direct and 20% for indirect) and N2O EF (150%) was provided in main calculation table. Information about rationale, scientific evidence and references will be included in the next NIR.
3.D.a.2.b Sewage sludge applied to soils – N2O	Explain in the NIR the trend interpolation used for the application of sewage sludge in agriculture	A.12	Resolved. Poland provided a detailed explanation in the NIR of how the AD for the amount of sewage sludge applied on fields since 1988 were derived from the annual mean changes of AD in the period 2003–2012	-
3.D.a.3 Crop residues	Consistently report crop production across all emission categories and between the CRF tables and the NIR	A.13	Resolved. Poland consistently reported crop production and crop residues between CRF table 3.F and the NIR (tables 5.14 and 5.20). The same crop residue data were used for GHG emission estimates from field burning of agriculture residues (category 4.F) and for direct soil emissions related to nitrogen-fixing crops (category 3.D.1.3) and crop residues returned to soils (category 3.D.1.4), as shown in table 5.20 in the NIR	-
3.F Field burning of agricultural residues – N2O	Include more information in the NIR about the assumptions used to estimate N2O emissions from field burning of agricultural residues	A.14	Include more information in the NIR about the assumptions used to estimate N2O emissions from field burning of agricultural residues	Chapter 5.5.2
ARR Table 5				
3.A Enteric fermentation – CH4	In the NIR Poland reported using a tier 2 method for cattle and a tier 1 method for other animals for estimating CH4 emissions from enteric fermentation. But in CRF summary table 3s2, the Party reported using tier 2 and tier 3 methods to estimate enteric CH4 emissions from livestock. During the review, Poland confirmed that only tier 1 and 2 methods were applied to estimate CH4 emissions from livestock and that there was an error in the CRF tables	A.15	issue resolved	CRF Summary3s2

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	The ERT recommends that Poland ensure consistency between the NIR and the CRF tables when reporting the methods used for its emission estimates			
3.B Manure management – CH4	Poland reported using a tier 2 method to establish a domestic CH4 EF for manure management for swine. The ERT noted, however, that the Party used IPCC default values for VS, maximum methane producing capacity and the methane conversion factor to determine this EF. Only the fraction of livestock category manure in given animal waste management systems is from country-specific data. The method used by the Party is not a tier 2 method. Poland has improved the default EF by using more appropriate country-specific data for manure management systems, which suggests that the Party used a tier 1 method, in accordance with the 2006 IPCC Guidelines (chapter 10.4.5, p.10.51) The ERT recommends that Poland correctly label the method as a tier 1 method for the estimation of CH4 emissions from manure management for swine	A.16	issue resolved	Chapter 5.3.2.1
3.B Manure management – CH4	The ERT noted that the values reported in table 5.9 of the NIR for the CH4 EFs for manure management for cattle and for swine are lower than the IPCC default values (tables 10A-4, 10A-5 and 10A-7). During the review, Poland informed the ERT that there were some errors in table 5.9 of the NIR; namely, in the CH4 EF and VS for dairy cattle, which are 11.64 kg CH4/animal/year and 2.09 kg d.m./animal/day in 2014, respectively. Poland explained that proper parameters are given in CRF table 3.B(a)s1 and those have been used for CH4 emissions calculation The ERT recommends that Poland improve its reporting by correcting the errors in the CH4 EFs for manure management for cattle and swine presented in table 5.9 in the NIR	A.17	issue resolved	Chapter 5.3.2.1
3.B Manure management – CH4	For the estimation of CH4 emissions from manure management, Poland reported in the NIR that poultry manure management systems were established at 11 per cent liquid systems and 89 per cent solid storage. The ERT noted that the default CH4 EF used for manure management for poultry reflects only dry systems (table 5.9 in the NIR). During the review, Poland informed the ERT that poultry is managed in dry systems with differentiation only for "with litter" and "litterfree" systems, and that the description in the NIR is not correct on this matter as the word "liquid" should be changed to "litter-free". Therefore, the CH4 EF for dry systems is used for the emissions calculation for poultry. At the same time, N2O emissions are for poultry "with litter" and "without litter" (0.001 kg N2O-nitrogen/kg nitrogen excreted) not for liquid/slurry The ERT recommends that Poland improve the transparency of its reporting on CH4	A.18	issue resolved	Chapter 5.3.2.1

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	emissions from manure management by including the information on the manure management system for poultry provided to the ERT during the review in the next annual submission			
3.B Manure management – CH4 and N2O	In the NIR, Poland indicated the revision according to national statistics of the livestock populations for 2012 and 2013 as a reason for the recalculation of CH4 and N2O emissions from manure management. During the review, Poland informed the ERT that the recalculations relate to the fact that livestock numbers changed in 2013 for swine and in 2012 for fur-bearing animals. The ERT noted, however, that Poland did not provide any information on the population trend for fur-bearing animals in the NIR. The Party reported that default Nex rates from the 2006 IPCC Guidelines (table 10.19) were used for rabbits and other fur-bearing animals in the NIR, while the notation key "NA" (not applicable) was used for fur-bearing animals in CRF table 3.B(b). Poland also informed the ERT that fur-bearing animals include rabbits, foxes, minks and polecats, and provided the population trend for fur-bearing animals The ERT recommends that Poland improve the transparency of its characterization of fur-bearing animals by reporting the population trend for rabbits, foxes, minks and polecats in the NIR. It also recommends that the Party ensure the consistency of reporting between the NIR and the CRF tables for rabbits and other fur-bearing animals	A.22	issue resolved	Chapter 5.3.1
3.D.a Direct N2O emissions from managed soils – N2O	In the NIR 2016 (page 180) and NIR 2015 (page 169), Poland reported that 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. In the response to the question raised during the review, Poland informed the ERT that the FracRemove(fraction of above-ground residues of crop removed annually for various purposes) used by the Party include the fraction removed from the field covers also straw used for later bedding. The ERT conclude that the bedding material was not taken into account for neither organic nitrogen fertilizers (FON) nor crop residues (FCR). The ERT recommend that Poland consider the additional nitrogen from the bedding material as part of the managed manure N applied to soils as suggested by IPCC (2006) GL in its next submission.	A.23	issue resolved. Additional N from bedding material has been taken into account when calculating N2O emissions from agricultural soils (animal manure)	Chapter 5.4.2.1
3.D.a Direct N2O emissions from managed soils – Add gas(es)	Poland indicated in the NIR that consistent public reporting of data on the application of sewage sludge in agriculture commenced in 2003; therefore, application data since 1988 have been supplemented with annual mean changes in AD for the period 2003–2012. The ERT noted that the amount of sewage sludge applied in agriculture consistently increases over the period 2003–2009 while it decreases from 2009 to 2012	A.24	issue resolved. The trend for sewage sludge use for agricultural purposes has been recalculated based on trend 2003-2009 back to 1988	Chapter 5.4.2.1

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	The ERT recommends that Poland consider explaining in the NIR how the trend in the annual mean changes in AD for the period 2003–2009 has been used to estimate the amount of sewage sludge application from 1988 to 2002			
3.D.a Direct N2O emissions from managed soils – N2O	The ERT noted that Poland did not indicate in the NIR the source of nitrogen content of belowground residues for crops and total annual harvested area of crops. Poland reported in the NIR that data on nitrogen content of above-ground residues, on the ratio of above-ground residues in dry matter to harvested yield for crops and on the fraction of crops burned come from country studies in which experimental data as well as data from the literature and default EFs were used. The NIR states that the nitrogen data are given in table 5.23; however, the table is missing in the NIR. The NIR also states that the AD for crop production are reported in table 5.12, but this table relates to changes in CH4 emissions from manure management due to recalculations. In response to a question raised by the ERT during the review, Poland provided the missing information and suggested a correction for the erroneous reference to table 5.12 The ERT recommends that Poland improve its QA/QC to ensure that the reference to the table containing AD for crop production is correct and that table 5.23 is included in the NIR	A.25	issue resolved	Chapter 5.5.2
3.G Liming – CO2	Poland reported in the NIR (p.192) that for the estimation of CO2 emissions from liming, it assumed that lime–magnesium fertilizers (CaMg(CO3)2) contain 89.1 per cent CaCO3 and 10.9 per cent MgCO3, but the rationale supporting this assumption was not provided. During the review, Poland could not justify the assumption, but explained that oxides of lime (CaO) are also used for soil liming in limited amounts, which is not reported in the NIR. As the amount of lime fertilizers used by Poland in order to estimate CO2 emissions from liming was expressed in terms of pure nutrient (CaO) in the national statistics (NIR, p.192), it was necessary for the Party to exclude the amount of oxides of lime that was used for soil liming from the amount of CaO reported in the national statistics prior to the estimation of the amount of dolomite (CaMg(CO3)2) used. Poland also explained that oxides of lime were excluded from the national statistics in the calculation of the amount of dolomite used for soil liming The ERT recommends that Poland provide more information on the different types of lime applied to soils as well as the rationale for the assumptions used to derive the amounts of each applied to soils.	A.26	description was corrected	Chapter 5.6
LULUCF				
ARR Table 3				

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
General	Provide detailed information on the rationale for and impact of the recalculations for the LULUCF sector	L.1	Not resolved. Poland did not provide sufficient information in the NIR on the rationale for and impact of the recalculations when changing from the gain–loss method to the stock-change method (see ID#L.27 in table 5 for ERT recommendation)	NIR section 6.6.7
General	Estimate and report the carbon stock changes from all mandatory categories	L.2	Not resolved. Poland reported land converted to cropland and land converted to settlements as "NO"; (not occurring) however, the ERT believes this is a completeness issue because these conversions do occur in Poland	Following the ERT recommendatio n, relevant etimates for the land reported as converted to cropland and land converted to settlements were provided in the CRF tables 4.E.2
General	Include in the NIR the information on the data discrepancy in the total forest land area reported to in the CRF tables with the data from FAO	L.3	Resolved. Poland provided relevant information in chapter 6.2.1.1 of the NIR	-
General	Provide in the NIR the data sources used for the uncertainty assumptions of the AD and EFs for each category or carbon pool	L.4	Not resolved. Poland did not provide in the NIR the data sources used for the uncertainty assumptions of the AD and EFs for each category or carbon pool	Information about data sources for the uncertainty assumptions are given in Annex 8
Land representation	Include the land-use transition matrices (approach 2) in the NIR and revise the time series of the landuse change data to ensure that the total territorial area is consistent for the entire inventory period since 1988	L.5	Not resolved. The land-use transition matrices were reported in annex 6 to the NIR. The total territorial area remains inconsistent over the inventory period	NIR section 6.1.3
4.A.1 Forest land remaining forest land – CO2	Provide more detailed information on how the national forest inventory data were factored into the calculation to estimate the growing stock volume since 2009	L.6	Addressing. Poland indicated during the review that the relevant information will be included in the next NIR	NIR section 6.2.4.3
4.A.1 Forest land remaining forest land – CO2	Seek to resolve the issue regarding time-series consistency between 2008 and 2009 for the gross timber resources using the IPCC approaches	L.7	Addressing. Poland indicated during the review that a new approach will be introduced for the next NIR	NIR section 6.2.4.3
4.A.1 Forest land remaining forest land – CO2	Explore the possibility of using country-specific values for the biomass expansion factor and the root-to-shoot ratio, and indicate the results of such an attempt and its limitations in the NIR	L.8	Addressing. Poland indicated during the review that a new approach will be introduced for the next NIR	NIR section 6.2.4.4
4.A.1 Forest land remaining forest land – CO2	Ensure time-series consistency of the reported estimates for both litter and dead wood using the appropriate IPCC approaches	L.9	Resolved. To ensure timeseries consistency, Poland has reverted to using a tier 1 method for the entire inventory. However, the ERT notes that doing so leads to another issue: the Party is not using the appropriate IPCC approach (which is tier 2 or higher) (see ID#L.28 in table 5 for ERT recommendation regarding the IPCC approach)	
4.A.1 Forest land remaining forest land – CO2	Use consistent regions when selecting the default values among the categories or derive a countryspecific adjustment factor reflecting the effect of the change from the previous forest type to the new one, using, as an interim measure, the results from the available literature	L.10	Addressing. Modifications have been applied to the approach used but Poland is also exploring the possibility of using country-specific adjustment factors, reflecting the effect of the carbon stock change on forest soils	NIR section 6.2.4.4
4.A.2 Land converted to forest land – CO2	Revise the default biomass increment value for living biomass	L.11	Not resolved. Poland continued to use the unit m 3 /ha/year rather than t d.m./ha/year in the NIR.	NIR section 6.2.5.3

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
			During the review Poland acknowledged the necessity for using the correct biomass increment unit (see ID#L.32 in table 5 for ERT recommendation)	
4.A.2 Land converted to forest land – CO2	Further analyse the national forest inventory data and use data exclusively from age class I (1–20 years) for the estimation of the carbon stock changes in living biomass and dead wood for land converted to forest land	L.12	Addressing. Poland did not use national forest inventory data exclusively from age class I (1–20 years) for the estimation of the carbon stock changes, but stated in the NIR (p.256) that a new approach would be introduced for the next NIR	NIR section 6.2.5.3
4.A.2 Land converted to forest land – CO2	Apply the gain–loss method (tier 2), which follows a more disaggregated approach and allows for more precise estimates of the carbon stock changes in biomass	L.13	Addressing. Poland stated in the NIR (p.256) that a new approach would be introduced for the next NIR (see ID#L.30 in table 5 for ERT recommendation)	NIR section 6.2.5.3
4.A.2 Land converted to forest land – CO2	Disaggregate the area converted by species and clarify in the NIR why the conversion occurs only for extensively managed forests and not intensively managed forests, as would be the case for plantations	L.14	Addressing. Poland stated in the NIR (p.256) that a new approach would be introduced for the next NIR	NIR section 6.2.5.3.
4.A.2 Land converted to forest land – CO2	Provide in the NIR more detailed information on the estimation methods used for the carbon stock changes in the dead organic matter and soil pools	L.15	Not resolved. Although information on the estimation methods used for carbon stock changes in dead organic matter is provided in chapter 6.2.5.4 of the NIR (p.204), information on the estimation methods for carbon stock changes in soils is not provided	NIR section 6.2.4.8
4.A.2.1 Cropland converted to forest land	Provide evidence that no orchards have been converted to forest land	L.16	Addressing. Poland indicated during the review that the relevant information will be included in the next NIR	NIR section 6.2.5.3
4.B.1 Cropland remaining cropland – CO2	Provide the interpolated and extrapolated results for the area of cropland under different soil types d	L.17	Addressing. Poland indicated during the review that it would provide interpolated and extrapolated results in the next NIR	NIR section 6.3.4.4
4.B.2 Land converted to cropland – CO2	Include justification for the use of the management factor of 1.09 (for temperate wet climates)	L.18	No longer relevant. During the review Poland explained that the recommendation is no longer relevant because of the change to using the 2006 IPCC Guidelines. In the NIR, the Party has applied the correct default management factor for cropland in accordance with the 2006 IPCC Guidelines	-
4.B.2 Land converted to cropland – CO_2	Provide an explanation for why the gain in carbon stock in living biomass occurred only in 2003 and clarify why the loss of living biomass occurred in 2004 (one year after the conversion)	L.19	Addressing. During the review Poland explained that it has revised estimates for the entire inventory period 1998– 2014, but the information is not provided in the current submission	CRF tables 4.B.2
4.C.1 Grassland remaining grassland – CO_2	Provide details in the NIR regarding the calculation of carbon stock changes in soils	L.20	Addressing. Poland indicated during the review that it intends to provide more specific information regarding the calculation of carbon stock changes in soils in the next NIR	NIR section 6.5.4.3
4.C.2 Land converted to grassland – CO_2	Include information on the extrapolated results from 2000 for the area of grassland under different soil types	L.21	Addressing. Poland indicated during the review that it intends to provide interpolated and extrapolated results for the area of grassland under different soil types in the next NIR	NIR section 6.5.4.3
4.C.2 Land converted to grassland – CO_2	Use the relative stock change factors from the IPCC good practice guidance	L.22	Not resolved. Poland applied an inconsistent climate zone for grassland, using the warm temperate–dry climate zone for the default biomass stock, and the	NIR section 6.5.4.3

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
			boreal–cold temperate climate zone for the default annual EF for drained organic soils	
4.C.2.2 Cropland converted to grassland	Provide estimates for the net carbon stock changes in organic soils for cropland converted to grassland (reported as "IE" (included elsewhere)) or clearly indicate the subcategory to which these emissions/removals have been allocated	L.23	Resolved. Cropland converted to grassland for organic soils is reported as "NO"; therefore, the estimates for the net carbon stock changes in organic soils for this category of land is also "NO"	
4.E.2.2 Cropland converted to settlements	Clearly explain the allocation of the emissions and removals from all carbon pools in the category cropland converted to settlements	L.24	Addressing. Poland included some relevant information in the NIR and indicated during the review that it intends to include further explanation in future submissions	NIR section 6.6.4.2
4 (V) Biomass burning – CO2	Provide more information on the values used for mass of available fuel, fraction of biomass combusted and EFs to estimate non-CO2 emissions from wildfires	L.25	Addressing. Poland indicated during the review that it intends to provide additional information on the fraction of biomass combusted and mass of fuel available in the next NIR	NIR section 6.4.4.5
ARR Table 5				
4. General (LULUCF) – CO2	Poland estimated soil organic carbon stock changes using default reference soil organic carbon stocks (SOCref) and default stock change factors (FLU, FMG, FI) for all land-use categories (2006 IPCC Guidelines, equation 2.25). As indicated in the NIR and confirmed during the review, the SOCref, FLU, FMG and FI values used by the Party were the same for determining SOCt0 and SOCt1 and so there was no carbon stock change over the transition period The ERT recommends that Poland apply different FLU or FMG values for different land-use or management categories, in accordance with the 2006 IPCC Guidelines	L.26	Issue under consideration. Following the ERT recomendation for determining SOCt0 and SOCt1 in estimation CSC in the mineral soils in t categories, Poland ihas applied approapriate values of FLU or FMG for different land use and management categories as outlined in relevant section of the Volume 4 of the IPCC 2006 Guidelines	NIR section 6.4.4.5
4. General (LULUCF) – All gases	The ERT noted that the Party has improved the transparency of the reporting of land representation in the NIR by continuing the provision of the land-use matrix for 2014 in annex 6 to the NIR. The land-use transitions from one category to another have been provided in Table 4.1 of the CRFs. However, the ERT noted that the total territorial area in annex 6 is only consistent for the period 2009–2014. For the other years since 1988, the total area shows annual variability from 31,267,938 ha to 31,268,800 ha, even with the inclusion of other land. In response to questions raised by the ERT during the review, the Party explained that the total country area (total land area) slightly fluctuates due mainly to geodesic re-measurements at subsequent surveys and that the unstable country borders are considered as the main factor of relative area changes. The ERT noted that IPCC Guidelines requires that total territorial area is consistent for the entire inventory period.The ERT reiterates the recommendation made in the previous review report that Poland revise the time series of the land-use change data to ensure that the total territorial area is consistent for the entire inventory period since 1988 in the next annual submission. The ERT reiterates the recommendation made in the previous review report that Poland revise the time series of the land-use change data to ensure that the total territorial area is	L.27	Issue under consideration. Relevant informatiuon has beem providedd in the NIR 2017 as well as in the NIR 2018. All relevant information related to land use area as well as to land use change area will be reflected in the CRF table 4.1. The land area values (Ai) are respective values in the land use change matrix in the inventory year, and include all area in the year in a 'remaining' category, or all areas for conversion category i that have been in the category for a maximum period of default length of 20 years. In general, total country area (total land area) slightly fluctuate with the following reason. Central Statistical Office (CSO) in the statistical yearbooks (Environment), indicated that country total area variations are driven mainly by geodesic re-measurements at subsequent surveys. The fact that the country borders are very unstable was considered as the main factor of relative area changes. Polish coastline is constantly changing as a result of water erosion. The same changes in the area are driven by the land boarders movement. A significant part of Polish border runs along the rivers mainstreams, where	NIR section 61.3 and table CRF 4.1

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	consistent for the entire inventory period since 1988 in the next annual submission.		a large part of these rivers is unregulated, so the frequent changes in the location of the mainstream occurs. Country area fluctuations were reflected in the changes of the area of other land.	
4.A.1 Forest land remaining forest land CO2, CH4 and N2O	As noted in ID#L.9 in table 3, Poland has reverted to using a tier 1 method for the entire inventory to achieve time-series consistency in emissions from both litter and dead wood carbon pools. However, the ERT notes that the Party is not using the appropriate IPCC approach (which is tier 2 or higher) The ERT recommends that Poland use a tier 2 or higher IPCC approach to estimate emissions from both the litter and dead wood carbon pools	L.28	Issue under consideration. Poland is exploring aplication of highest tier aprroach application. Nevertheless it has to be noted, that without proper samplings and data it is not possible to develop estimates from emissions/removals from deadwood and litter on a statistical basis. Since , the conversions of non-forest land to forest land results, in all probability, in net removals in the DOM & litter pools, approach i which this pool is reported with the notation "NO" (application of "a not a source provisions") in these pools is considered as the most acceptable approach for L-FL until a more advanced estimation would be developed.	NIR section 6.2.4.8
4.A.2 Land converted to forest land – CO2	To estimate emissions/removals in land converted to forest land, Poland uses a default value of 4m3/ha/year, which is a reasonable and conservative value for new forest land areas in the ecological region of Poland. However, the ERT determined that the Central Statistical Office of Poland has national data for growing stock volumes per age class from which IEFs can be obtained for land converted to forest land. The Party informed the ERT during the review that it is exploring the possibility of estimating carbon stock changes in the biomass pool of newly established forests with an empirical model of growing stock over age on a unit area of afforestation The ERT recommends that Poland use a higher-tier method (e.g. using national forest inventory data exclusively from age class I (1–20 years)) to estimate a country-specific biomass increment value to increase the accuracy of the estimate for the land converted to forest land category, and provide the results and the limitations encountered in the next NIR	L.30	Issue under consideration. It has to be noted that National Forest Inventory wouldn't provide annual data related to increment, exclusively from age class I (1–20 years old), aplicabele or the removal stimation in this category. Application of the default values results in a consistent time series of both the area and the GHG information. With respect to the estimation related to the biomass, data from the forest monitoring system is used, the primary objective of which has been to obtain accurate information on the status and development of all forests in the country. The forest inventory was designed to collect data at the stand level, but provide accurate estimates at aggregated levels. However, Poland is exploring the possibility to estimate carbon stock changes in the biomass pool of the newly established forests with an empirical model of growing stock over age on a unit area of afforestation. In order to estimate the volume data, we are analysing available species-specific simplified models for the young forests using a sample of young stands of varying age (known based on the year of the afforestation) for which volume was known. This volume would preferably available either from direct assessment or from yield tables (in this last case, height was measured).	NIR section 6.2.5.1
4.A.2 Land converted to forest land – CO2	Poland reports dead wood and litter emissions/removals as "NO" in land converted to forest land. Given the explanations and stock values of dead wood provided by the Party during the review, the ERT	L.31	Issue under consideration. Poland is exploring aplication of highest tier aprroach application. Nevertheless it has to be noted, that without proper samplings and data it is not possible	NIR section 6.2.5.1

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	acknowledges that these pools can probably be a net sink. The ERT found that the national forest inventory has data available on dead wood stocks The ERT, given that this is a key category, recommends that Poland account for emissions and removals from dead wood and litter following the 2006 IPCC Guidelines (volume 4, chapter 2.3.2) with the highest possible tier approach		to develop estimates from emissions/removals from deadwood and litter on a statistical basis. Since , the conversions of non-forest land to forest land results, in all probability, in net removals in the DOM & litter pools, approach i which this pool is reported with the notation "NO" (application of "a not a source provisions") in these pools is considered as the most acceptable approach for L-FL until a more advanced estimation would be developed.	
4. General (LULUCF) – Gen	The previous ERT recommended that Poland provide detailed information on the rationale for and impact of the recalculations in the next annual submission. The main reason for this recommendation was that Poland made recalculations between the 2013 submission and later annual submissions for the LULUCF sector. The three most significant recalculations were in the forest land, cropland and grassland categories. The recalculations were made for the entire inventory period following changes in the methodology used to estimate carbon stock changes in living biomass in forest land from the default (gain–loss) method to the stock-change method; as a result of the revision of biomass increments on land converted to forest land; as a result of the revision of soil classification; and following the introduction of new country-specific soil organic carbon stock estimates. Compared with the 2013 annual submission, the recalculations in the 2016 annual submission resulted in an increase in removals in the LULUCF sector of 17,377.42 Gg CO2 eq (79.3 per cent) for 2011. Moreover, the change for 1992 was –12,553.99 Gg CO2 eq (–153 per cent) while the changes during the period 1996–1999 were more than 400 per cent. Responding to the recommendation, the Party provided the rationale for the recalculations as well as the percentage change and the net effect (in CO2 eq) at the category level in chapter 6.6.7 of the NIR. However, the information was for changes in 2016 only. Despite the large changes in total emissions/removals in the LULUCF sector between the 2013 submission and later annual submissions, sufficient information on the rationale, the impacts and the change from the gain–loss to the stock-change method for estimating CO2 emissions/removals in forest land remaining forest land has not been provided The ERT recommends that Poland include in its NIR sufficient information on the rationale, the impacts and the change from the gain–loss to the stock-change method for estimating CO2 emissions/removals in forest land remaining forest land for all years	L.27	Issue resolved. Recalculations of previously submitted estimates of emissions and removals as a result of changes in methodologies, changes in the manner in which EFs and AD are obtained and used, or the inclusion of new sources or sinks which have existed since the base year but were not previously reported, shall be reported for the base year and all subsequent years of the time series up to the year for which the recalculations are made. It has to be noted, the approach applied by Poland to calculate the percentage change as well as the net effect (in the CO2 eq.) of changes in methodologies, changes in the manner in which EFs and AD, or the inclusion of new sources or sinks which have existed since the base year, allows to maintain TACCC principle in relatively simple way. Despite the fact that recalculations of reported data, driven mainly by the ERT recommendations are frequent and sometimes substantial (see Annex I) but as long as the whole time series of data is updated this is not an issue for time consistency. Since the recalculations always affects all reported time series, we consider the recalculated values consistent with the trends in the activity data, and thus more accurate and comparable than before. The percentage change as well as the net effect (in the CO2 eq.) of recalculations will be provided in the section 6.6.7 of the NIR 2018 at the category level.	
4.A.1 Forest land remaining forest land – CO2, CH4, N2O	The title of table 6.10 of the NIR (p. 203) indicates that the reference for EFs is table 2.5 of the 2006 IPCC Guidelines (volume 4, p.2.47). During the review, Poland acknowledged that the EFs in table 6.10 are	L.29	Issue resolved. EF used in biomass burning emission estimation has been corrected, consistent with the notation given under table 2.5, p. 2.47 of IPCC 2006 Guidelines,	NIR section 6.2.4.11.

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
	EFs for biofuel burning rather than for extra-tropical forests. The ERT notes that under table 2.5 in the 2006 IPCC Guidelines, the information states that for forests other than tropical, extra-tropical forest EFs should be applied The ERT recommends that Poland apply the correct EFs for estimating emissions from biomass burning			
4.A.2 Land converted to forest land – CO2	In the 2014 submission, Poland applied an incorrect default biomass increment unit for estimating CO2 emissions/removals from land converted to forest land. Table 6.11 of the NIR (p.203) refers to a default biomass increment unit of 4 m3/ha/year. However, the correct default biomass increment unit from the 2006 IPCC Guidelines is 4 t d.m./ha/year (volume 4, table 4.12, p.4.63). During the review, the Party agreed on the necessity for using the correct default biomass increment unit of 4 t d.m./ha/year The ERT recommends that Poland correct the default biomass increment unit used for estimating CO2 emissions/removals from land converted to forest land in the next annual submission	L.32	Issue resolved. The correct biomass increment applied in the estimations is 4 tonnes d.m./ha/year. Following the ERT recmendation, related amendment has been implemented in the NIR 2017.	NIR section 6.2.5.1
4.E.2 Land converted to settlements – CO2	In 2014, 20.76 kha of wetlands were converted to settlements (CRF table 4.E); however, the corresponding net CO2 emissions/removals were reported as "NO". This issue was also noted by the ERT for other years. During the review, Poland explained that reporting of this category is not mandatory but it proposed changing the notation key from "NO" to "NA" The ERT encourages Poland to estimate and report the carbon stock changes from wetlands converted to settlements or change the notation key to "NE"	L.33	Issue under consideration. In the recent version of the NIR, Poland's approach is to fiil the relevant tables and blanks with the notation key " NA". This approach will mainly facilitate the assessment of the completeness of an inventory. Nevertheless, to maintain TACCC principle, Poland is exploring potential data sources, applicable for the reporting of emissions in source categories for which estimation methods in the 2006 IPCC Guidelines are not in appendices due to the limited availability of information.	NIR section 61.3 and table CRF 4.1
Waste				
ARR Table 3				
5.A Solid waste disposal on land – CH_4	Include information on the method used to estimate the degradable organic carbon value for solid waste disposal on land	W.1	Resolved. Poland reported the required information on the emission estimates in the NIR	-
5.A Solid waste disposal on land – CH_4	Correct the information in CRF summary table 3 to indicate that a tier 2 method was used, and improve the corresponding QA/QC procedures	W.2	Resolved. No discrepancies were identified in CRF summary table 3, suggesting that QA/QC procedures were improved	-
5.D.1 Domestic wastewater – CH_4	Report the practices related to CH_4 recovery in the NIR	W.3	Resolved. Poland included this information in the NIR	-
5.D.1 Domestic wastewater – CH_4	Report revised estimates for the CH_4 emissions from domestic and commercial wastewater (sludge), as planned	W.4	Resolved. Poland recalculated CH_4 emissions from domestic and commercial wastewater (sludge) using new data and information	-
5.D.1 Domestic wastewater – N_2O	Update the values of protein consumption to the latest available data in FAOSTAT	W.5	Not resolved. Poland advised the ERT during the review that FAO is yet to update its data on protein consumption	Chapter 7.5.2.1
ARR Table 5				

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
5.C.1 Waste incineration – CO2	During the review, Poland acknowledged an error in the calculation of CO_2 emissions from the incineration of non-biogenic municipal solid waste and advised that CO_2 emission estimates have been corrected and will be reported in the next annual submission. Although the ERT accepted the Party's reporting for the 2016 submission, the ERT believes that this issue should be considered further in future reviews to confirm that there is not an underestimate of emissions The ERT recommends that Poland report the corrected estimates for municipal solid waste incineration in the next annual submission. The ERT further recommends that the recalculation is appropriately described in the NIR	W.6	issue resolved	Chapter 7.4.2.1
KP-LULUCF				
ARR Table 3				
General	Provide more detailed information in the NIR on the methodologies and assumptions applied for each pool	KL.1	Addressing. Poland indicated during the review that it intends to provide more specific information regarding carbon stock changes in each pool in the next NIR	NIR section 6.2.4.8
ARR Table 5				
General (KPLULUCF) – CO_2	Total land area values are different throughout the time series. This issue does not affect areas or emissions and removals under afforestation, reforestation, deforestation or forest management activities; however, there were small differences in these areas due to rounding, as confirmed by the Party during the review The ERT recommends that Poland provide consistent values for land area for the entire time series and correct the rounding errors in order to ensure compliance with decision 2/CMP.8, annex II, paragraph 2(d), noting also footnote 7 to CRF table NIR-2, which states that "the total land area should be the same for the current inventory year and the previous inventory year"	KL.4	Issue under consideration. Relevant informatiuon has beem provided in the NIR 2017 as well as in the NIR 2018. All relevant information related to land use area as well as to land use change area will be reflected in the CRF table NIR 2. Please see the comment made on recomendation no. L.27.	NIR section 6.1.3
General (KPLULUCF) – All gases	Since the adoption of the FMRL, there have been substantial changes in the methodologies used to calculate biomass, soil, dead organic matter and harvested wood product stock changes as a result of the development of new methodologies and the application of the 2006 IPCC Guidelines and the Kyoto Protocol Supplement. During the review, Poland indicated that a technical correction is planned. The ERT notes that it is good practice to specify methodological elements or historical activity used in the reporting of forest management emissions and removals that are different from those used for constructing the FMRL, as outlined in decision 2/CMP.7, annex, paragraphs 14 and 15 (Kyoto Protocol Supplement, chapter 2.7.5.2) The ERT recommends that Poland provide a list in the NIR summarizing any methodological inconsistencies that may trigger a technical correction	KL.5	Since the Expert Review Team recommendations have been systematically applied in the country's LULUCF GHG inventory which triggered some methodological changes of relevant estimations, Poland intends to perform a submission related to the technical correction of the Forest Management Reference Level at the later stage to implement any potential recommendations and issues that might be raised by the ERT. Thiss approach would allow any FMRL correction on case any updated historical data appears.	NIR 2018 11.5.2.3 Technical Corrections of FMRL

CRF category / issue	Review recommendation	Review report / paragraph	MS response / status of implementation	Chapter/section in the NIR
Forest management – CO_2	Dead wood and litter in the category forest management is reported with the notation key "NO". During the review, the ERT acknowledged that the dead wood and litter pool has been reported in previous submissions using the default values for litter in the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry and a transition period of 20 years. However, the use of these default values is applicable only when the forest land is transitioning from one state to another (for instance, because of a change in management intensity or practices, a change in disturbance regime or a change in forest type). Therefore, considering that the carbon stock changes from dead wood and litter under forest management activities under Article 3, paragraph 4, of the Kyoto Protocol are not a net source of CO2 emissions, Poland decided not to estimate emissions or removals under this pool and category. During the review, the Party justified the fact that dead wood and litter under forest management is not a net source of CO_2 emissions in the country The ERT recommends that Poland provide a more detailed explanation to demonstrate that the pool dead wood and litter in the category forest management is not a net source of CO_2 emissions	KL.6	Issue under consideration. Poland is exploring aplication of highest tier aprroach application. Nevertheless it has to be noted, that without proper samplings and data it is not possible to develop estimates from emissions/removals from deadwood and litter on a statistical basis. Since , the conversions of non-forest land to forest land results, in all probability, in net removals in the DOM & litter pools, approach i which this pool is reported with the notation "NO" (application of "a not a source provisions") in these pools is considered as the most acceptable approach for L-FL until a more advanced estimation would be developed.	NIR 2018 11.3.1.2 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected and mandatory activities under Article 3.4

10.5. Changes in methodological description

The major changes in methodological descriptions that have been made since the previous Polish submission in 2017 are presented below in aggregated form.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please mark the relevant cell where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	Please mark the relevant cell where this is also reflected in recalculations compared to the previous years' CRF	If the cell is marked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed
1. Energy			
A. Fuel Combustion (sectoral approach)			
1. Energy industries			
2. Manufacturing industries and construction			
3. Transport			
4. Other sector			
5. Other			
B. Fugitive emissions from fuels			
1. Solid fuels			
2. Oil and natural gas and other emissions from energy production			
C. CO2 transport and storage			
2. Industrial processes and product use			
A. Mineral industry			
B. Chemical industry			
C. Metal industry			
D. Non-energy products from fuels and solvent use			
E. Electronic industry			
F. Product uses as substitutes for ODS			
G. Other product manufacture and use			
H. Other			
3. Agriculture			
A. Enteric fermentation			
B. Manure management			
C. Rice cultivation			
D. Agricultural soils			
E. Prescribed burning of savannahs			
F. Field burning of agricultural residues			
G. Liming			
H. Urea application			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please mark the relevant cell where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	Please mark the relevant cell where this is also reflected in recalculations compared to the previous years' CRF	If the cell is marked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed
I. Other carbon containing fertilisers			
J. Other			
4. Land use, land-use change and forestry			
A. Forest land	X	X	Update of data on mineral soil share on forest land; corretion of AD for amount of biomass burned
B. Cropland		X	Update of LUC matrix; ccorrection of EF for organic soils emssions
C. Grassland		X	Uupdate of LUC matrix; correction of EF for organic soils emssions; corrected EF for N_2O form biomass burning
D. Wetlands		X	Uupdate of LUC matrix; Wl's organic soils emssions was restored to maitain the correctness of reported data
E. Settlements		X	AD corretion (evaluation of biomass stock estimates with the assesment of green area's biomass increament)
F. Other land			
G. Harvested wood products			Update of AD on sawn wood production and trade
H. Other			
5. Waste			
A. Solid waste disposal	X	X	Update of fraction of CH_4 in biogas for industrial, unmanaged and uncategorized waste disposal according to latest CS research.
B. Biological treatment of solid waste			
C. Incineration and open burning of waste			
D. Wastewater treatment and discharge			
E. Other			
6. Other (as specified in Summary 1.A)			
KP LULUCF			
Article 3.3 activities			

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Please mark the relevant cell where the latest NIR includes major changes in methodological descriptions compared to the NIR of the previous year	Please mark the relevant cell where this is also reflected in recalculations compared to the previous years' CRF	If the cell is marked please provide a reference to the relevant section or pages in the NIR and if applicable some more detailed information such as the sub-category or gas concerned for which the description was changed
Afforestation/reforestation			
Deforestation			
Article 3.4 activities			
Forest management		X	Update of AD on sawn wood production and trade; Update of data on mineral soil share on forest land; Corretion of AD for amount of biomass burned
Cropland management (if elected)			
Grazing land management (if elected)			
Revegetation (if elected)			
Wetland drainage and rewetting (if elected)			

PART II:
SUPPLEMENTARY INFORMATION
REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11. KP-LULUCF

11.1. General information

According to relevant provisions, Parties to the Kyoto Protocol (KP) must submit information on land use, land use change and forestry (LULUCF) that is supplementary to what is contained in the report under the UNFCCC (i.e., Section 6). These provisions set principles to govern the treatment of LULUCF activities; require a consistent definition for terms such as "forest", as well as definitions for activities under Article 3.3 and agreed activities under Article 3.4; and describe how modalities, rules and guidelines are implemented relating to the accounting of activities under Articles 3.3 and 3.4. Good practice guidance concerning the methodology for estimating GHG emissions and removals are given in IPCC guidelines (2013).

As Poland only elected Forest Management (FM) under Art. 3.4 for the first commitment period (it is obligatory to report on FM in the second commitment period), and no other activity has been elected for the second commitment period, this part of the NIR mainly covers issues related to the forestry sector. Information on other land use related activities (e.g. cropland management) is limited to relevant information about land use conversions.

11.1.1. Definition of forest and any other criteria

For the needs of reporting to Articles 3.3 and 3.4 of the Kyoto Protocol, Poland selected the following minimum values for the forest definition[2]:

1. minimum forest land area: 0.1 hectare
2. minimum width of forests land area[3]: 10 m
3. minimum tree crown cover: 10% with trees having a potential to reach a minimum height of 2 meters at maturity in situ. Young stands and all plantations that have yet to reach a crown density of 10 percent of tree height of 2 meters are included under forest. Areas normally forming part of the forest area that are temporarily un-stocked as 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.

According 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], a forest is a land:

1. of contiguous area greater than or equal to 0.1 ha, covered with forest vegetation (or plantation forest) – trees and shrubs and ground cover, or else in part deprived thereof, that is:
    - designated for forest production, or
    - constituting a Nature Reserve or integral part of a National Park, or
    - entered on the Register of Monuments;

[2] These values are not in contradiction to forest definition in the Polish law (A*ct on forests of 28 Sep 1991* [Journal of Law of 1991 No 101 item 444, as amended]).

[3] Excluding small private properties, private land given to State Forest [Państwowe Gospodarstwo Leśne Lasy Państwowe] or land belonging to Agriculture Real Estate Agency [Agencja Nieruchomości Rolnych Skarbu Państwa].

2. associated with forest management, but occupied in the name thereof by buildings or building sites, melioration installations and systems, forest division lines, forest roads, land beneath power lines, forest nurseries and timber stores; or else put to use as forest car parks or tourist infrastructure.

As indicated in the above forest definition, areas normally forming part of the forest area that are temporarily un-stocked as result of human intervention, shall also be included. Therefore, land associated with forest management is considered as temporary un-stocked area subject to forest management activity. A pivotal feature of the UNFCCC definition of forest is that temporarily un-stocked forest areas are classified as forest provided that their land use remains forestry. There are a number of reasons why the term `temporary' should be qualified.

Many lands which for legal or administrative reasons are classified as forest lands falling under forestry land use may not be covered with trees in a near future (or ever). On the other hand, there may be other ways than legal provisions or administrative decisions to ensure that the tree cover will be re-established and that forestry continues to be the land use. For example, existence of a management plan to reforest the land (soon) could be considered a qualifier, or that the tree cover is expected to expand to more than 10% of the crown cover and reach a minimum of 2 meters in height, if the area is brought under protection and not further disturbed by human intervention.

Minimum forest stand dimensions are included within forestry definition to keep the task of monitoring forested areas feasible. For the purposes of forestry operations, the limit was set as 0.1 ha, with minimum width of only 10 m. Although such resolution is required at the scale of forestry operations, it creates practical difficulties in monitoring extensive areas for changes (such as those associated with ARD activities). The cost of monitoring rises sharply with increasing resolution. Thus, in practice, monitoring and reporting agency (Forest Management and Geodesy Bureau) is constrained by the cost of measurement programs and by available resources.

11.1.2. Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

Poland reports GHG emissions and CO_2 removals on afforestation/reforestation and deforestation (ARD), forest management (FM). Forest management activity accounted in the first commitment period under the Kyoto Protocol continues to be accounted during the second commitment period. The land area reported and changes in land area subject to the various activities in the inventory year are reported in the CRF in NIR-2 table.

11.1.3. Description of how the definitions of each activity under Article 3.3 and each mandatory and elected activity under Article 3.4 have been implemented and applied consistently over time

The definitions given below refer to those caused by human activities that increase or reduce the total area of forest land.

a) Afforestation

Afforestation refers to the conversion of land not fulfilling the forest definition to forest land according to the following assumptions:

1. area of the transformed land is at least equal to 0.1 ha;
2. transformed land remained without cover of forest vegetation for at least 50 years, until 31.12.1989;
3. transformation is directly caused by intended human activity.

Land subject to the afforestation activity, was assigned to the area of forest land, established on the basis of legal land use conversion since 1990. This approach was applied due to the fact that from the moment of conversion afforested land is at least subject of the protective measures listed respectively in the Act on forests of September 28th, 1991 (Journal of Laws of 1991 No. 101, item. 444, as amended) as well as in the Act on the protection of agricultural and forest land of February 3rd, 1995 (Journal of Laws of 1995 No. 16, item. 78, as amended) considered as direct human-induced activities, intended for the forest land including newly established.

b) <u>Reforestation</u>

Reforestation refers to the conversion of land not fulfilling the forest definition to forest land according to the following assumptions:

1. area of the transformed land is at least equal to 0.1 ha;
2. transformed land remained without cover of forest vegetation for less than 50 years, until 31.12.1989;
3. transformation is directly caused by intended human activity

Forestry legislation in Poland does not distinguish between afforestation (A) and reforestation activities (R) in the sense of the Marrakesh Accord, so they were treated similarly in the national GHG inventory and supplementary reporting. This lands are included under 4.A.2 conversions to forest lands. Artificial plantations of forest trees on lands which are expected to meet forest definitions thresholds are reported as AR. Currently, data provided by National Statistics is used.

c) <u>Deforestation</u>

Deforestation refers to the conversion of forest land to other categories of land use. Within the national statistical surveys that category of land use change is considered as the exclusion of forest land for non –forestry purposes. The assumptions used to determine the size of deforestation are as follows:

1. the area of transformed land was covered with forest vegetation on 1 January 1990;
2. transformation is directly caused by intended human activity.

Deforestation is strictly limited by the national law. The main document in this regard is the Act on the protection of agricultural and forest land of February 3rd, 1995 (Journal of Laws of 1995 No. 16, item. 78, as amended). Any exclusion of forest land for non –forestry and non agricultural purposes requires:

1) for the agricultural land consisting valuation land classes I-III – the consent of the minister responsible for rural development;
2) for the forest land owned by the State – the consent of the minister responsible for the environment or the person having the minister's authorization;
3) for the remaining forest land - the consent of the province marshal, issued considering the opinion expressed by the local Chamber of Agriculture.

d) <u>Forest Management</u>

Forest management has been defined in paragraph 1 (f) of the Annex to Decision 16/CMP.1 as a system of practices aimed as management of forests, including their ecological (including protection of biodiversity), economic and social functions conducted in a sustainable manner. Sustainable forest management as described in the *Act on Forest Forests of 28 Sep 1991...* sets out principles for the retention, protection and augmentation of forest resources, as well as for the management of forests and other elements of the environment in reference to the national economy.

Sustainable forest management practices, consistent to the provisions of this *Act on Forests*..., apply to all forests irrespectively of their form of ownership. Such activities carried out mainly by the State Forest National Forests Holding result in biomass increase leading to growth of carbon sequestration. Increasing forest area as well as activities aiming at saving forest resources in Poland support this process. The following main activities are performed within forest management by the General Direction of The State Forests:

- increasing of the area undergrowth plants,
- change of species structure from monoculture to multi-species-stands rebuilding,
- introducing second storey into one storey stands,
- using the maximum age for cutting main species of trees,
- if it is advisable not to harvesting some parts of stands above their normal cutting age,
- if it advisable using selective cutting instead of clear cutting method,
- leaving residues on cutting area,
- enhancing natural regeneration,
- enhancing forest fire prevention.

"Forest management" in general includes all kinds of activities in the forest from protecting forests through their economic utilization (of all kinds) to making use of a wide variety of social and ecological functions and services of the forests. All these activities often require rather intensive management of all forests, although this intensity is quite different in the various stands depending on site, species, and the local objective of managing the stand. Managing forests involves preparing forest management plans, afforesting, regenerating, intensive thinning, harvesting, forest protection, maintenance of roads and road building, inspecting of forestry operations and others. The intensity of management is characterized by the length of the operational cycle of returning to each forest compartment, which varies from about a few weeks (in afforested or regenerated areas where tending in necessary) to a year (in young poplar stands for tending) to five years (between pre-commercial thinnings in young stands of fast growing species) to maximum 15-20 years (between thinnings in older stands of slow growing species). Forest management planning covers all forests, and forest management plans are made for 10(-12) years. That all forests (in the sense of the above "forest" definition) are managed in one way or another in Poland is partly an economic and practical necessity because the country uses more wood a year than what it produces, and because the density of the population, which requires all kinds of products and services from the forests, is quite high according to official statistics.

Land under the "FM since 1990" activity is identified by establishing FM in 31 December 1989 (which equaled the total FL at that point) and then subtracting D areas in subsequent years. It thus excludes D areas.

11.1.4. Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified

As stated in previous section, as soon as site preparation and planting or seeding of propagation material is done, all AR lands become "forest" from the viewpoint of the definition of "forest" under the KP. From a domestic administrative point of view, when an AR land becomes a "forest" under the relevant regulations, it right away becomes an area subject to FM. Thus, since the category "AR since 1990" includes all areas that have been afforested since 1990, these areas could also be regarded as 3.4 FM. These areas are, however, not considered as FM areas to avoid double counting.

This separation is done, thus, double counting is avoided, and full consistency with the report under the UNFCCC is achieved, by first establishing the area of AR and then developing FM as all forests ("FL" in the report under the UNFCCC) minus the total of the "AR since 1990" as well as minus "D since

1990". In this way, AR since 1990 that would otherwise classify as FM is automatically excluded from FM.

Since only one activity of the listed Article 3.4 Activities was elected by Poland, no precedence conditions among Article 3.4 activities are applicable. The ranking of priority is given in the following order: Deforestation – Afforestation – Forest management.

11.2. Land-related information

11.2.1. Information on geographical location and identification of land

National boundaries were applied for all activities.

11.2.2. Spatial assessment unit used for determining the area of the units of land under Article 3.3

Artificial plantations of forest trees on lands which are expected to meet forest definitions thresholds are reported as AR. Currently, data provided by National Statistics is used, but the system improves to provide better data by statistical sampling associated to NFI combined with spatial information from register of land and buildings.

With regard to the regulations of art. 3 of the act on forests, forest land considered a subject to the forest management is the area:

3) 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;
4) of contiguous area greater than or equal to 0.10 ha, associated with forest management.

Provisions of this act allow to standardize the definition of forest land as a part of land use scheme. Party has established a system of regulations allowing to identify, collect, process, report and publish data of land use in the annual statistics. Annual summary reports on land use areas submitted by the Head Office of Geodesy and Cartography are prepared on the basis of regulations of *Act on geodesy and cartography* (Journal of Laws of 1989 No. 30, item. 163, as amended) constituting the basis for the statistical publications fulfilling requirements of National Land Identification System.

11.2.3. Methodology used to develop the land transition matrix

The land transition matrix is developed the following way:

1. Areas under annual AR activities are identified on a per stand basis each year, and the area of these stands are summed up.
2. Areas under D activity are identified since 1 Jan 1990 on a per stand basis each year, and the area of these stands is summed up.
3. The total (known) forest area at the end of each year (since 1990) is identified on the basis of the NFD that includes appropriate records for each known stand in the country.
4. By identifying the total forest area, as well as all additions to, and reductions from, the forest area of the previous year, the constant elements (i.e. FM) can be identified. Land under FM was first identified at 31 December 1989. FM area has subsequently been reduced by the area of the deforested stand.

The above procedure ensures the consistency of land identification under all KP activities, as well as FL under the UNFCCC. We identified all changes in the land use statistics and classified them so that, eventually, all land can be accounted for in the respective categories since 1990 (see also section 6.) Land statistics based on annually updated data obtained from National Record of land and buildings directly refers to changes in land use caused by intended human intervention at the level of single cadastral unit.

Any changes in land use categories are recorded with the attribute of the area being a subject of any type of conversion and are aggregated in a form of annual reports on land prepared by the Head Office of Geodesy and Cartography. Data on the condition and changes in the registered intended use of land were developed on the basis of annual reports on land are published as the official statistical information by the Central Statistical Office. Publications of the different categories of land use are subsequently used to determine the direction of changes in land use.

Considering the area of the country and its specific conditions, there is no applicable stratification that would justify reporting on smaller scale than at the national level. This is also supported by the attributes of the available activity data. However, the land-use representation and land-use change identification system developed for the KP and UNFCCC reporting purposes permit a truly detailed spatial assessment and identification of AR and D activities at the level of the individual cadastral units.

Methodology for the preparation of the land use change matrix is described in the LULUCF section 6.2. There were two matrices developed: one that starts in 1988, developed for the inventory purpose (which covers GHG inventory 1988-2015) and another one that starts in 1990 developed for the Kyoto Protocol reporting and accounting purpose. The two are fully consistent, the difference is that Convention's one implements 20 years transition period,

Since 1988 is applied as the base year for Poland, pre-1990 data was only needed to provide a net GHG emission/removals estimate for the Convention categories activity in 1988 and 1989. The complete matrix used for estimation of emission/removals on KP eligible lands is available in NIR-2 table in CRFas well as in Annex 6.2 KP LULUCF LTM.

11.2.4. Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

Afforestation and reforestation (AR) - mapping and identification

The identification of land area eligible as AR activities could be done based on forest management plans and their forest maps, in which these areas are included after the conversion to the forest land. Thus, the explicit location and plantation/stand description is available for each such area. Further on, such land can be tracked in time through the numbering systems of the forest parcels (compartments), as far as the number (code) remains unchanged over the planning cycles. A piece of land covered by afforestation is subject of plantation and, if necessary, repeated gap filling according technical norms for afforestation.

Deforestation (D) - mapping and identification

Deforested lands are identified by statistical sampling method.

Forest management (FM) - mapping and identification

For each year, all FM area (i.e. each stand) is allocated to one of the geographical locations, thus, aggregate data (e.g. volume stocks, volume stock changes etc.) for these locations can be developed for each year. The identification system of sub-compartments is made up of three elements which are registered for every sub-compartment. These elements are: the municipality (village, or town), the compartment (a larger piece of forest, e.g. a hillside or a valley) and sub-compartment (which is part of a compartment). Measurements and observations are made on permanent sample plots. System of permanent observation plots (ICP Forest) was applied as a basis for damage assessment in forests, according to the European Union regulations (ie. the network 16x16 km).

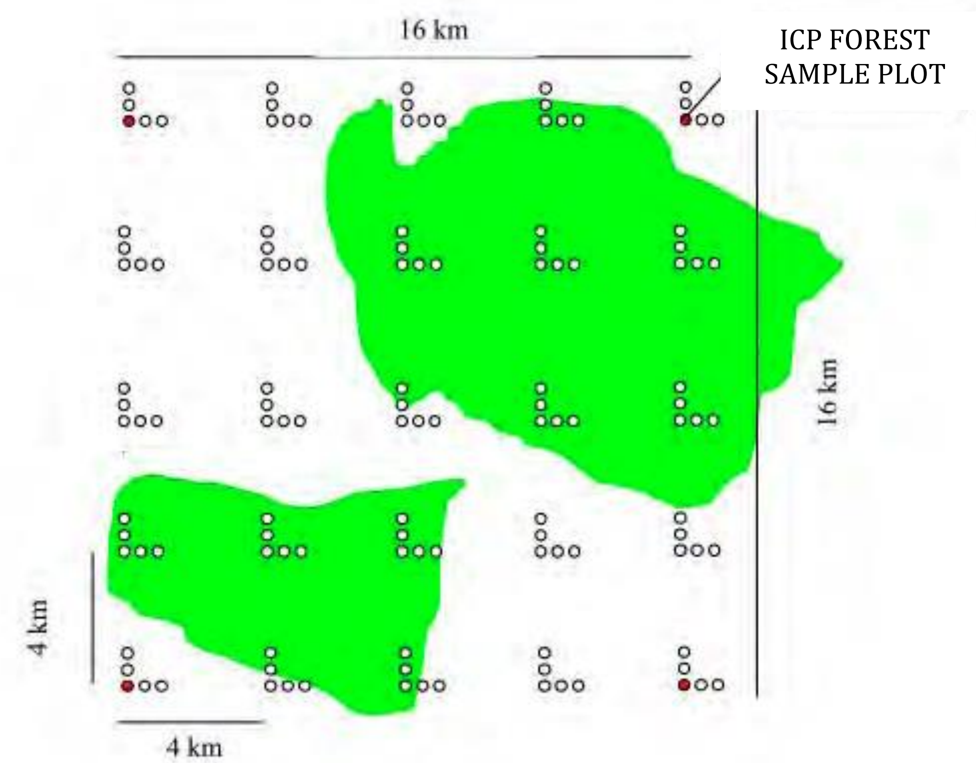

Figure 11.1. The general layout of sample plots

The network of sample plots for large-scale inventory system was concentrated to 4x4 km, with the individual specification of single plots coordinates in WGS 84 and PUWG 1992 systems. The individual sample plot was located schematically in line with the system schemes deployed in the 4x4 km network, while within each line 200 meters long (shaped L with equal arms) five sample plots is located.

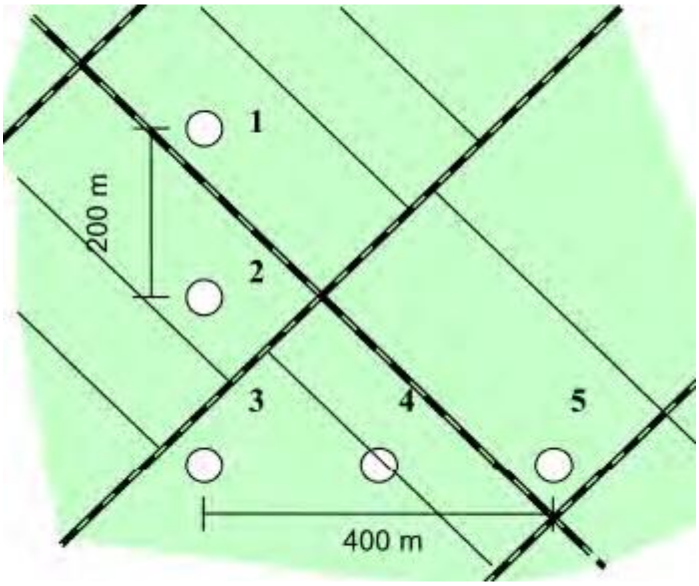

Figure 11.2. Routes system with the background of the sample plots distribution

Over 28 thous. of sample plots have been established in Polish forests during the current inventory process. Location of every single sample plots in the area was marked up on the map with its marker points designation and identification (determined by the location of individual sample plots). Since the long term stabilization was completed and single points were marked (by punching a metal tube about 1 inch in diameter around 30 cm into the ground and punching the nails in his neck the next three root trees), offsets to the centre of each sample plot were measured (using the azimuth and distance). Locations of sample plots were recorded mostly by GPS receivers, starting from the point of marker and by navigation to the ground of the next trial area where it was possible to read the GPS coordinates with appropriate measurement parameters. This point was also marked as an intermediate point, stabilized in the same manner as marker point.

11.3. Activity-specific information

11.3.1. Methods for carbon stock change and GHG emission and removal estimates

Further implementation of the 2006 Guidelines has affected insignificantly the estimates for KP activities. All emissions are estimated, none is considered as insignificant in the sense of para 37 of the Annex to decision 24/CP19.

11.3.1.1. Description of the methodologies and the underlying assumptions used

Similar methodological approaches were implemented under the convention and KP reporting. Estimation of GHG emissions from sources is consistent with data and methods used in the convention estimation and are described under section 6 of the NIR.

Afforestation/reforestation

Net changes in C stocks in aboveground and belowground biomass, and soil organic matter pools during each year of the annual commitment period are estimated and reported for accounting purposes under Tier 2.

Good practice for forest carbon accounting allows application of conservative assumptions, where accounting relies on values and procedures with high uncertainty. The most conservative option in the biological range should be chosen so as not overestimate sinks or underestimate sources of GHGs. Conservative carbon estimates can also be achieved through the omission of carbon pools, therefore Poland considered that the CSC related to deadwood and litter pools due to carbon loss/gain associated with land-use conversions on land subject to the Afforestation and Reforestation activities under Article 3, paragraph 3, of the Kyoto Protocol are not a net source of CO_2 emissions (provision of the art 26 of the Annex to the Decision 2/CMP.7).

Deforestation

Emissions are calculated using Tier 2 methods and input data as described under the chapter 6. All carbon pools are reported and D is not a key activity under KP.

Forest management

Emissions/removals from FM activity have been calculated, using the same assumptions, formulas and parameters as used for the estimation of the GHG inventory (see section 6 of the NIR). The FM is a key category under KP.

Following the ERT 2014 recommendation , Poland considered that the carbon stock changes from litter under forest management activities under Article 3, paragraph 4, of the Kyoto Protocol are not a net source of CO_2 emissions. At the same time Poland recognised that the default approach as provided in the section 2.4.2 of Section 2 of the Volume 4 of the IPCC 2006 GL for assessment of the carbon stock changes from litter under Forest management activities under Article 3, paragraph 4, could lead to potential net overestimation of removals for the litter pool under the forest management. Therefore, demonstration that litter pool in not a source was considered more appropriate. The following justifications was considered:

1. direct implementation of Tier 1 default approach as provided in the section 2.4.2 of Section 2 of the Volume 4 of the IPCC 2006 guidance assuming that the average transfer rate into the litter pool is equal to the transfer rate out of the litter pool so the net change is equal to zero;
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.

Taking into account above considerations Party decided, following ERT 2014 recommendation, to apply tier 1 as provided in the section 2.4.2 of Section 2 of the Volume 4 of the IPCC 2006 GL guidance for LULUCF to support the option given in the paragraph 2e in the annex II to the decision 2/CMP.8, and report net carbon stock change in litter pool as not occurring. Relevant reporting tables KP-LULUCF CRF 5(KP-I)B.1 in relation to litter pool for the full time series has been corrected and filled up with notation key "NO".

Nevertheless, as the result of subsequent improvements in GHG's inventory, partially driven by the implementation of 2nd commitment period's related KP decision's as well as by implementation of new guidelines to be applied by Annex I Parties and also following the ERT 2014 recommendation, Poland applied Tier 1 approach as provided in the section 2.3.2 of the chapter 4 of the volume 4 of the IPCC 2006.

Poland would like to highlight that since the deadwood and litter pool and its carbon stock change is assumed as insignificant and to keep the notations keys use relevant, notation key "NE" will be applied in relevant CRF table in the forthcoming submission, with the view to provide additional, more detailed explanation that this pools are demonstrated not a net source (instead of "NO" and "NA" reported respectively).

11.3.1.2. Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected and mandatory activities under Article 3.4

For the litter and dead wood pools on AR land, the option of paragraph 2e of decision 2/CMP.8 is selected, and it is demonstrated (see below) that these pools are not a source, thus, no accounting is made for these pools.

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 1990-2012, 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.

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 afforestation. After afforestation, 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. Overall for all AR land, also considering that AR activity has been continuous since 1990 and stands on AR land are usually younger for deadwood and litter accumulation to saturate, it can safely be concluded that the carbon in the deadwood and litter pools in AR lands was increasing between 2008-2010, i.e. these pools are not a source. 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.

According to the article 30 of *Act on forests of 28th September, 1991 (Journal of Law of 1991 No 101 item 444, as amended)* 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. To keep correctness in CRF tables notation keys NO (not occurring) were used in the table NIR 1 and connected tables for all indicated activities for wildfires on forest land.

The size of forest land with the relation to legitimacy of fertilization on forest land in a large scale causing that fertilization is limited only to the forest nurseries where use of fertilizers is a part of intensive production technology. In this situation, to prevent the possibility of double emission estimation in conjunction with the sector "Agriculture", it is assumed that fertilization on forest land is not affected. To keep correctness in CRF tables notation keys NO (not occurring) were used in the table NIR 1 and connected tables for all indicated activities for fertilization on forest land.

11.3.1.3. Information on whether or not indirect and natural GHG emissions and removals have been factored out

Available activity data and methodologies did not allow the exclusions of indirect and natural GHG emissions from the present estimation of anthropogenic GHG emissions for the relevant activities.
According to the report of a rather recent IPCC meeting (Expert Meeting on Revisiting the Use of

Managed Land as a Proxy for Estimating National Anthropogenic Emissions and Removals, 5-7 May 2009, Sao Paulo, Brazil), there are currently no scientifically sound methods to separate out indirect and natural GHG emissions and removal (IPCC, 2010). On the other hand, this is not necessarily needed if appropriate proxies are used. The above mentioned meeting, among others, stated that, although not perfect, the currently applied proxy, i.e. the so called "managed land" proxy is one that approximates the effects of direct human induced activities.

We also note that, especially for FM, this separation is taken care of by the various steps of the accounting, thus, no additional separation is necessary, and we have indeed not have done any.

11.3.1.4. Changes in data and methods since the previous submission (recalculations)

All changes are caused by the change in activity data, for forest and forest management activity. In this submission, we have implemented a number of recalculations. The main reason for the recalculations is that we identified some minor calculation updates in the area of some categories. A few other recalculations were made due to some minor category-specific issues that are reported in the relevant sections. For previous recalculations, see our previous NIRs.

Table 11.1. Recalculation of CO_2 made in CRF 2018 comparing to CRF 2017

Accounting category	Unit	2008	2009	2010	2011	2012	2013	2014	2015
4.KP.A.1. Afforestation/ Reforestation	[kt]	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
4.KP.A.2. Deforestation	[kt]	0.00	0.01	0.02	-0.02	0.00	-0.13	-0.12	-0.17
	[%]	0.00	0.00	0.01	-0.01	0.00	-0.06	-0.04	-0.06
4.KP.B.1. Forest management	[kt]	-245.62	-514.41	-453.82	-904.58	-1350.06	-2707.83	-2415.04	-2258.35
	[%]	0.64	1.42	1.30	2.15	3.21	5.95	6.33	6.64

Table 11.2. Recalculation of CH_4 made in CRF 2018 comparing to CRF 2017

Accounting category	Unit	2008	2009	2010	2011	2012	2013	2014	2015
4.KP.A.1. Afforestation/ Reforestation	[kt]	-0.07	-0.08	-0.08	-0.08	-0.08	-0.10	-0.09	-0.09
	[%]	-12.81	-13.11	-14.13	-14.14	-14.69	-17.53	-16.28	-15.85
4.KP.A.2. Deforestation	[kt]	NA	NA	NA	NA	NA	NA	NA	NA
	[%]	NA	NA	NA	NA	NA	NA	NA	NA
4.KP.B.1. Forest management	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	[%]	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	0.53

Table 11.3. Recalculation of N_2O made in CRF 2018 comparing to CRF 2017

Accounting category	Unit	2008	2009	2010	2011	2012	2013	2014	2015
4.KP.A.1. Afforestation/ Reforestation	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	-4.69	-7.46	-3.38	-4.88	-14.46	-2.25	-5.33	-11.64
4.KP.A.2. Deforestation	[kt]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	[%]	68.03	70.09	72.67	73.33	75.89	76.96	84.24	84.35
4.KP.B.1. Forest management	[kt]	-0.01	-0.01	-0.01	-0.01	-0.02	0.00	-0.01	-0.02
	[%]	-988.04	-991.84	-983.80	-987.72	-995.37	-976.62	-987.97	-1331.58

11.3.1.6. Uncertainty estimation

Uncertainties are associated with each step of the estimation of emissions and removals. Some of the uncertainties are already assessed above, and uncertainties are also covered to some extent in Chapter 6.5.7. Uncertainties are further assessed in a detailed procedure below. This section describes methods and results of uncertainty estimation both for categories under the Kyoto Protocol and those under the UNFCCC as it seems more practicable to describe similar systems once and highlight differences.

One of the objectives of the uncertainty analysis is to demonstrate that emissions are not underestimated. It is therefore underlined here, too, that, whenever the inherent uncertainties of our estimation procedure justify that, we always take a conservative approach to avoid the underestimation of emissions and to minimize those sources of uncertainties that we are aware of. Another, by far not unimportant, aspect of dealing with uncertainties is to identify and quantify them in order that the inventory can be developed so that the more important and/or less certain estimates can be improved first. One principle in this identification and quantification is that we should first identify and quantify, and then prioritize uncertainties that could effectively be reduced by practicable policies and measures.

We note here that the uncertainty of some forest characteristics, e.g. the size of the area of land under the various activities, is rather unimportant *in the process of estimating emissions and removals* in our system because they do not directly enter the algorithm of the GHG estimation. However, when estimating the stand-level values during surveys, the area is used to upscale sampling plot information (or unit area information in case of using yield tables). Whether a land is identified or not, i.e. whether carbon stock changes on that land must be estimated or not, is also important, see the first bullet point above. In this respect, we believe that our data collection system can be regarded as conservative and may in this sense result in an underestimation of removals and overestimation of emissions.

The analysis involves calculations of the emissions and removals at the same levels that are used for the GHG inventory, but, in order to obtain information on the error distributions, we applied some calculations at the category level (see below), too. The quantifiable uncertainties were calculated using a (Tier 1) Monte Carlo (MC) analysis.

According to the results, the combined uncertainty of the net removal estimates of categories under the KP amount to between about ±23% (for AR and D) and ±20% (for FM), and the uncertainty of the activity data (volume stock change, volume and area) is the source of roughly the half of all uncertainties except for FM where it has a larger share. For AR we estimated uncertainties somewhere in between the above estimates.

As the absolute value of total emissions from D are smaller than that of the removals from AR and FM by a factor of two, the uncertainty of emissions from D is considered satisfactory. The overall uncertainty of the emissions from D is also mainly affected by the litter uncertainty, but the biomass and soil uncertainties are also considerable. Although the factors used to estimate emissions from litter and soil can be considered country-specific. For both AR and FM, the combined uncertainty practically comes from that of the biomass stock change due to the fact that other emissions are very small. Concerning the uncertainty of the biomass stock change estimates, they are affected by the uncertainty of the area, volume stock change, wood density, root-to-shoot ratio and carbon fraction estimates. Of all these, the uncertainty of the area is very small (0.03% at the country level), and that of the wood density, root-to-shoot ratio and carbon fraction cannot really be affected by any policy, nor it is practicable to obtain more accurate estimates.

The uncertainty of the volume stock change at the stand level is due to sampling errors, measurement errors, and errors resulting from the use of yield tables. The resulting uncertainty of the volume stock changes at the level of various species or species group varies between ±27%. The results suggest that efforts should be taken to reduce the uncertainty of data at the stand level. The distribution of the uncertainty could also be studied in relation to the age as well as other characteristics of the stands (e.g. the mixing rates, heterogeneity of the stand structure etc.)

Aggregated result of the Approach 1 uncertainty analysis for AR, D and FM are provided in Annex 8.

11.3.1.7. Information on other methodological issues

This often, but not always, represents Tier 2 or 3. In order not to underestimate emissions and overestimate removals, a highly conservative approach is applied in all steps of the inventory whenever the application of higher Tiers is not possible. This approach is characterized by always selecting data and methods that overestimate emissions and underestimate removals.

Generally, the area, harvest and forest fire statistics are based on annual nationwide assessments, whereas the emission factors and models applied do not consider the inter-annual variability of the physical processes. Therefore, the estimated emissions and removals partly, but not completely, reflect the inter-annual variability of the true processes.

It also needs to be underlined that the net removal values for either FM or AR represent rather small changes (i.e., net removals) relative to rather large stocks (i.e., the total carbon stocks of the biomass of all forests in the respective categories). It is due to the nature of such relatively small net values that they have a rather high inter-annual variability, and are not a result of some artefacts.
In principle, we consistently use the same methods for estimating carbon stock change and non-CO_2 greenhouse gas emissions for the whole 1990-2015 period, and data reported under the KP is consistent with those under the UNFCCC.

With respect to the methodological Tiers applied in this report, at least the same or higher Tiers are applied for the categories under the KP as in our report under the UNFCCC. In general, higher tier, or at least methods of higher accuracy, are applied with respect to the identification and estimation of areas in the various land use and land use change categories under the KP. In general, too, Tier 2/3 is applied for AR, D and FM land: the land area identification is country-specific, and so is the estimation of volume, as well as that of the biomass conversion factor from volume to above-ground biomass. For the expansion of above-ground to total biomass, a Tier 1 factor is applied. The application of such a Tier 1 default factor is well compensated by selecting a conservatively low root-to-shoot factor, which may result in a bias in the estimation, but this bias is conservative as it is towards lower net removals.

Almost all forestry data that have been used for the development of the GHG emission and removal estimates are collected, processed, aggregated and archived by the forest *authorities.* This system ensures that all background data are collected and processed at the required quality, and the number of possible sources of errors and uncertainties are reduced.

11.3.1.8.1. Information that demonstrates methodological consistency between the reference level and reporting for forest management

In order to avoid expectance of net debits and credits, during the second commitment period, the consistency of parameters used for FMRL and estimates over the CP2 has to be ensured for, i.e. area accounted for, the treatment of harvested wood products, and the accounting of any emissions from natural disturbances.

It is important to highlight that we always use the best methods and data that is currently available.

This often, but not always, represents Tier 2 or 3. In order not to underestimate emissions and overestimate removals, a highly conservative approach is applied in all steps of the inventory whenever the application of higher Tiers is not possible. This approach is characterized by always selecting data and methods that overestimate emissions and underestimate removals.

Generally, the area, harvest and forest fire statistics are based on annual nationwide assessments, whereas the emission factors and models applied do not consider the inter-annual variability of the physical processes. Therefore, the estimated emissions and removals partly, but not completely, reflect the inter-annual variability of the true processes. (The annual stock data mainly reflect actual harvests, but partly only modelled increment data.) It also needs to be underlined that the net removal values for either FM or AR represent rather small changes (i.e., net removals) relative to rather large stocks (i.e., the total carbon stocks of the biomass of all forests in the respective categories). It is due to the nature of such relatively small net values that they have a rather high inter-annual variability, and are not a result of some artefacts.

In principle, we consistently use the same methods for estimating carbon stock change and non-CO_2 greenhouse gas emissions for the whole 1988-2015 period, and data reported under the KP is consistent with those under the UNFCCC.

With respect to the methodological Tiers applied in this report, at least the same or higher Tiers are applied for the categories under the KP as in our report under the UNFCCC. In general, higher tier, or at least methods of higher accuracy, are applied with respect to the identification and estimation of areas in the various land use and land use change categories under the KP. In general, too, Tier 2/3 is applied for AR, D and FM land: the land area identification is country-specific, and so is the estimation of volume, as well as that of the biomass conversion factor from volume to above-ground biomass. For the expansion of above-ground to total biomass, a Tier 1 factor is applied. The application of such a Tier 1 default factor is well compensated by selecting a conservatively low root-to-shoot factor, which may result in a bias in the estimation, but this bias is conservative as it is towards lower net removals.

11.3.2.8.2. Technical corrections

A technical correction is planned in the light of new data available from NFI at the later stage.

1.3.1.8.3. The year of the onset of an activity, if after 2013

Data on the year of onset of activity is reflected in the time series used to derive the activity data. Under current method, which determines the land use change periodically, interpolation is used between successive moments in time. The Kyoto CRF tables, as well as data and calculations as demonstrated above, clearly and transparently report both the areas and the associated emissions and removals under Article 3.3 that have entered the accounting system. For Art. 3.4 FM, activities on all land are assumed to be started before the beginning of the first commitment period. As a consequence, the Polish accounting system fully complies with paragraph 23 in Annex to Decision 2/CMP.7.

11.4. Article 3.3

11.4.1. Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

The annually updated cadastral information from the National Record of Lands and Buildings refers exclusively to intentional, i.e. human-induced interventions into land use. These interventions are thereby reflected in the corresponding records, including the time attribute, collected and summarized at the level of cadastral units. Summarised area of land use changes at the level of cadastral units are annually reported as a official statistical data by the Central Statistical Office

11.4.2. Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

Since no remote sensing technology is directly involved in the KP LULUCF emission inventory, there is no issue related to distinguishing harvesting or forest disturbance from deforestation. Harvesting and forest disturbance always occur on forest land, while deforestation is a cadastral change of land use from forest land to other land use categories

The forest disturbance alone cannot trigger land conversions from forestland, i.e. land is subject to further forest management. Thus distinction between harvested and disturbance affected areas, on the one hand, and deforestation, on the other, is made as follows: for the former, there is legal obligation for the forest owner/administrator to maintain the land under forests category and forestry regime (including tree harvest based on permit), to apply the forest management plans specifications and regenerate it within a given timeframe (maximum 5 years); for the latter, following legal procedure with the issuance of the approval, a new land use category is assigned to that land, and the forestry regime is no longer applicable.

Any deforestation in terms of land use change in the in-country land use scheme requires an official decision. Hence, no permanent loss of forest cover may occur prior to this approval, which is reflected in cadastral land use. A temporary loss of forest cover up to an area of 2 [ha] ha may occur as part of forest management operations on Forest land (units of land subject to FM), which is not qualified as deforestation in terms of Art. 3.3. KP LULUCF activity. Nevertheless, forest owners (art. 13.1 of the the *Act on forests* of September 28th, 1991 *(Journal of Laws of 1991 No. 101, item. 444, as amended)* shall be obliged to ensure the permanent maintenance of forest cover, as well as continuity of utilization, and in particular:

1) to preserve forest vegetation (plantations) in forests, as well as natural marshlands and peatlands;
2) to reintroduce forest vegetation (plantations) in forest areas within five years of a stand being cleared;
3) to tend and protect forest, including against fire;
4) to convert and rebuild stands, where these are not in a condition to ensure achievement of the objectives of forest management set out in the Forest Management Plan, Simplified Forest Management Plan or Decision;
5) to make rational use of forests in a manner permanently ensuring optimal discharge of all the functions thereof, by means of:
    a) the harvesting of wood within limits not exceeding a forest's productive capabilities,
    b) the harvesting of raw materials and by-products of forest use, in a manner providing for biological renewal, and also ensuring protection of forest-floor vegetation.

A basic requirement of the forest regime is that an area has to be restocked in maximum 5 years, without reference to a minim area. In practice, such lands can regenerate either by plantations (usually followed by state forests) or by assisted natural regeneration (, or by mixed ways. Its implementation is observed by public authority responsible for forestry. These areas cannot be confounded with deforested areas as far as they are subject to continuous planning and management (i.e. planting/ gap filling, maintenance, etc).

In Poland, all forests must be regenerated after clearing mature stands by law (as defined by Forestry Act. Regeneration usually means that a cut-and-regeneration sequence of operations is applied, which involves that most of the area that is cut in a year is void of mature trees for many years.

Harvests on afforested area have so far mainly been final cuttings in stands that have reached their rotation age. In case an area is regenerated that was afforested or reforested earlier but after 1989, the same rules apply by law than for all other forests. These rules require that harvested forests must be regenerated at least in fifth year from the disturbance. All areas under regeneration are continuously surveyed by the Forest Authorities, and tough penalties are applied to those that violate relevant provisions.

11.4.3. Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

The actions referred to the deforestation under Article 3.3 of the Kyoto Protocol and the provisions of Article 5 of the *Act on Agricultural and Forest Land Protection (Journal of Laws of 1995, No 16, item78 as amended*) require a formal decision to exclude individual forest plots as administrative units of forestry production. National legal considerations indicate deforestation as a process of administrative changes in land use category, while the temporary deprivation of the forest land of forest cover cannot be equated with deforestation process and should be treated as part of sustainable forest management. Size of final felling sites at the country level that have lost forest cover but which is not yet classified as deforested is presented in the table below.

Table 11.5. Size of final felling sites

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
Land area [thos. ha]	72.7	76.9	78	77.9	79.6	79	77.9	79.4	81.7

Data source: Statistical yearbook: "Forestry 2017"; CSO 2017

11.4.4. Information related to the natural disturbances provision under article 3.3

Not applicable

11.4.5. Information on Harvested Wood Products under article 3.3

As requested by para 26 of Annex to 2/CMP.7, carbon stock changes in the HWP pool are reported and accounted for in the Polish inventory. The methodology of estimation is described in Section 11.5.2.5 because, due to lack of data, we are unable to separate harvest from AR and FM. Therefore, according to page 2.118 of the IPCC 2013 KP Supplement, "in case it is not possible to differentiate between the harvest from AR and FM, it is conservative and in line with good practice to assume that all HWP entering the accounting framework originate from FM", thus we report carbon stock changes together for the two categories. In contrast, harvest from D is separated and excluded, and treated as instantaneous oxidation.

11.5. Article 3.4

11.5.1. Information that demonstrates that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced

Confirmation that the FM activity is human induced and occurred since 1990 is given by the fact that associated lands were reported as part of the national economic system by continuous planning and implementation of the management measures or subject to forest regime in any case.

The basis for the management is forest management plans that are prepared for all forests of the country, i.e. all stands of both the AR and the FM category. These plans, which are parts of the underlying documentation, contain information, among others, on the status of the stand during the survey, long-term objectives, plans for short-term operations (for as long as a maximum 10-year period) and information on the last harvesting operations. These plans thus demonstrate that activities under Article 3.4 have occurred since 1 January 1990 and are human-induced.

11.5.2. Information relating to Forest Management

Forest management activity refers to forest for which a management plan has been set up (some 90% of forests) while the rest are subject to wood harvesting permission. First category are managed according to management plans, they are continuously surveyed for disturbances; forest operations and harvesting are subject to 10 years cycle planning; forest regeneration is closely and intensively assisted. Such lands are mapped, landmarked and annually up-dated in statistics. The forestry regime relies primarily on the forest law, then in subsequent legislation and technical norms, in order to ensure sustainable forests management at national scale.

11.5.2.1. Information that the definition of forest for this category conforms with the definition in item 11.1 above

FM land only includes managed forest areas that are included in the FL category, for which the definition of "forest" is applied as required by the the *Act on forests* of September 28th, 1991 *(Journal of Laws of 1991 No. 101, item. 444, as amended)*, as it is demonstrated above in section 11.1.

11.5.2.2. Conversion of natural forest to planted forest

It is assumed that this type of conversion does not occur in Poland.

11.5.2.3. Forest Management Reference Level (FMRL)

In order to avoid expectance of net debits and credits, during the second commitment period, the consistency of parameters used for FMRL and estimates over the CP2 has to be ensured for, i.e. area accounted for, the treatment of harvested wood products, and the accounting of any emissions from natural disturbances.

Emissions from harvested wood products originating from forests prior to the start of the second commitment period have been calculated in the FMRL using the stock change approach defined in IPCC 2006 (data used were associated with years starting with 1900).

11.5.2.3. Technical Corrections of FMRL

The methodology of the projection, shall consider the effect of policies on the projections, the same as in the Preparation of original FMRL. Therefore, the technical correction should only concern the revised estimates of the historical time series of the emissions and removals from FM that are used for the adjustment. Technical correction is planned in the light of new data available from NFI.

Considering all the above, technical correction is planned in the light of new data available from NFI. All elements of the necessary technical correction will consider Equation 2.7.1 of the IPCC 2013 KP Supplement:

$$FMRLcorr = FMRL + Technical\_Correction$$

where:

FRMLcorr = the corrected FMRL,
FMRL = Forest Management Reference Level inscribed in Appendix to Decision 2/CMP.7
Technical_Correction = the total of the partial corrections in Table 11.16.

11.5.2.4. Information related to the natural disturbances provision under article 3.4

Not applicable. Poland does not intend to use the provision to exclude emissions caused by natural disturbances during the second commitment period of the Kyoto-Protocol.

11.5.2.5. Information on Harvested Wood Products under article 3.4

From a methodological point of view, emissions and removals HWP under FM are treated similarly than that under the UNFCCC, see Section 6.5.4.2.4. However, there are a number of elements where, due to KP-specific provisions, accounting has to follow specific rules and involves reporting different amounts of emissions and removals than those under the UNFCCC.

The estimation was done with annual historical production data, specific half-lives for product types, application of the first-order decay function using equation 12.1 from the 2006 IPCC Guidelines, with default half-lives of two years for paper, 25 years for wood panels and 35 years for sawn wood and instantaneous oxidation assumed for wood in solid waste disposal sites. Historical data dated back to 1964. It was assumed that, with the exception of wood harvested in deforestations, all harvested wood is allocated to forest management and that all forests in Polish are managed. The estimates include exports. As a result of the above procedure, the net emission estimates from the HWP pool in the FM category under the KP are only different from those under the UNFCCC in that while the latter includes harvested wood products produced from all harvests from all forests, the former excludes harvested wood products from the Deforestation category.

First, HWP from FM under the KP is treated together with HWP from AR, see Section 11.4.5. Second, an important specific methodological element of the estimation of carbon stock changes in the HWP pool under the KP is that, complying with Paragraph 16 of the Annex to Decision 2/CMP.7 and the methodological guidance of the IPCC 2013 KP Supplement (page 2.121), which is applicable in case the FMRL is based on a projection representing a 'business as usual scenario' (see Section 11.5.2.2), inherited emissions from before the start of the second commitment period are excluded from accounting.

As a consequence of the above, whereas losses from the HWP pool accounted for under the UNFCCC are partly from wood products that were produced prior to the second CP, losses from the HWP pool accounted for under the KP are only from wood products produced during the second CP. Recent estimates of carbon stock changes in the HWP pool under the KP using statistical data for inventory year 2015.

11.5.3. Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

As Poland did not elect either Cropland Management, nor Grazing Land Management, nor Wetland drainage and Rewetting, nor Revegetation, this is a non-issue.

11.6. Other information

11.6.1. Key category analysis for Article 3.3 activities, forest management and any elected activities under Article 3.4

In the national GHG inventory, the Tier 1 analysis (Level Assessment, including LULUCF), showed that the CO_2 removals from the category 4.A.1 *Forest Land remaining Forest Land* is a key category. Country specific data is used for this category, noting that reporting some C pools are still achieved according to Tier 1.

Significant changes regarding the two related estimates ("Forest Land remaining Forest Land" under the Convention tables and "Forest Management" activity under the KP) are not expected for the following years.

11.7. Information relating to Article 6

There are no Article 6 activities concerning the LULUCF sector in Poland.

12. Information on accounting of Kyoto units

12.1. Background information

The information on accounting of Kyoto units is provided as a part of greenhouse gas inventories of Poland. The following paragraphs present relevant data on holdings and transactions with Kyoto Protocol Units within the Polish registry. The Polish registry operates within the Consolidated System of European Union Registries (hereafter: CSEUR).

Information related to transactions, CDM notifications and accounting of Kyoto units are based on data derived from the consolidated Union Registry.

12.2. Summary of information reported in the SEF tables

In accordance with paragraph 11 of the annex I.E to Decision 15/ CMP.1 the Standard Electronic Format report for 2017 (hereafter: SEF) has been submitted in conjunction with this report (please refer to the files: RREG1_PL_2017_1_1.xlsx and RREG1_PL_2017_1_1.xml, RREG1_PL_2017_2_1.xlsx and RREG1_PL_2017_2_1.xml).

The SEF includes information regarding: total quantities of Kyoto Protocol units held on national accounts at the beginning and at the end of reported year, annual internal transactions and transaction between PPSR accounts, share of proceeds transactions under decision 1/CMP.8, paragraph 21 - Adaptation Fund, expiry, cancellation and replacement of CER units and summary information for the commitment period.

12.3. Discrepancies and notifications

In accordance with respective paragraphs of the annex I.E to Decision 15/CMP.1 relevant information is provided:

a) *paragraph 12: List of discrepant transactions*
   <u>No discrepant transactions occurred in 2017.</u>
b) *paragraph 13 & 14: List of CDM notifications*
   <u>No CDM notifications occurred in 2017.</u>
c) *paragraph 15: List of non-replacements*
   <u>No non-replacements occurred in 2017.</u>
d) *paragraph 16: List of invalid units*
   <u>No invalid units exist as at 31 December 2017.</u>
e) *paragraph 17: Actions and changes to address discrepancies*
   <u>No actions were taken or changes made to address discrepancies for the period under review.</u>

12.4. Publicly accessible information

The information that was made available to the public in accordance with section E in Part II of Annex to Decision 13 / CMP.1 is provided at http://www.kobize.pl/pl/article/rejestr-uprawnien/id/661/publicly-available-reports. It contains data regarding accounts, transactions and holdings, article 6 projects, transactions with Kyoto units and authorized legal entities information:

a) *paragraph 45: Account information*
   In this report following information were provided:
   - *paragraph 45 (a): Account name: the holder of the account*

- *paragraph 45 (b): Account type: the type of account (holding, cancellation or retirement)*
- *paragraph 45(c): Commitment period: the commitment period with which a cancellation or retirement account is associated*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART45.pdf)

In line with the data protection requirements of Regulation (EC) No 45/2001 and Directive 95/46/EC and in accordance with Article 110 and Annex XIV of Commission Regulation (EU) No 389/2013, the information on account identifier and account representatives held in the EUTL, the Union Registry and any other KP registry (required by paragraph 45) is considered confidential.

b) paragraph 46: Article 6 project information

- *paragraph 46 (a): Project name*
- *paragraph 46 (b): Project location - the Party and town or region in which the project is located*
- *paragraph 46 (c): Years of ERUs issuance as a result of the Article 6 project*
- *paragraph 46 (d): Reports - downloadable electronic version of all publicly available documentation relating to the project*

These information is available in the report - *Joint Implementation (JI) project information*
(reference: https://dokumenty.kobize.pl/projekty_ji/index.htm)

c) paragraph 47: Holding and transaction information

- *paragraph 47 (a): The total quantity of ERUs, CERs, AAUs and RMUs at the beginning of the year*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_a.pdf)

Information on the total quantity of ERUs, CERs, AAUs and RMUs held in each account is considered to be confidential (in accordance with article 110 (1) of Commission Regulation (EU) No 389/2013 of 2 May 2013). Therefore, the report details were limited to information related to subtotals per account type only.

- *paragraph 47 (b): The total quantity of AAUs issued on the basis of the assigned amount pursuant to Article 3*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_b_h_k.pdf)

- *paragraph 47 (c): The total quantity of ERUs issued on the basis of Article 6 projects*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_c_e_g_i_j.pdf)

- *paragraph 47 (d): The total quantity of ERUs, CERs, AAUs and RMUs acquired from other registries and the identity of the transferring registries*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_d_f.pdf)

Information on details of transactions carried out is considered to be confidential (in accordance with article 110 (1) of Commission Regulation (EU) No 389/2013 of 2 May 2013). Therefore, the transaction details were limited to transferring and/or acquiring registry ID only.

- *paragraph 47 (e): The total quantity of RMUs issued on the basis of each activity under Article 3*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_c_e_g_i_j.pdf)

- *paragraph 47 (f): The total quantity of ERUs, CERs, AAUs and RMUs transferred to other registries and the identity of the acquiring registries*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_d_f.pdf)

Information on details of transactions carried out is considered to be confidential (in accordance with article 110 (1) of Commission Regulation (EU) No 389/2013 of 2 May 2013). Therefore, the transaction details were limited to transferring and / or acquiring registry ID only.

- *paragraph 47 (g): The total quantity of ERUs, CERs, AAUs and RMUs cancelled on the basis of activities under Article 3*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_c_e_g_i_j.pdf)

- *paragraph 47 (h): The total quantity of ERUs, CERs, AAUs and RMUs cancelled following determination by the Compliance Committee that the Party is not in compliance with its commitment under Article 3*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_b_h_k.pdf)
- *paragraph 47 (i): The total quantity of other ERUs, CERs, AAUs and RMUs cancelled*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_c_e_g_i_j.pdf)
- *paragraph 47 (j): The total quantity of ERUs, CERs, AAUs and RMUs retired*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_c_e_g_i_j.pdf)
- *paragraph 47 (k): The total quantity of ERUs, CERs and AAUs carried over from the previous commitment period*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_b_h_k.pdf)
- *paragraph 47 (l): Current holdings of ERUs, CERs, AAUs and RMUs in each account*

(reference: https://dokumenty.kobize.pl/raporty/Public_ART47_l.pdf)

Information on the total quantity of ERUs, CERs, AAUs and RMUs held in each account is considered to be confidential (in accordance with article 110 (1) of Commission Regulation (EU) No 389/2013 of 2 May 2013). Therefore, the report details were limited to information related to subtotals per account type only.

d) paragraph 48: Authorized Legal Entities Information
(reference: https://dokumenty.kobize.pl/raporty/Public_ART48.pdf)

In line with the data protection requirements of Regulation (EC) No 45/2001 and Directive 95/46/EC and in accordance with Article 110 and Annex III of the Commission Regulation (EU) no 389/2013, the legal entity contact information (required by paragraph 48) is considered confidential.

12.5. Calculation of the commitment period reserve (CPR)

The recent value of commitment period reserve of Poland is **1 425 544 942 tCO_2 eq**. The calculation of Poland's CPR is contained in the Annex II of the "Report on the individual review of the annual submission of Poland submitted in 2015" (ref.: FCCC/ARR/2015/POL, http://unfccc.int/resource/docs /2016/arr/pol.pdf).

13. INFORMATION ON CHANGES IN NATIONAL SYSTEM

There were no changes in the national system for GHG inventories in Poland since the last NIR was issued.

14. INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of Poland have occurred in 2017:

a) *15/CMP.1 annex II, paragraph 32.(a): Change of name or contact*

No change in the name or contact information of the registry administrator occurred during the reported period.

b) *15/CMP.1 annex II, paragraph 32.(b): Change of cooperation arrangement*

No change of cooperation arrangement occurred during the reported period.

c) *15/CMP.1 annex II, paragraph 32.(c): Change to the database or the capacity of national registry*

Versions of the CSEUR released after 8.0.7 (the production version at the time of the last year submission) introduced minor changes in the structure of the database.

These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. The database model is provided in Annex 9 (please refer to CSEUR_entity relationship diagram).

No change to the capacity of the national registry occurred during the reported period.

d) *15/CMP.1 annex II, paragraph 32.(d): Change of conformance to technical standards*

Changes introduced since version 8.0.7 of the national registry are listed in Annex 9 (please refer to *Changes from EUCR v8.0.7-v8.0.8*).

Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (please refer to Annex 9 *Changes from EUCR v8.0.7-v8.0.8).*

No other change in the registry's conformance to the technical standards occurred for the reported period.

e) *15/CMP.1 annex II, paragraph 32.(e): Change of discrepancies procedures*

No change of discrepancies procedures occurred during the reported period.

f) *15/CMP.1 annex II, paragraph 32.(f): Change of Security*

No changes regarding security occurred during the reported period.

g) *15/CMP.1 annex II, paragraph 32.(g): Change of list of publicly available information*

No change to the list of publicly available information occurred during the reporting period.

h) *15/CMP.1 annex II, paragraph 32.(h): Change of Internet address*

No change of the registry internet address occurred during the reporting period.

i) *15/CMP.1 annex II, paragraph 32.(i): Change of data integrity measure*

No change of data integrity measures occurred during the reporting period.

j) 15/CMP.1 annex II, paragraph 32.(j): Change of test results

Changes introduced since version 8.0.7 of the national registry are listed in Annex 9. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission (please refer to Annex 9 *Changes from EUCR v8.0.7-v8.0.8*).

15. CHANGES IN INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3.14

According to chapter I.H of the annex to the decision 15/CMP.1 below Poland provides new information on how it is implementing its commitment under Article 3.14 of the Kyoto Protocol related to striving to implement its commitment under Article 3.1 of the Kyoto Protocol in such a way as to minimize potential adverse social, environmental and economic impacts on developing countries.

In 2016, the total amount of climate aid donated was more than PLN 23 million (€ 5.6 million) and included countries such as Ethiopia, Georgia, Indonesia, Iraq, Kenya, Moldova, Nigeria, Tanzania, the West Bank and the Gaza Strip. Approximately 20% of the climate aid provided by the bilateral channel concerned adaptation projects, 20% of activities related to emission reduction. The remaining part was devoted to the implementation of horizontal projects.

ABBREVIATIONS

AR	Afforestation/ Reforestation
AWMS	Animal waste management system
BEF	Biomass expansion factor (LULUCF)
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CRF	Common reporting format
D	Deforestation
DOC	Degradable organic component
DW	Dead wood
ERT	Expert Review Team
FM	Forest management
FMRL	Forest Management Reference Level
GHG	Greenhouse Gases
HWP	Harvested wood products
IE	Included elsewhere
KOBiZE	National Centre for Emissions Management
LT	Litter
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
SOC	Soil organic carbon
SWDS	Solid waste disposal site
TC	Technical correction

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ANNEX 1. KEY CATEGORIES IN 2016

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.

Additionally, qualitative method is used to indentify key categories.

Poland's key category analysis guides the inventory preparation and is used to set priorities for the development of more advanced methodologies.

The biggest contributors of the GHG emissions (without sector LULUCF) identified as key sources in level assessment analysis in 2016 are:

1.A.1 *Fuel combustion - Energy Industries - Solid Fuels*	CO_2
1.A.3.b *Road Transportation*	CO_2
1.A.4 *Other Sectors - Solid Fuels*	CO_2

Emission from abovementioned sources made up to 59.04% of the total GHG emissions in Poland expressed in units of CO_2 equivalents.

The biggest contributors of the GHG emissions in trend assessment (without sector LULUCF) in 2016 are categories:

1.A.3.b *Road Transportation*	CO_2
1.A.4 *Other Sectors - Solid Fuels*	CO_2
1.A.1 *Fuel combustion - Energy Industries - Solid Fuels*	CO_2

Share of these sources made up to 59.04% 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 2016

No.	IPCC Source Categories	GHG	Identification criteria (Level, Trend, Qualitative)			Comments
1	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	L	T		
2	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	L	T		
3	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CO_2		T		
4	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	L	T		
5	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	L	T		
6	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	L	T		
7	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO_2	L	T		
8	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	L	T		
9	1.A.3.b Road Transportation	CO_2	L	T		
10	1.A.3.c Railways	CO_2		T		
11	1.A.3.e Other Transportation	CO_2		T		
12	1.A.4 Other Sectors - Biomass	CH_4		T		
13	1.A.4 Other Sectors - Gaseous Fuels	CO_2	L	T		
14	1.A.4 Other Sectors - Liquid Fuels	CO_2	L	T		
15	1.A.4 Other Sectors - Solid Fuels	CO_2	L	T		
16	1.A.4 Other Sectors - Solid Fuels	CH_4	L	T		
17	1.B.1 Fugitive emissions from Solid Fuels	CH_4	L			
18	1.B.1 Fugitive emissions from Solid Fuels	CO_2	L			
19	1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH_4		T		
20	1.B.2.d Fugitive Emissions from Fuels - Other	CO_2	L	T		
21	2.A.1 Cement Production	CO_2	L	T		
22	2.A.2 Lime Production	CO_2		T		
23	2.A.4 Other Process Uses of Carbonates	CO_2	L	T		
24	2.B.1 Ammonia Production	CO_2	L	T		
25	2.B.2 Nitric Acid Production	N2O		T		
26	2.C.1 Iron and Steel Production	CO_2	L	T		
27	2.F.1 Refrigeration and Air conditioning	F-gases	L	T		
28	3.A Enteric Fermentation	CH_4	L	T		
29	3.B Manure Management	N_2O	L			
30	3.B Manure Management	CH_4	L			
31	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	L			
32	3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	L			
33	3.G Liming	CO_2		T		
34	4(III).Direct N2O emissions from N mineralization/immobilization	N_2O		T		
35	4.A.1 Forest Land Remaining Forest Land	CO_2	L	T		
36	4.A.2 Land Converted to Forest Land	CO_2	L	T		
37	4.C.2 Land Converted to Grassland	CO_2		T		
38	4.D.1.2 Flooded Land Remaining Flooded Land	CO_2	L	T		
39	4.E.2 Land Converted to Settlements	CO_2	L	T		
40	4.G Harvested Wood Products	CO_2	L	T		
41	5.A Solid Waste Disposal	CH_4	L	T		
42	5.D Wastewater Treatment and Discharge	CH_4		T		

Summary of key category analysis without sector LULUCF in 2016

No.	IPCC Source Categories	GHG	Identification criteria (Level, Trend, Qualitative)			Comments
1	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	L	T		
2	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	L	T		
3	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CO_2		T		
4	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	L	T		
5	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	L	T		
6	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	L	T		
7	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO_2	L	T		
8	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	L	T		
9	1.A.3.b Road Transportation	CO_2	L	T		
10	1.A.3.c Railways	CO_2		T		
11	1.A.3.e Other Transportation	CO_2		T		
12	1.A.4 Other Sectors - Biomass	CH_4		T		
13	1.A.4 Other Sectors - Gaseous Fuels	CO_2	L	T		
14	1.A.4 Other Sectors - Liquid Fuels	CO_2	L	T		
15	1.A.4 Other Sectors - Solid Fuels	CO_2	L	T		
16	1.A.4 Other Sectors - Solid Fuels	CH_4	L	T		
17	1.B.1 Fugitive emissions from Solid Fuels	CH_4	L			
18	1.B.1 Fugitive emissions from Solid Fuels	CO_2	L			
19	1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH_4		T		
20	1.B.2.d Fugitive Emissions from Fuels - Other	CO_2	L	T		
21	2.A.1 Cement Production	CO_2	L	T		
22	2.A.2 Lime Production	CO_2		T		
23	2.A.4 Other Process Uses of Carbonates	CO_2	L	T		
24	2.B.1 Ammonia Production	CO_2	L	T		
25	2.B.2 Nitric Acid Production	N_2O		T		
26	2.C.1 Iron and Steel Production	CO_2	L	T		
27	2.F.1 Refrigeration and Air conditioning	F-gases	L	T		
28	3.A Enteric Fermentation	CH_4	L	T		
29	3.B Manure Management	N_2O	L			
30	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	L	T		
31	3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	L			
32	3.G Liming	CO_2		T		
33	5.A Solid Waste Disposal	CH_4	L	T		
34	5.D Wastewater Treatment and Discharge	CH_4		T		

Summary of key category analysis with sector LULUCF in 1988

No.	IPCC Source Categories	GHG	Identification criteria (Level, Trend, Qualitative)			Comments
1	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	L			
2	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	L			
3	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	L			
4	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	L			
5	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	L			
6	1.A.3.b Road Transportation	CO_2	L			
7	1.A.4 Other Sectors - Gaseous Fuels	CO_2	L			
8	1.A.4 Other Sectors - Liquid Fuels	CO_2	L			
9	1.A.4 Other Sectors - Solid Fuels	CO_2	L			
10	1.A.4 Other Sectors - Solid Fuels	CH_4	L			
11	1.B.1 Fugitive emissions from Solid Fuels	CH_4	L			
12	1.B.1 Fugitive emissions from Solid Fuels	CO_2	L			
13	2.A.1 Cement Production	CO_2	L			
14	2.A.2 Lime Production	CO_2	L			
15	2.B.1 Ammonia Production	CO_2	L			
16	2.B.2 Nitric Acid Production	N_2O	L			
17	2.C.1 Iron and Steel Production	CO_2	L			
18	3.A Enteric Fermentation	CH_4	L			
19	3.B Manure Management	N_2O	L			
20	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	L			
21	3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	L			
22	4.A.1 Forest Land Remaining Forest Land	CO_2	L			
23	4.D.1.2 Flooded Land Remaining Flooded Land	CO_2	L			
24	5.A Solid Waste Disposal	CH_4	L			
25	5.D Wastewater Treatment and Discharge	CH_4	L			

Summary of key category analysis without sector LULUCF in 1988

No.	IPCC Source Categories	GHG	Identification criteria (Level, Trend, Qualitative)			Comments
1	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	L			
2	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	L			
3	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	L			
4	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	L			
5	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	L			
6	1.A.3.b Road Transportation	CO_2	L			
7	1.A.4 Other Sectors - Gaseous Fuels	CO_2	L			
8	1.A.4 Other Sectors - Liquid Fuels	CO_2	L			
9	1.A.4 Other Sectors - Solid Fuels	CO_2	L			
10	1.A.4 Other Sectors - Solid Fuels	CH_4	L			
11	1.B.1 Fugitive emissions from Solid Fuels	CH_4	L			
12	2.A.1 Cement Production	CO_2	L			
13	2.A.2 Lime Production	CO_2	L			
14	2.B.1 Ammonia Production	CO_2	L			
15	2.B.2 Nitric Acid Production	N_2O	L			
16	2.C.1 Iron and Steel Production	CO_2	L			
17	3.A Enteric Fermentation	CH_4	L			
18	3.B Manure Management	N_2O	L			
19	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	L			
20	3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	L			
21	5.A Solid Waste Disposal	CH_4	L			
22	5.D Wastewater Treatment and Discharge	CH_4	L			

Level assessment without sector LULUCF in 2016

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	GHG	Level Assessment	Cumulative Total
1	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	0.380	0.380
2	1.A.3.b Road Transportation	CO_2	0.128	0.508
3	1.A.4 Other Sectors - Solid Fuels	CO_2	0.082	0.590
4	1.B.1 Fugitive emissions from Solid Fuels	CH_4	0.043	0.633
5	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	0.038	0.671
6	1.A.4 Other Sectors - Gaseous Fuels	CO_2	0.032	0.703
7	3.A Enteric Fermentation	CH_4	0.031	0.734
8	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	0.027	0.761
9	5.A Solid Waste Disposal	CH_4	0.023	0.783
10	1.A.4 Other Sectors - Liquid Fuels	CO_2	0.022	0.806
11	2.F.1 Refrigeration and Air conditioning	F-gases	0.021	0.827
12	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	0.020	0.847
13	2.A.1 Cement Production	CO_2	0.016	0.863
14	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	0.016	0.880
15	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	0.011	0.891
16	2.B.1 Ammonia Production	CO_2	0.010	0.901
17	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO_2	0.008	0.909
18	3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	0.006	0.915
19	1.A.4 Other Sectors - Solid Fuels	CH_4	0.006	0.921
20	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	0.006	0.927
21	1.B.1 Fugitive emissions from Solid Fuels	CO_2	0.005	0.932
22	2.C.1 Iron and Steel Production	CO_2	0.005	0.937
23	3.B Manure Management	N_2O	0.005	0.942
24	2.A.4 Other Process Uses of Carbonates	CO_2	0.005	0.947
25	1.B.2.d Fugitive Emissions from Fuels - Other	CO_2	0.004	0.952

Level assessment without sector LULUCF in 1988

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	GHG	Level Assessment	Cumulative Total
1	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	0.430	0.430
2	1.A.4 Other Sectors - Solid Fuels	CO_2	0.159	0.589
3	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	0.070	0.659
4	1.B.1 Fugitive emissions from Solid Fuels	CH_4	0.042	0.701
5	3.A Enteric Fermentation	CH_4	0.038	0.739
6	1.A.3.b Road Transportation	CO_2	0.036	0.775
7	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	0.025	0.800
8	5.A Solid Waste Disposal	CH_4	0.021	0.821
9	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	0.014	0.835
10	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	0.013	0.848
11	2.A.1 Cement Production	CO_2	0.012	0.860
12	2.C.1 Iron and Steel Production	CO_2	0.012	0.873
13	1.A.4 Other Sectors - Gaseous Fuels	CO_2	0.011	0.884
14	1.A.4 Other Sectors - Liquid Fuels	CO_2	0.009	0.893
15	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	0.009	0.902
16	1.A.4 Other Sectors - Solid Fuels	CH_4	0.009	0.910
17	2.B.2 Nitric Acid Production	N_2O	0.007	0.918
18	5.D Wastewater Treatment and Discharge	CH_4	0.007	0.925
19	2.B.1 Ammonia Production	CO_2	0.007	0.932
20	3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	0.006	0.938
21	2.A.2 Lime Production	CO_2	0.006	0.944
22	3.B Manure Management	N_2O	0.005	0.950

Level assessment with sector LULUCF in 2016

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	GHG	Level Assessment	Cumulative Total
1	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	0.332	0.332
2	1.A.3.b Road Transportation	CO_2	0.112	0.445
3	4.A.1 Forest Land Remaining Forest Land	CO_2	0.075	0.520
4	1.A.4 Other Sectors - Solid Fuels	CO_2	0.072	0.592
5	1.B.1 Fugitive emissions from Solid Fuels	CH_4	0.037	0.629
6	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	0.034	0.662
7	1.A.4 Other Sectors - Gaseous Fuels	CO_2	0.028	0.690
8	3.A Enteric Fermentation	CH_4	0.027	0.717
9	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	0.023	0.741
10	5.A Solid Waste Disposal	CH_4	0.020	0.760
11	1.A.4 Other Sectors - Liquid Fuels	CO_2	0.020	0.780
12	2.F.1 Refrigeration and Air conditioning	F-gases	0.019	0.799
13	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	0.018	0.816
14	4.E.2 Land Converted to Settlements	CO_2	0.017	0.833
15	2.A.1 Cement Production	CO_2	0.014	0.847
16	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	0.014	0.861
17	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	0.010	0.871
18	4.D.1.2 Flooded Land Remaining Flooded Land	CO_2	0.010	0.881
19	4.G Harvested Wood Products	CO_2	0.009	0.890
20	2.B.1 Ammonia Production	CO_2	0.008	0.899
21	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO_2	0.007	0.906
22	3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	0.006	0.912
23	4.A.2 Land Converted to Forest Land	CO_2	0.006	0.917
24	1.A.4 Other Sectors - Solid Fuels	CH_4	0.005	0.923
25	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	0.005	0.927
26	1.B.1 Fugitive emissions from Solid Fuels	CO_2	0.005	0.932
27	2.C.1 Iron and Steel Production	CO_2	0.004	0.936
28	3.B Manure Management	N_2O	0.004	0.941
29	2.A.4 Other Process Uses of Carbonates	CO_2	0.004	0.945
30	1.B.2.d Fugitive Emissions from Fuels - Other	CO_2	0.004	0.949
31	3.B Manure Management	CH_4	0.003	0.953

Level assessment with sector LULUCF in 1988

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	GHG	Level Assessment	Cumulative Total
1	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	0.408	0.408
2	1.A.4 Other Sectors - Solid Fuels	CO_2	0.151	0.560
3	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	0.066	0.626
4	1.B.1 Fugitive emissions from Solid Fuels	CH_4	0.040	0.665
5	3.A Enteric Fermentation	CH_4	0.036	0.702
6	4.A.1 Forest Land Remaining Forest Land	CO_2	0.036	0.738
7	1.A.3.b Road Transportation	CO_2	0.034	0.772
8	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	0.024	0.796
9	5.A Solid Waste Disposal	CH_4	0.020	0.815
10	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	0.013	0.828
11	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	0.013	0.841
12	2.A.1 Cement Production	CO_2	0.012	0.853
13	2.C.1 Iron and Steel Production	CO_2	0.012	0.864
14	1.A.4 Other Sectors - Gaseous Fuels	CO_2	0.011	0.875
15	1.A.4 Other Sectors - Liquid Fuels	CO_2	0.009	0.884
16	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	0.008	0.892
17	1.A.4 Other Sectors - Solid Fuels	CH_4	0.008	0.900
18	4.D.1.2 Flooded Land Remaining Flooded Land	CO_2	0.007	0.908
19	2.B.2 Nitric Acid Production	N_2O	0.007	0.915
20	5.D Wastewater Treatment and Discharge	CH_4	0.007	0.922
21	2.B.1 Ammonia Production	CO_2	0.007	0.928
22	3.D.2 Indirect N_2O Emissions From Managed Soils	N_2O	0.006	0.934
23	2.A.2 Lime Production	CO_2	0.006	0.940
24	3.B Manure Management	N_2O	0.005	0.945
25	1.B.1 Fugitive emissions from Solid Fuels	CO_2	0.005	0.950

Trend assessment without sector LULUCF in 2016

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	GHG	Trend Assessment	Cumulative Total
1	1.A.3.b Road Transportation	CO_2	0.133	0.223
2	1.A.4 Other Sectors - Solid Fuels	CO_2	0.111	0.410
3	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	0.072	0.531
4	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	0.045	0.606
5	2.F.1 Refrigeration and Air conditioning	F-gases	0.031	0.658
6	1.A.4 Other Sectors - Gaseous Fuels	CO_2	0.030	0.707
7	1.A.4 Other Sectors - Liquid Fuels	CO_2	0.019	0.739
8	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	0.018	0.769
9	3.A Enteric Fermentation	CH_4	0.011	0.787
10	2.C.1 Iron and Steel Production	CO_2	0.010	0.805
11	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	0.009	0.820
12	5.D Wastewater Treatment and Discharge	CH_4	0.009	0.834
13	2.B.2 Nitric Acid Production	N_2O	0.008	0.849
14	1.B.2.d Fugitive Emissions from Fuels - Other	CO_2	0.006	0.859
15	1.A.3.c Railways	CO_2	0.006	0.870
16	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO_2	0.006	0.880
17	2.A.1 Cement Production	CO_2	0.006	0.889
18	2.A.4 Other Process Uses of Carbonates	CO_2	0.005	0.898
19	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	0.004	0.905
20	1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH_4	0.004	0.912
21	2.B.1 Ammonia Production	CO_2	0.004	0.918
22	1.A.4 Other Sectors - Solid Fuels	CH_4	0.004	0.924
23	2.A.2 Lime Production	CO_2	0.004	0.930
24	1.A.4 Other Sectors - Biomass	CH_4	0.003	0.936
25	1.A.3.e Other Transportation	CO_2	0.003	0.941
26	5.A Solid Waste Disposal	CH_4	0.003	0.945
27	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	0.003	0.950
28	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CO_2	0.003	0.955
29	3.G Liming	CO_2	0.003	0.959
30	3.D.1 Direct N_2O Emissions From Managed Soils	N_2O	0.002	0.962

Trend assessment with sector LULUCF in 2016

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	GHG	Trend Assessment	Cumulative Total
1	1.A.3.b Road Transportation	CO_2	0.112	0.175
2	1.A.4 Other Sectors - Solid Fuels	CO_2	0.100	0.333
3	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO_2	0.076	0.452
4	4.A.1 Forest Land Remaining Forest Land	CO_2	0.057	0.542
5	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO_2	0.041	0.606
6	2.F.1 Refrigeration and Air conditioning	F-gases	0.026	0.646
7	1.A.4 Other Sectors - Gaseous Fuels	CO_2	0.025	0.685
8	4.E.2 Land Converted to Settlements	CO_2	0.022	0.719
9	1.A.4 Other Sectors - Liquid Fuels	CO_2	0.016	0.744
10	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO_2	0.015	0.768
11	3.A Enteric Fermentation	CH_4	0.011	0.784
12	4.G Harvested Wood Products	CO_2	0.010	0.801
13	2.C.1 Iron and Steel Production	CO_2	0.009	0.815
14	4.A.2 Land Converted to Forest Land	CO_2	0.008	0.827
15	5.D Wastewater Treatment and Discharge	CH_4	0.008	0.839
16	2.B.2 Nitric Acid Production	N_2O	0.007	0.850
17	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO_2	0.007	0.862
18	1.B.2.d Fugitive Emissions from Fuels - Other	CO_2	0.005	0.870
19	1.A.3.c Railways	CO_2	0.005	0.879
20	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO_2	0.005	0.887
21	2.A.1 Cement Production	CO_2	0.004	0.894
22	2.A.4 Other Process Uses of Carbonates	CO_2	0.004	0.900
23	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO_2	0.004	0.906
24	4.D.1.2 Flooded Land Remaining Flooded Land	CO_2	0.004	0.912
25	4.C.2 Land Converted to Grassland	CO_2	0.003	0.918
26	1.A.4 Other Sectors - Solid Fuels	CH_4	0.003	0.923
27	4(III) Direct N_2O emissions from N mineralization/immobilization	N_2O	0.003	0.928
28	1.B.2.c Fugitive Emissions from Fuels - Venting and flaring	CH_4	0.003	0.934
29	2.A.2 Lime Production	CO_2	0.003	0.939
30	2.B.1 Ammonia Production	CO_2	0.003	0.943
31	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO_2	0.003	0.948
32	1.A.4 Other Sectors - Biomass	CH_4	0.003	0.952
33	1.A.3.e Other Transportation	CO_2	0.003	0.956
34	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CO_2	0.002	0.960
35	3.G Liming	CO_2	0.002	0.964
36	5.A Solid Waste Disposal	CH_4	0.002	0.966

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	1125.171	1109.523	1163.381	1148.642	1060.617	1033.585
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	53.627	57.099	52.877	49.691	51.163	51.652
Fuel wood and wood waste	3.398	3.461	4.886	4.809	5.799	8.913	17.228	20.583	25.111	37.976	54.823
Biogas	0.349	0.443	0.563	0.615	0.843	0.526	0.561	0.944	1.158	2.025	2.199
Industrial wastes	0.575	0.883	1.031	1.520	0.372	0.459	0.541	0.477	0.440	0.209	0.314
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	0.000
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	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	9.960	8.120	8.040	7.320	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	12.491	11.523	14.540	16.024	16.765	13.112
Blast furnace gas	3.286	4.317	4.976	4.783	5.715	7.053	4.489	8.677	6.395	10.204	7.730
Gas works gas	2.507	2.390	2.338	3.109	2.592	3.694	4.806	4.876	4.463	4.502	4.828
Fuels											
Liquid fuels	18.538	15.837	16.923	15.701	14.154	11.505	9.321	9.199	8.050	8.215	7.632
Gaseous fuels	16.210	21.627	28.242	38.700	45.496	53.627	57.099	52.877	49.691	51.163	51.652
Solid fuels	1671.753	1648.958	1665.608	1611.570	1690.270	1663.282	1664.662	1717.463	1676.806	1613.352	1553.359
Other fuels	0.575	0.883	1.031	1.520	0.372	0.459	0.541	0.477	0.440	0.593	0.682
Biomass	3.747	3.904	5.449	5.424	6.642	9.439	17.789	21.527	26.269	40.001	57.022
Total	**1710.823**	**1691.209**	**1717.253**	**1672.915**	**1756.934**	**1738.312**	**1749.412**	**1801.543**	**1761.256**	**1713.324**	**1670.347**

Table 1. (cont.) Fuel consumption [PJ] in 1.A.1.a category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	1095.945	1054.878	990.212	993.766	920.138	927.882	949.036
Lignite	477.467	517.018	527.314	539.685	513.429	508.002	484.904
Hard coal briquettes (patent fuels)	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	0.002
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	52.286	57.961	61.963	53.395	52.017	60.426	70.592
Fuel wood and wood waste	65.114	78.589	105.585	87.694	96.989	95.657	74.057
Biogas	2.778	3.328	4.219	4.887	5.732	6.314	7.231
Industrial wastes	0.442	0.458	0.420	0.381	0.470	0.693	0.544
Municipal waste - non-biogenic fraction	0.367	0.403	0.371	0.337	0.343	0.859	3.615
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.016	0.009	0.330
Other petroleum products	0.060	0.000	0.031	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	0.057	0.028	0.028	0.028	0.028	0.000	0.001
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	0.006
Motor gasoline	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
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	0.866	1.040	0.823	0.909	0.866	1.204	1.200
Fuel oil	7.360	7.000	6.320	5.560	4.600	4.720	5.570
Feedstocks	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
Coke oven gas	18.611	16.640	15.993	17.867	17.789	20.883	22.820
Blast furnace gas	9.954	11.001	11.328	11.729	13.937	16.242	14.630
Gas works gas	5.072	5.357	5.202	5.307	5.069	4.723	3.511
Fuels							
Liquid fuels	8.286	8.040	7.174	6.469	5.466	5.924	6.776
Gaseous fuels	52.286	57.961	61.963	53.395	52.017	60.426	70.592
Solid fuels	1607.106	1604.922	1550.077	1568.382	1470.390	1477.732	1474.904
Other fuels	0.809	0.861	0.791	0.718	0.813	1.552	4.159
Biomass	67.892	81.917	109.804	92.581	102.737	101.980	81.618
Total	**1736.379**	**1753.701**	**1729.809**	**1721.545**	**1631.423**	**1647.614**	**1638.049**

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	0.113
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	15.535	14.482	14.900	20.816	18.816	17.511
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	0.986
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	43.000	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	55.979	53.915	55.858	61.194	62.085	60.608
Gaseous fuels	10.832	12.110	11.354	10.124	12.770	15.535	14.482	14.900	20.816	18.816	17.511
Solid fuels	0.637	0.277	0.140	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.113
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**	**71.735**	**68.682**	**70.982**	**82.010**	**80.901**	**78.232**

Table 2. (cont.) Fuel consumption [PJ] in 1.A.1.b category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	0.114	0.114	0.091	0.113	0.158	0.916	0.802
Lignite	0.000	0.050	0.022	0.063	0.023	0.011	0.000
Hard coal briquettes (patent fuels)	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
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	19.363	27.468	30.638	34.779	35.103	25.957	25.802
Fuel wood and wood waste	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
Industrial wastes	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Municipal waste - non-biogenic fraction	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
Other petroleum products	0.450	0.660	1.271	0.992	0.960	0.785	1.223
Petroleum coke	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
Liquid petroleum gas (LPG)	0.000	0.092	0.092	0.092	0.138	0.644	0.843
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.009
Aviation gasoline	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
Diesel oil	0.130	0.173	0.130	0.043	0.087	0.172	0.012
Fuel oil	46.560	39.280	31.400	22.200	21.640	33.760	32.568
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	22.869	21.532	28.215	20.988	15.444	18.909	21.819
Coke oven gas	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
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels							
Liquid fuels	70.009	61.737	61.108	44.315	38.269	54.270	56.475
Gaseous fuels	19.363	27.468	30.638	34.779	35.103	25.957	25.802
Solid fuels	0.114	0.164	0.113	0.176	0.181	0.927	0.802
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total	**89.486**	**89.369**	**91.859**	**79.270**	**73.553**	**81.154**	**83.081**

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	3.560	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	4.200	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**	**123.966**	**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	18.341	15.099	11.974	19.965	14.265	9.458
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	40.940	35.719	40.126	43.722	44.789	32.527
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	59.914	51.066	52.353	65.137	61.482	42.905
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**	**72.565**	**62.876**	**64.155**	**76.392**	**72.203**	**53.531**

Table 3. (cont.) Fuel consumption [PJ] in 1.A.1.c category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	2.221	4.534	2.482	2.184	2.473	2.810	3.537
Lignite	1.442	1.666	0.728	0.221	0.283	0.102	0.063
Hard coal briquettes (patent fuels)	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
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	10.321	9.805	11.205	12.013	12.788	24.089	17.805
Fuel wood and wood waste	0.349	0.162	0.160	0.122	0.039	0.000	0.026
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.022
Industrial wastes	0.002	0.010	0.001	0.002	0.002	0.002	0.003
Municipal waste - non-biogenic fraction	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
Other petroleum products	0.030	0.060	0.062	0.032	0.000	0.000	0.020
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	0.000	0.057	0.000	0.000	0.000	0.000	0.001
Liquid petroleum gas (LPG)	0.000	0.000	0.000	0.000	0.000	0.000	0.003
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.040
Aviation gasoline	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	0.001
Diesel oil	1.645	2.079	1.472	1.819	1.429	1.892	1.354
Fuel oil	0.080	0.040	0.040	0.040	0.000	0.000	0.027
Feedstocks	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
Coke oven gas	43.667	41.153	38.653	40.220	40.298	42.385	40.631
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.012	0.009	0.012	0.008	0.001	0.000	0.000
Fuels							
Liquid fuels	1.755	2.179	1.574	1.891	1.429	1.892	1.445
Gaseous fuels	10.321	9.805	11.205	12.013	12.788	24.089	17.805
Solid fuels	47.342	47.419	41.875	42.633	43.055	45.297	44.233
Other fuels	0.002	0.010	0.001	0.002	0.002	0.002	0.003
Biomass	0.349	0.162	0.160	0.122	0.039	0.000	0.047
Total	**59.769**	**59.575**	**54.815**	**56.661**	**57.313**	**71.280**	**63.534**

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	9.076	19.909	22.910	28.028	34.566	28.031	25.180	29.632	24.400
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	74.910	72.626	73.599	85.080	96.976	118.715	112.791	113.712	99.754
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**	**143.012**	**121.285**	**112.116**	**119.553**	**129.752**	**148.712**	**141.054**	**147.318**	**125.653**

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	16.840	10.744	9.071	11.747	3.950	4.784
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	19.964	20.455	20.998	22.716	20.397	16.595
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	21.724	22.144	17.650	20.776	22.147	22.831	15.847	12.684	4.874	5.613	2.679
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	0.087
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	15.302	12.570	12.835	13.885	9.850	5.296
Blast furnace gas	24.034	31.874	26.768	23.876	25.282	26.721	18.896	20.226	28.194	18.347	9.873
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	0.133
Gaseous fuels	21.440	22.024	18.328	15.463	14.827	19.964	20.455	20.998	22.716	20.397	16.595
Solid fuels	80.715	89.854	76.419	72.933	77.378	83.348	59.022	55.860	60.013	38.753	23.106
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	**104.348**	**113.620**	**95.749**	**88.758**	**92.522**	**103.583**	**79.565**	**76.988**	**82.816**	**59.283**	**39.835**

Table 4. (cont.) Fuel consumption [PJ] in 1.A.2.a category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	2.635	2.545	2.299	1.972	2.448	0.756	0.688
Lignite	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	0.000	0.000	0.000	0.000
Brown coal briquettes	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
Natural gas	16.916	17.209	16.905	16.242	16.096	16.701	19.459
Fuel wood and wood waste	0.000	0.000	0.000	0.001	0.001	0.001	0.001
Biogas	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
Municipal waste - non-biogenic fraction	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
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	0.000	0.032	0.064	0.032	0.064	0.064	0.053
Coke	3.050	8.062	9.636	10.601	9.687	11.260	8.531
Liquid petroleum gas (LPG)	0.046	0.046	0.092	0.046	0.046	0.046	0.051
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Aviation gasoline	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
Diesel oil	0.087	0.087	0.043	0.043	0.087	0.086	0.115
Fuel oil	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
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	8.378	8.420	8.230	8.518	9.014	5.555	4.360
Blast furnace gas	12.059	11.258	11.352	10.797	11.863	10.228	10.528
Gas works gas	0.187	0.203	0.047	0.028	0.099	0.770	0.607
Fuels							
Liquid fuels	0.133	0.165	0.199	0.121	0.197	0.196	0.222
Gaseous fuels	16.916	17.209	16.905	16.242	16.096	16.701	19.459
Solid fuels	26.309	30.489	31.593	31.916	33.112	28.569	24.716
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.000	0.000	0.000	0.001	0.001	0.001	0.001
Total	**43.358**	**47.863**	**48.697**	**48.280**	**49.406**	**45.467**	**44.397**

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	6.402	6.464	6.880	6.740	6.537	5.846
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	1.763	0.961	0.951	0.949	1.220	1.086
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	6.402	6.464	6.880	6.740	6.537	5.846
Solid fuels	11.115	11.446	12.497	11.455	10.582	8.811	6.799	7.017	7.960	7.860	7.356
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**	**15.871**	**13.881**	**14.515**	**15.078**	**14.775**	**13.581**

Table 5. (cont.) Fuel consumption [PJ] in 1.A.2.b category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	0.000	0.250	0.114	0.113	0.091	0.023	0.061
Lignite	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
Brown coal briquettes	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
Natural gas	6.039	6.670	6.890	6.703	6.950	7.225	7.226
Fuel wood and wood waste	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
Industrial wastes	0.001	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
Municipal waste – biogenic fraction	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
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	6.042	6.214	6.384	6.270	6.469	6.840	5.236
Liquid petroleum gas (LPG)	0.046	0.046	0.000	0.000	0.000	0.000	0.023
Motor gasoline	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
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Diesel oil	0.216	0.173	0.173	0.173	0.173	0.129	0.163
Fuel oil	0.120	0.120	0.120	0.120	0.080	0.120	0.241
Feedstocks	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
Coke oven gas	0.000	0.039	0.043	0.039	0.051	0.047	0.053
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.960	0.967	0.928	1.066	1.275	1.316	1.202
Fuels							
Liquid fuels	0.382	0.339	0.293	0.293	0.253	0.249	0.428
Gaseous fuels	6.039	6.670	6.890	6.703	6.950	7.225	7.226
Solid fuels	7.002	7.470	7.469	7.488	7.886	8.226	6.553
Other fuels	0.001	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
Total	**13.424**	**14.479**	**14.652**	**14.484**	**15.089**	**15.700**	**14.207**

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	26.665	27.446	25.398	26.780	43.781	42.011
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	7.494	8.061	9.009	8.754	7.950	9.707
Fuel wood and wood waste	0.000	0.000	0.000	0.001	0.153	0.094	0.153	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	1.070	0.570	0.671	0.707	0.509	0.584
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	7.280	3.880	3.840	3.560	0.640	1.080
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	33.608	25.961	29.290	29.765	23.485	26.741
Gaseous fuels	9.041	9.464	8.481	7.199	6.457	7.494	8.061	9.009	8.754	7.950	9.707
Solid fuels	52.421	51.772	50.353	47.485	30.174	29.171	29.514	28.909	29.376	45.603	43.378
Other fuels	0.582	0.607	0.618	0.567	0.875	1.070	0.570	0.671	0.707	0.509	0.584
Biomass	0.000	0.000	0.000	0.001	0.153	0.094	0.153	0.000	0.121	0.000	0.058
Total	**101.176**	**100.187**	**92.596**	**88.159**	**71.142**	**71.437**	**64.259**	**67.879**	**68.723**	**77.547**	**80.468**

Table 6. (cont.) Fuel consumption [PJ] in 1.A.2.c category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	47.304	47.704	46.768	47.308	46.501	42.588	41.332
Lignite	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	0.001
Brown coal briquettes	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
Natural gas	11.807	13.887	13.568	14.696	14.500	14.860	12.068
Fuel wood and wood waste	0.058	0.053	0.131	0.050	0.103	0.088	0.138
Biogas	0.000	0.000	0.000	0.000	0.008	0.006	0.006
Industrial wastes	0.770	0.732	0.581	1.092	1.082	0.936	0.652
Municipal waste - non-biogenic fraction	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
Other petroleum products	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
Coke	0.826	1.340	3.164	3.021	2.992	3.164	3.457
Liquid petroleum gas (LPG)	0.138	0.138	0.138	0.184	0.138	0.230	5.020
Motor gasoline	0.000	0.045	0.045	0.045	0.000	0.000	0.009
Aviation gasoline	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
Diesel oil	4.200	3.637	3.334	4.027	2.468	2.279	1.482
Fuel oil	0.600	0.720	0.560	0.440	0.400	0.560	0.409
Feedstocks	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Refinery gas	17.176	12.276	9.702	11.979	10.296	7.425	8.015
Coke oven gas	0.627	0.616	0.595	0.639	0.645	0.624	0.598
Blast furnace gas	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
Fuels							
Liquid fuels	22.114	16.816	13.779	16.675	13.302	10.494	14.934
Gaseous fuels	11.807	13.887	13.568	14.696	14.500	14.860	12.068
Solid fuels	48.757	49.660	50.527	50.968	50.138	46.376	45.388
Other fuels	0.770	0.732	0.581	1.092	1.082	0.936	0.652
Biomass	0.058	0.053	0.131	0.050	0.111	0.094	0.144
Total	**83.506**	**81.148**	**78.586**	**83.481**	**79.133**	**72.760**	**73.187**

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	4.972
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	4.972
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**	**34.671**

Table 7. (cont.) Fuel consumption [PJ] in 1.A.2.d category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	10.086	11.301	10.643	11.460	11.291	10.922	9.790
Lignite	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
Brown coal briquettes	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
Natural gas	5.134	4.587	5.535	6.271	6.994	7.166	7.991
Fuel wood and wood waste	19.581	19.402	20.358	27.152	26.987	27.070	30.415
Biogas	0.049	0.073	0.083	0.091	0.105	0.086	0.111
Industrial wastes	0.000	0.000	0.000	0.037	0.125	0.108	0.190
Municipal waste - non-biogenic fraction	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
Other petroleum products	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
Coke	0.028	0.000	0.000	0.000	0.000	0.000	0.000
Liquid petroleum gas (LPG)	0.092	0.092	0.092	0.092	0.092	0.092	0.109
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.015
Aviation gasoline	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
Diesel oil	0.260	0.216	0.173	0.260	0.173	0.258	0.473
Fuel oil	1.640	1.680	1.520	1.520	1.280	1.480	1.323
Feedstocks	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
Coke oven gas	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
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels							
Liquid fuels	1.992	1.988	1.785	1.872	1.545	1.830	1.921
Gaseous fuels	5.134	4.587	5.535	6.271	6.994	7.166	7.991
Solid fuels	10.114	11.301	10.643	11.460	11.291	10.922	9.790
Other fuels	0.000	0.000	0.000	0.037	0.125	0.108	0.190
Biomass	19.630	19.475	20.441	27.243	27.092	27.156	30.526
Total	**36.870**	**37.351**	**38.404**	**46.883**	**47.047**	**47.182**	**50.417**

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	2014	2015	2016
Hard coal	25.903	25.614	26.172	24.724	24.428	22.011	23.220
Lignite	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
Brown coal briquettes	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
Natural gas	21.610	22.128	23.704	24.475	25.094	26.008	27.589
Fuel wood and wood waste	0.441	0.534	0.436	0.664	0.747	1.134	1.383
Biogas	0.101	0.145	0.199	0.202	0.350	0.345	0.407
Industrial wastes	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
Municipal waste – biogenic fraction	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
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	0.627	0.542	0.314	0.370	0.456	0.627	0.649
Liquid petroleum gas (LPG)	0.828	0.782	0.690	0.828	0.966	0.966	1.124
Motor gasoline	0.045	0.000	0.000	0.000	0.000	0.000	0.025
Aviation gasoline	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	0.001
Diesel oil	2.901	2.382	2.944	1.992	1.516	1.290	1.389
Fuel oil	1.240	1.360	1.360	1.080	1.000	0.600	0.739
Feedstocks	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
Coke oven gas	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
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels							
Liquid fuels	5.014	4.524	4.994	3.900	3.482	2.856	3.279
Gaseous fuels	21.610	22.128	23.704	24.475	25.094	26.008	27.589
Solid fuels	26.530	26.156	26.486	25.094	24.884	22.638	23.869
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	0.542	0.679	0.635	0.866	1.097	1.479	1.790
Total	**53.696**	**53.487**	**55.819**	**54.335**	**54.557**	**52.981**	**56.527**

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	32.309	31.182	31.523	43.846	36.975	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	38.225	38.955	41.274	42.465	39.696	41.394
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	38.225	38.955	41.274	42.465	39.696	41.394
Solid fuels	69.195	60.767	46.906	39.208	35.992	38.528	35.186	36.078	50.003	41.280	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**	**91.001**	**91.883**	**92.874**	**106.177**	**95.086**	**91.033**

Table 9. (cont.) Fuel consumption [PJ] in 1.A.2.f category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	28.045	34.403	26.766	22.808	23.013	20.539	21.780
Lignite	0.224	0.283	0.549	0.347	0.487	0.545	0.526
Hard coal briquettes (patent fuels)	0.000	0.000	0.000	0.000	0.000	0.000	0.009
Brown coal briquettes	0.000	0.000	0.000	0.180	0.000	0.000	0.000
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	42.872	44.492	42.349	40.911	40.873	40.514	43.984
Fuel wood and wood waste	0.299	0.348	0.407	0.498	0.724	0.623	0.511
Biogas	0.000	0.000	0.000	0.004	0.044	0.040	0.038
Industrial wastes	10.454	11.729	12.170	12.763	15.171	15.068	17.249
Municipal waste - non-biogenic fraction	4.512	5.017	3.913	3.752	4.060	4.011	8.179
Municipal waste – biogenic fraction	0.123	1.338	1.360	1.391	1.528	1.664	2.094
Other petroleum products	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Petroleum coke	1.792	0.064	0.064	0.160	0.032	0.000	0.933
Coke	2.536	2.679	2.508	2.366	2.508	3.164	2.754
Liquid petroleum gas (LPG)	0.414	0.368	0.230	0.322	0.414	0.368	0.321
Motor gasoline	0.000	0.000	0.000	0.000	0.000	0.043	0.040
Aviation gasoline	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
Diesel oil	1.992	2.338	1.862	1.472	1.299	1.290	1.411
Fuel oil	1.840	1.640	1.400	1.320	0.680	0.280	0.212
Feedstocks	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
Coke oven gas	1.614	1.866	1.687	1.552	1.951	1.841	2.006
Blast furnace gas	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
Fuels							
Liquid fuels	6.038	4.410	3.556	3.274	2.425	1.981	2.917
Gaseous fuels	42.872	44.492	42.349	40.911	40.873	40.514	43.984
Solid fuels	32.419	39.231	31.510	27.253	27.959	26.089	27.074
Other fuels	14.966	16.746	16.083	16.515	19.231	19.079	25.428
Biomass	0.422	1.686	1.767	1.893	2.296	2.327	2.642
Total	**96.717**	**106.565**	**95.265**	**89.846**	**92.784**	**89.990**	**102.045**

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	22.582	23.324	23.289	23.541	26.265	22.861
Fuel wood and wood waste	8.604	10.105	10.716	12.300	11.897	12.184	12.193	11.624	13.235	14.043	14.004
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	22.582	23.324	23.289	23.541	26.265	22.861
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	12.193	11.626	13.240	14.044	14.007
Total	**96.137**	**90.392**	**79.698**	**76.526**	**77.019**	**74.088**	**73.047**	**73.042**	**68.048**	**68.163**	**61.539**

Table 10. (cont.) Fuel consumption [PJ] in 1.A.2.g category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	11.348	10.096	7.619	7.288	6.676	7.602	6.686
Lignite	0.089	0.363	0.269	0.432	0.158	0.181	0.291
Hard coal briquettes (patent fuels)	0.000	0.029	0.000	0.000	0.000	0.000	0.000
Brown coal briquettes	0.080	0.200	0.100	0.040	0.040	0.040	0.037
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	24.964	23.876	23.019	26.036	23.395	22.750	24.490
Fuel wood and wood waste	17.901	20.051	20.854	24.842	25.929	27.937	30.034
Biogas	0.000	0.000	0.000	0.000	0.000	0.044	0.042
Industrial wastes	0.070	0.052	0.069	0.098	0.064	0.045	0.037
Municipal waste - non-biogenic fraction	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
Other petroleum products	0.090	0.090	0.093	0.064	0.096	0.068	0.093
Petroleum coke	0.000	0.000	0.416	0.224	0.736	0.704	0.111
Coke	0.370	0.228	0.171	0.199	0.142	0.085	0.129
Liquid petroleum gas (LPG)	1.150	1.196	0.966	1.150	1.334	1.150	1.370
Motor gasoline	0.270	0.135	0.090	0.090	0.176	0.086	0.122
Aviation gasoline	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Jet kerosene	0.043	0.043	0.000	0.043	0.043	0.000	0.039
Diesel oil	8.661	8.703	7.101	6.538	6.668	6.063	7.048
Fuel oil	1.480	1.480	0.960	0.560	0.560	0.200	0.297
Feedstocks	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
Coke oven gas	0.020	0.025	0.010	0.010	0.004	0.003	0.004
Blast furnace gas	0.009	0.012	0.004	0.004	0.002	0.000	0.000
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels							
Liquid fuels	11.694	11.647	9.626	8.669	9.613	8.271	9.080
Gaseous fuels	24.964	23.876	23.019	26.036	23.395	22.750	24.490
Solid fuels	11.916	10.953	8.173	7.973	7.022	7.911	7.147
Other fuels	0.070	0.052	0.069	0.098	0.064	0.045	0.037
Biomass	17.901	20.051	20.854	24.842	25.929	27.981	30.076
Total	**66.545**	**66.579**	**61.741**	**67.618**	**66.023**	**66.958**	**70.830**

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	69.564	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	5.020	7.104
Biogas	0.663	0.678	0.860	0.683	0.700	1.325	1.602	1.582	1.438	1.795	1.675
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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	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	69.564	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	9.192	6.596	6.430	6.452	7.353	7.773	6.162	6.920	6.815	8.779
Total	**85.126**	**86.309**	**95.222**	**120.162**	**127.317**	**126.652**	**122.105**	**130.377**	**128.096**	**136.292**	**143.880**

Table 11. (cont.) Fuel consumption [PJ] in 1.A.4.a category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	34.503	31.119	32.855	30.116	27.068	25.958	26.811
Lignite	1.475	0.702	0.531	0.515	0.402	0.327	0.273
Hard coal briquettes (patent fuels)	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
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	83.433	78.278	80.888	76.501	67.429	71.823	80.972
Fuel wood and wood waste	8.029	7.818	6.833	7.433	6.556	6.530	7.716
Biogas	1.830	1.963	2.280	2.123	2.118	2.361	2.701
Industrial wastes	0.021	0.011	0.009	0.388	0.079	0.145	0.116
Municipal waste - non-biogenic fraction	0.005	0.035	0.028	0.033	0.152	0.050	0.239
Municipal waste – biogenic fraction	0.000	0.000	0.000	0.000	0.000	0.000	0.808
Other petroleum products	0.060	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
Coke	2.109	1.824	0.741	1.083	0.570	0.826	1.120
Liquid petroleum gas (LPG)	3.404	3.312	4.048	2.852	3.726	2.990	3.596
Motor gasoline	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
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.002
Diesel oil	27.409	25.634	18.402	15.155	14.722	14.448	14.502
Fuel oil	0.080	0.040	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
Refinery gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke oven gas	0.001	0.001	0.001	0.000	0.001	0.000	0.000
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.017	0.018	0.014	0.010	0.002	0.000	0.000
Fuels							
Liquid fuels	30.953	28.986	22.450	18.007	18.448	17.438	18.099
Gaseous fuels	83.433	78.278	80.888	76.501	67.429	71.823	80.972
Solid fuels	38.105	33.664	34.142	31.724	28.043	27.111	28.204
Other fuels	0.026	0.046	0.037	0.421	0.231	0.195	0.355
Biomass	9.859	9.781	9.113	9.556	8.674	8.891	11.225
Total	**162.376**	**150.755**	**146.630**	**136.209**	**122.825**	**125.458**	**138.854**

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	2014	2015	2016
Hard coal	319.753	275.817	291.964	280.095	257.420	252.837	269.100
Lignite	4.035	3.593	3.619	4.022	3.214	3.105	2.930
Hard coal briquettes (patent fuels)	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
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	148.427	135.471	141.397	143.187	131.598	132.202	145.148
Fuel wood and wood waste	112.746	115.000	116.850	116.850	105.450	105.450	111.435
Biogas	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
Municipal waste - non-biogenic fraction	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
Other petroleum products	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
Coke	6.526	5.700	5.415	5.700	4.845	4.275	4.480
Liquid petroleum gas (LPG)	24.840	23.000	23.000	21.620	22.540	21.390	22.546
Motor gasoline	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
Jet kerosene	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Diesel oil	4.546	4.763	3.767	3.464	3.031	3.010	3.010
Fuel oil	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
Refinery gas	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
Blast furnace gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas works gas	0.067	0.059	0.040	0.047	0.036	0.003	0.000
Fuels							
Liquid fuels	29.386	27.763	26.767	25.084	25.571	24.400	25.556
Gaseous fuels	148.427	135.471	141.397	143.187	131.598	132.202	145.148
Solid fuels	330.381	285.169	301.038	289.864	265.515	260.220	276.510
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	112.746	115.000	116.850	116.850	105.450	105.450	111.435
Total	**620.940**	**563.403**	**586.052**	**574.985**	**528.134**	**522.272**	**558.649**

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	9.175	8.125	7.076	18.020	21.999	13.905	8.200	10.930	8.831
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	63.143	60.120	67.737	93.683	104.962	101.174	104.852	123.003	110.432
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**	**103.095**	**120.383**	**133.037**	**177.818**	**189.802**	**184.216**	**190.861**	**199.479**	**181.570**

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	19.047	19.978	19.062	19.024	19.030
Biogas	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.094	0.097
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	0.000	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	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	8.642	8.400	8.191	6.776	8.172	8.579	9.432	3.825	3.375	3.453	4.311
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	113.057	123.601	116.024	114.052	116.811	119.230	122.316	87.949	80.974	81.098	80.216
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	17.100	17.100	19.043	19.010	19.017	19.878	19.047	19.978	19.062	19.118	19.127
Total	**186.028**	**178.839**	**177.771**	**169.041**	**171.096**	**176.128**	**181.448**	**155.447**	**142.604**	**147.451**	**145.867**

Table 13. (cont.) Fuel consumption [PJ] in 1.A.4.c category

Fuels	2010	2011	2012	2013	2014	2015	2016
Hard coal	47.291	41.488	43.715	41.611	39.003	36.305	39.000
Lignite	1.667	1.337	1.327	1.609	1.286	1.144	0.977
Hard coal briquettes (patent fuels)	0.029	0.059	0.205	0.293	0.264	0.146	0.291
Brown coal briquettes	0.000	0.000	0.020	0.520	1.360	0.700	0.392
Crude oil	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Natural gas	1.486	1.531	1.796	1.501	1.438	1.144	1.305
Fuel wood and wood waste	21.088	23.931	20.948	20.937	19.310	19.116	21.458
Biogas	0.039	0.223	0.252	0.286	0.328	0.385	0.357
Industrial wastes	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
Municipal waste – biogenic fraction	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
Petroleum coke	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coke	0.940	0.998	0.285	0.570	0.627	0.256	0.280
Liquid petroleum gas (LPG)	2.300	2.346	2.300	2.300	2.760	2.622	2.761
Motor gasoline	0.045	0.045	0.045	0.045	0.044	0.043	0.050
Aviation gasoline	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
Diesel oil	73.480	74.130	74.692	73.177	70.579	69.832	73.957
Fuel oil	3.451	3.926	4.039	3.436	3.096	3.173	3.477
Feedstocks	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
Coke oven gas	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
Gas works gas	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Fuels							
Liquid fuels	79.276	80.447	81.076	78.958	76.479	75.670	80.245
Gaseous fuels	1.486	1.531	1.796	1.501	1.438	1.144	1.305
Solid fuels	49.927	43.882	45.552	44.603	42.540	38.551	40.940
Other fuels	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biomass	21.127	24.154	21.200	21.223	19.638	19.501	21.815
Total	**151.816**	**150.014**	**149.624**	**146.285**	**140.095**	**134.866**	**144.305**

Table 14. CO_2 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	94.94	94.92	94.97	94.98	94.90	94.96	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**	**2014**	**2015**	**2016**							
Hard coal	94.99	94.98	94.96	94.92	94.96							
Lignite	109.76	109.91	110.77	110.68	110.88							

Table 15. CO_2 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							94.73	94.69	94.69
Lignite												109.53
	2012	**2013**	**2014**	**2015**	**2016**							
Hard coal	94.70	94.73	94.74	94.67	94.76							
Lignite	109.74	109.91	109.75	110.66								

Table 16. CO_2 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	94.37	94.22	94.32	94.36	94.55	94.54	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**	**2014**	**2015**	**2016**							
Hard coal	93.88	93.88	93.85	93.87	93.66							
Lignite	109.74	109.91	109.75	110.66	106.77							

Table 17. CO_2 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	94.52	94.65	94.63
Lignite												
	2012	**2013**	**2014**	**2015**	**2016**							
Hard coal	95.37	94.87	94.89	94.63	94.35							
Lignite												

Table 18. CO_2 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**	**2014**	**2015**	**2016**							
Hard coal	94.69	94.73	94.70	94.64	94.90							
Lignite												

Table 19. CO_2 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**	**2014**	**2015**	**2016**							
Hard coal	94.70	94.74	94.73	95.09	95.06							
Lignite												

Table 20. CO_2 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**	**2014**	**2015**	**2016**							
Hard coal	94.70	94.74	94.73	94.56	94.61							
Lignite												

Table 21. CO_2 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**	**2014**	**2015**	**2016**							
Hard coal	94.70	94.74	94.73	94.66	94.54							
Lignite												

Table 22. CO_2 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**	**2014**	**2015**	**2016**							
Hard coal	94.70	94.74	94.73	94.67	94.04							
Lignite	109.74	109.91	109.75	110.66	110.81							

Table 23. CO_2 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**	**2014**	**2015**	**2016**							
Hard coal	94.70	94.74	94.73	94.67	94.53							
Lignite	109.74	109.91	109.75	110.66	104.73							

Table 24. CO_2 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	93.90	94.06
Lignite											109.72	109.61
	2012	**2013**	**2014**	**2015**	**2016**							
Hard coal	93.96	94.04	94.05	94.06	94.12							
Lignite	111.17	111.16	111.20	110.51	106.40							

Table 25. CO_2 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		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	93.90	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**	**2014**	**2015**	**2016**							
Hard coal	93.96	94.04	94.05	94.06	94.05							
Lignite	111.19	111.18	111.22	110.53	105.51							

Table 26. CO_2 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	93.90	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**	**2014**	**2015**	**2016**							
Hard coal	93.96	94.04	94.05	94.06	94.05							
Lignite	111.19	111.17	111.21	110.52	105.51							

Table 27. CO_2 EFs [kg/GJ] applied for other fuels in the years 1988-2016 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 1988-2016 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 1988-2016 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 1988-2016 (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
CO_2 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	2014	2015	2016
Desulphurization plaster production in lime wet FGD	1177	1240	1338	1596	2076	2389	2505	2572	2768	2768	2768	2768
Consumption of limestone sorbents to desulfurize the off-gases by wet method (lime WFGD)	699	736	795	948	1233	1418	1487	1527	1644	1644	1644	1644
Limestone consumption in lime WFGD	664	700	755	900	1171	1347	1413	1451	1561	1561	1561	1561
CO_2 emission from decomposition of calcium carbonate in WFGD	**292**	**308**	**332**	**396**	**515**	**593**	**622**	**638**	**687**	**687**	**687**	**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 1988-2016 (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
SO_2 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
SO_2 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
SO_2 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
CO_2 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	2014	2015	2016
SO_2 emission captured by FGD in power plants and autoproducers CHP	1967	2075	2091	2178	2136	2299	2524	2297	2302	2322	2275	2415
SO_2 captured with use of lime wet FGD method	438	461	498	594	773	889	932	957	1030	1030	1030	1030
SO_2 captured with use of other FGD method	1529	1614	1593	1584	1363	1410	1592	1340	1272	1292	1245	1385
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	2220	2140	2381
Limestone consumption in FGD in FBB and in FGD other than lime wet FGD	2575	2718	2683	2668	2297	2375	2681	2257	2142	2176	2097	2333
CO_2 emission from calcium carbonate in FGD in FBB and in FGD other than lime WFGD	**1133**	**1196**	**1181**	**1174**	**1010**	**1045**	**1180**	**993**	**943**	**957**	**923**	**1027**

Table 3. CO_2 emission values from carbonate use in 2.A.4.d subcategory for the years 1988-2016 (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
CO_2 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	2014	2015	2016
Sum of limestone use presented in the tables 1-2	3239	3417	3438	3569	3468	3723	4094	3708	3704	3737	3658	3895
CO_2 emission from carbonate use in 2.A.4.d subcategory	**1425**	**1504**	**1513**	**1570**	**1526**	**1638**	**1802**	**1631**	**1630**	**1644**	**1610**	**1714**

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/emission data	**Unit**												
Natural gas consumption	[10^3 m^3]	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 consumption	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 consumption	[10^3 m^3]	183 960	113 672	30 560									
Coke oven gas consumption	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									
Process CO_2 emission from ammonia production	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
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Activity/emission data	**Unit**												
Natural gas consumption	[10^3 m^3]	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 consumption	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 consumption	[10^3 m^3]												
Coke oven gas consumption	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												
Process CO_2 emission from ammonia production	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
		2012	**2013**	**2014**	**2015**	**2016**							
Activity/emission data	**Unit**												
Natural gas consumption	[10^3 m^3]	2 242 281	2 207 620	2 295 270	2 363 754	2 286 461							
Natural gas consumption	TJ	81 150	79 269	83 391	86 145	83 951							
Coke oven gas consumption	[10^3 m^3]												
Coke oven gas consumption	TJ												
CO_2 emission from natural gas use	kt	4 473	4 403	4 565	4 720	4 625							
CO_2 emission from coke oven gas use	kt												
Process CO_2 emission from ammonia production	kt	4 473	4 403	4 565	4 720	4 625							
Ammonia production	kt	2467.458	2228.303	2634.506	2720.446	2625.757							

Table 2. CO_2 amount connected with fertilizer urea production deducted from CO_2 process emission from ammonia production

		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Activity/emission data	**Unit**												
Fertilizer urea production	kt	775.527	808.932	771.812	660.998	606.719	567.208	698.866	824.372	742.790	588.957	496.479	512.603
CO_2 amount used in fertilizer urea production which is deducted from CO_2 emission generated in ammonia production	kt	568.720	593.217	565.996	484.732	444.928	415.953	512.502	604.539	544.713	431.901	364.084	375.909
Total CO_2 emission from 2.B.1	kt	3930.885	3943.317	2344.257	2402.200	2223.177	2380.178	2856.265	3270.508	3260.490	3432.021	3204.386	2790.081
		2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Activity/emission data	**Unit**												
Fertilizer urea production	kt	565.795	368.552	486.326	628.048	618.41	700.642	705.319	734.52	781.464	867.261	723.719	979.722
CO_2 amount used in fertilizer urea production which is deducted from CO_2 emission generated in ammonia production	kt	414.916	270.271	356.639	460.569	453.501	513.804	517.234	538.648	573.074	635.991	530.727	718.463
Total CO_2 emission from 2.B.1	kt	3504.927	3467.105	2546.256	3773.041	3889.141	4095.508	3866.290	3822.291	3857.892	2983.509	3223.150	3393.590
		2012	**2013**	**2014**	**2015**	**2016**							
Activity/emission data	**Unit**												
Fertilizer urea production	kt	1078.683	1036.753	1122.85	1158.011	1106.873							
CO_2 amount used in fertilizer urea production which is deducted from CO_2 emission generated in ammonia production	kt	791.034	760.286	823.423	849.208	811.707							
Total CO_2 emission from 2.B.1	kt	3681.569	3643.181	3741.539	3870.485	3813.599							

Fertilizer urea production amount was estimated according to data from [GUS 1989e-2017e]. CO_2 amount used in fertilizer urea production and deducted from CO_2 emission generated in ammonia production was calculated based on assumption on the complete conversion of NH_3 and CO_2 to urea, what means that 0.733 t of CO_2 per tonne of urea produced was required (2006 GLs, box 3.3, p. 3.16).

ANNEX 4. ENERGY BALANCE DATA FOR MAIN FUELS IN 2016

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. Data source – Eurostat.

Lignite consumption

National fuel balance	Lignite	
	kt	TJ
In	60 530	491 268
From national sources	60 246	488 962
1) Indigenous production	60 246	488 962
2) Transformation output or return	0	0
3) Stock decrease	0	0
Import	284	2 306
Out	60 530	491 268
National consumption	60 385	490 089
1) Transformation input	59 846	484 904
a) input for secondary fuel production	0	0
b) fuel combustion	59 846	484 904
2) Direct consumption	539	5 185
Non-energy use	10	126
Combusted directly	529	5 059
Combusted in Poland	60 375	489 963
Stock increase	-67	-541
Export	212	1 720
Losses and statistical differences	0	0

Net calorific value	MJ/kg	8.12

Natural gas consumption

National fuel balance	Natural gas
	TJ
In	658 911
From national sources	148 745
1) Indigenous production	148 745
2) Transformation output or return	0
3) Stock decrease	0
Import	510 166
Out	658 911
National consumption	613 794
1) Transformation input	95 664
a) input for secondary fuel production	0
b) fuel combustion	95 664
2) Direct consumption	518 130
Non-energy use	88 272
Combusted directly	429 858
Combusted in Poland	525 522
Stock increase	16 275
Export	29 965
Losses and statistical differences	-1 123

Coke oven gas consumption

National fuel balance	Coke oven gas
	TJ
In	70 473
From national sources	70 473
1) Indigenous production	0
2) Transformation output or return	70 473
3) Stock decrease	0
Import	0
Out	70 473
National consumption	70 473
1) Transformation input	22 820
a) input for secondary fuel production	0
b) fuel combustion	22 820
2) Direct consumption	47 653
Non-energy use	0
Combusted directly	47 653
Combusted in Poland	70 473
Stock increase	0
Export	0
Losses and statistical differences	0

Blast furnace gas consumption

National fuel balance	Blast furnace gas
	TJ
In	25 158
From national sources	25 158
1) Indigenous production	0
2) Transformation output or return	25 158
3) Stock decrease	0
Import	0
Out	25 158
National consumption	25 158
1) Transformation input	14 630
a) input for secondary fuel production	0
b) fuel combustion	14 630
2) Direct consumption	10 528
Non-energy use	0
Combusted directly	10 528
Combusted in Poland	25 158
Stock increase	0
Export	0
Losses and statistical differences	0

ANNEX 5. METHOLOGICAL NOTES RELATED TO ELABORATION OF REPRESENTATIVE RESEARCH ON LIVESTOCK ANIMALS PERFORMED BY CENTRAL STATISTICAL OFFICE [GUS R1(2015)]

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

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) $$W1_{whi} = \frac{N_{wh}}{n_{wh}},$$

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) $$c_{wh} = \frac{n1_{wh} + n2_{wh}}{n_{wh} - n4_{wh}},$$

Then the number of the n_{awh} active farms in h-stratum of w-voivodship is calculated for the drawn sample:

(4) $$n_{awh} = n1_{wh} + n2_{wh} + c_{wh} * n4_{wh}$$

On this basis, the R_{wh} correction factor is calculated for a given stratum:

(5) $$R_{wh} = \frac{n_{awh}}{n1_{wh}},$$

The purpose of this factor is to correct the $W1_{whi:}$ weight in order to obtain final $W_{hi:}$ weight:

(6) $$W_{whi} = R_{wh} * W1_{whi},$$

The sum of X variable value for Poland is the sum of values obtained for particular voivodships, i.e.:

(7) $\hat{x} = \sum_{w} \hat{x}_w,$ (w = 1, 2, ... , 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. **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) $$\hat{x}_w = \sum_h \sum_i W1_{whi} * x_{whi}, \quad (i = 1, 2, \dots, n_{wh};\ h = 1, 2, \dots, 9)$$

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) $$\hat{x} = \sum_{w} \hat{x}_w, \qquad (\ w = 1, 2, \ldots\ , 16)$$

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) $$v\ (x_w) = \frac{\sqrt{d^2(\hat{x}_w)}}{\hat{x}_w} * 100,$$

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 6.1. UNFCCC LAND TRANSITION MATRIX

4. Land Use, Land-Use Change and Forestry	Unit	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Forest land (managed)																														
Remaining Forest land (managed)	kha	8659.18	8665.68	8677.82	8693.29	8705.94	8714.49	8714.45	8723.54	8741.13	8778.29	8808.85	8860.76	8876.74	8902.84	8915.10	8967.74	9030.40	9105.71	9152.43	9163.49	9223.51	9250.78	9275.14	9304.21	9328.57	9353.24	9368.63	9381.84	9381.53
Converted to Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Cropland	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Settlements	kha	1.32	1.32	0.68	0.61	0.36	3.71	0.57	0.67	0.40	0.42	0.58	0.49	0.40	0.72	0.53	0.42	0.69	0.65	0.47	0.60	0.60	0.62	0.64	0.55	0.60	0.49	0.78	0.74	13.64
Converted to Other land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area	kha	8660.50	8667.00	8678.50	8693.90	8706.30	8718.20	8715.02	8724.22	8741.53	8778.71	8809.43	8861.25	8877.14	8903.56	8915.63	8968.16	9031.09	9106.37	9152.90	9164.08	9224.11	9251.40	9275.78	9304.76	9329.18	9353.73	9369.40	9382.58	9395.17
Final area	kha	8667.00	8678.50	8693.90	8706.30	8718.20	8715.02	8724.22	8741.53	8778.71	8809.43	8861.25	8877.14	8903.56	8915.63	8968.16	9031.09	9106.37	9152.91	9164.08	9224.11	9251.40	9275.78	9304.76	9329.18	9353.73	9369.40	9382.58	9395.17	9381.98
Forest land (unmanaged)																														
Remaining Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Cropland	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Settlements	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Other land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Final area	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Cropland																														
Remaining Cropland	kha	14702.00	14678.50	14652.72	14644.85	14620.95	14607.09	14581.06	14567.42	14536.31	14518.16	14446.69	14467.34	14438.73	14405.47	14345.13	14282.17	14331.94	14332.27	14329.35	14278.60	14281.33	14261.48	14216.30	14182.92	14138.13	14103.69	14011.29	13997.87	13979.03
Converted to Forest land (managed)	kha	6.04	9.90	12.42	10.05	9.47	0.41	7.54	13.90	29.03	24.06	40.48	12.66	20.71	9.88	40.98	48.94	58.68	36.46	9.00	46.83	21.54	19.31	22.88	19.29	19.44	12.49	10.78	10.30	0.35
Converted to Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (managed)	kha	23.30	5.94	5.94	3.29	9.42	13.32	11.76	1.12	1.38	0.75	34.92	8.74	6.19	NO	17.48	35.91	5.14	NO	3.92	NO	9.77	7.65	11.52	7.89	6.77	5.76	NO	NO	30.16
Converted to Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Settlements	kha	7.66	7.66	7.33	5.94	5.22	6.58	7.69	6.37	1.42	1.21	0.98	1.32	1.72	1.50	1.88	1.77	1.88	2.24	6.72	3.92	3.92	6.61	10.79	6.21	18.59	11.56	81.63	3.11	13.72
Converted to Other land	kha	NO	NO	0.58	NO	NO	NO	NO	NO	NO	NO	NO	5.98	NO	25.81	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	4.63	NO	NO	NO
Converted to Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area	kha	14739.00	14702.00	14679.00	14664.13	14645.06	14627.39	14608.05	14588.80	14568.14	14544.17	14523.07	14496.04	14467.34	14442.66	14405.47	14368.78	14397.64	14370.97	14348.99	14329.35	14316.55	14295.06	14261.48	14216.30	14182.92	14138.13	14103.69	14011.29	14023.26
Final area	kha	14702.00	14678.50	14664.60	14644.89	14627.39	14608.05	14588.80	14568.14	14544.17	14523.07	14496.04	14467.34	14442.67	14405.47	14368.79	14397.64	14370.97	14348.99	14329.35	14316.55	14295.06	14261.48	14216.30	14182.92	14138.13	14103.69	14011.29	14023.26	13979.03
Grassland (managed)																														
Remaining Grassland (managed)	kha	4306.90	4317.26	4303.56	4298.62	4291.43	4293.56	4301.64	4306.59	4301.49	4298.73	4287.06	4308.00	4302.05	4287.29	4272.30	4260.51	4274.39	4262.08	4235.22	4210.11	4182.86	4175.85	4167.46	4165.15	4162.81	4156.36	4153.20	4150.16	4159.35
Converted to Forest land (managed)	kha	1.78	2.92	3.66	2.96	2.79	0.12	2.22	4.09	8.55	7.09	11.92	3.73	6.10	2.91	12.07	14.41	17.28	10.74	2.65	13.79	6.35	5.69	6.74	5.68	5.72	3.68	3.17	3.03	0.10
Converted to Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Cropland	kha	NO	NO	11.88	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	2.43	NO	0.39	13.73	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (managed)	kha	1.41	5.01	1.52	2.51	0.99	1.58	0.03	2.72	2.47	0.07	1.02	3.66	3.64	0.68	2.91	14.87	4.74	1.69	1.27	5.39	3.42	1.96	4.78	2.21	1.05	2.08	NO	NO	1.62
Converted to Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Settlements	kha	5.61	5.01	2.58	5.41	6.70	5.59	2.99	NO	NO	NO	4.18	6.59	4.96	NO	NO	NO	NO	2.59	6.69	10.06	3.76	9.13	7.35	5.94	3.46	5.76	5.75	NO	11.90
Converted to Other land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	17.36	NO	NO	NO	NO	16.26	NO	NO	NO	NO	NO	NO	1.69	NO	NO	NO
Converted to Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area	kha	4315.70	4330.20	4323.20	4309.50	4301.91	4300.86	4306.88	4313.40	4312.51	4305.88	4304.18	4321.97	4316.74	4308.23	4287.29	4289.78	4296.41	4279.53	4262.09	4239.75	4210.11	4192.62	4186.32	4178.97	4173.03	4169.58	4162.12	4153.20	4172.97
Final area	kha	4330.20	4323.20	4309.50	4301.91	4300.86	4306.88	4313.40	4312.51	4305.88	4304.18	4321.98	4316.74	4308.23	4287.29	4300.91	4396.44	4279.53	4262.08	4240.12	4210.11	4192.62	4186.32	4178.98	4173.03	4169.58	4162.12	4153.20	4172.97	4203.03
Grassland (unmanaged)																														
Remaining Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Cropland	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Settlements	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Other land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Final area	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

4. Land Use, Land-Use Change and Forestry	Unit	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Wetlands (managed)																														
Remaining Wetlands (managed)	kha	1322.09	1323.49	1328.47	1329.91	1332.40	1333.38	1334.92	1334.91	1337.17	1338.19	1338.05	1338.98	1341.90	1341.62	1341.24	1343.06	1357.08	1360.61	1360.05	1359.72	1363.51	1362.18	1362.92	1366.59	1367.74	1368.78	1366.39	1366.39	1369.75
Converted to Forest land (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Cropland	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.39	NO	NO	NO	NO	NO	NO	NO	NO	0.99	NO	NO	2.80	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Settlements	kha	0.01	0.01	0.03	0.08	0.02	0.01	0.04	0.04	0.47	0.07	0.20	0.10	0.74	0.68	1.05	1.09	0.85	1.21	1.27	1.60	1.60	1.96	1.22	1.10	1.06	0.00	4.48	NO	NO
Converted to Other land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3.24	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area	kha	1322.10	1323.50	1328.50	1329.99	1332.42	1333.39	1334.97	1334.95	1337.63	1339.64	1338.25	1339.08	1342.63	1345.53	1342.30	1344.16	1357.93	1361.82	1362.30	1361.32	1365.11	1366.93	1364.14	1367.70	1368.80	1368.78	1370.86	1366.39	1369.75
Final area	kha	1323.50	1328.50	1329.99	1332.42	1333.39	1334.97	1334.95	1337.63	1339.64	1338.25	1339.08	1342.63	1345.53	1342.30	1344.16	1357.93	1361.82	1362.30	1361.32	1365.11	1366.93	1364.14	1367.70	1368.80	1368.78	1370.86	1366.39	1369.75	1371.36
Wetlands (unmanaged)																														
Remaining Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Cropland	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Settlements	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Other land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Final area	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Settlements																														
Remaining Settlements	kha	1944.90	1958.40	1972.40	1983.02	1995.06	2007.36	2023.24	2029.74	2033.81	2032.78	2034.47	2040.41	2048.90	2028.64	2019.00	2007.01	1999.60	2003.02	2009.71	2024.86	2041.03	2060.04	2080.44	2104.30	2120.23	2145.62	2157.31	2198.39	2209.03
Converted to Forest land (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Cropland	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	12.53	15.44	10.68	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	25.39	NO
Converted to Grassland (managed)	kha	NO	NO	NO	NO	NO	NO	NO	4.80	3.01	3.32	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	22.81	NO
Converted to Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	3.36	NO
Converted to Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Other land	kha	3.20	1.10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	28.08	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	6.13	NO	NO
Converted to Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area	kha	1948.10	1959.50	1972.40	1983.02	1995.06	2007.36	2023.24	2034.54	2036.82	2036.10	2034.47	2040.41	2048.90	2056.72	2031.53	2022.45	2010.29	2003.02	2009.71	2024.86	2041.03	2060.04	2080.44	2104.30	2120.23	2145.62	2163.44	2249.94	2209.03
Final area	kha	1959.50	1972.40	1983.02	1995.06	2007.36	2023.24	2034.54	2036.82	2036.10	2034.47	2040.41	2048.90	2056.72	2031.53	2022.45	2010.29	2003.02	2009.71	2024.86	2041.03	2060.04	2080.41	2104.30	2119.79	2145.62	2163.44	2249.94	2209.03	2248.29
Other land																														
Remaining Other land	kha	282.90	286.60	287.20	287.75	281.30	280.33	272.59	271.87	264.01	259.10	209.75	209.75	211.79	211.79	275.17	175.15	146.81	132.51	132.33	111.03	101.89	99.80	95.94	93.81	92.13	92.13	98.45	97.79	84.27
Converted to Forest land (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Cropland	kha	NO	NO	NO	0.04	6.44	0.97	7.75	0.72	7.86	4.90	49.35	NO	3.95	NO	11.12	100.03	28.34	14.29	NO	37.56	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	11.12	100.03	NO	NO	NO	NO	NO	0.03	NO	NO	NO	NO	NO	NO	13.52
Converted to Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Settlements	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	9.14	2.06	3.87	1.68	1.68	NO	NO	6.79	NO
Converted to Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area	kha	282.90	286.60	287.20	287.78	287.75	281.30	280.33	272.59	271.87	264.01	259.10	209.75	215.74	211.79	297.42	375.20	175.15	146.81	132.33	148.59	111.03	101.89	99.80	95.49	93.81	92.13	98.45	104.58	97.79
Final area	kha	286.10	287.70	287.78	287.75	281.30	280.33	272.59	271.87	264.01	259.10	209.75	215.74	211.79	286.28	275.17	175.15	146.81	132.51	148.59	111.03	101.89	99.80	95.94	93.81	92.13	98.45	104.58	97.79	84.27
Total unmanaged land																														
Remaining Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Cropland	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (managed)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Settlements	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Converted to Other land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Initial area (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Final area (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Net change																														
Forest land (managed)	kha	6.50	11.50	15.40	12.40	11.90	-3.18	9.19	17.31	37.18	30.72	51.82	15.90	26.41	12.07	52.53	62.93	75.28	46.54	11.18	60.03	27.29	24.38	28.98	24.41	24.56	15.67	13.17	12.59	-13.19
Forest land (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Cropland	kha	-37.00	-23.50	-14.40	-19.24	-17.67	-19.34	-19.25	-20.66	-23.97	-21.11	-27.03	-28.70	-24.67	-37.19	-36.68	28.86	-26.67	-21.97	-19.64	-12.80	-21.50	-33.57	-45.18	-33.38	-44.79	-34.44	-92.40	11.98	-44.23
Grassland (managed)	kha	14.50	-7.00	-13.70	-7.59	-1.05	6.02	6.52	-0.89	-6.63	-1.70	17.79	-5.23	-8.51	-20.95	13.62	106.66	-16.88	-17.45	-21.96	-29.63	-17.49	-6.30	-7.35	-5.94	-3.46	-7.45	-8.93	19.77	30.06
Grassland (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Wetlands (managed)	kha	1.40	5.00	1.49	2.43	0.97	1.58	-0.01	2.68	2.01	-1.39	0.82	3.56	2.90	-3.24	1.86	13.77	3.89	0.49	-0.99	3.79	1.83	-2.80	3.56	1.10	-0.01	2.08	-4.48	3.36	1.62
Wetlands (unmanaged)	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Settlements	kha	11.40	12.90	10.62	12.04	12.30	15.88	11.29	2.28	-0.72	-1.63	5.94	8.49	7.82	-25.19	-9.08	-12.16	-7.27	6.69	15.15	16.17	19.01	20.38	23.86	15.49	25.39	17.82	86.50	-40.92	39.26
Other land	kha	3.20	1.10	0.58	-0.04	-6.44	-0.97	-7.75	-0.72	-7.86	-4.90	-49.35	5.98	-3.95	74.49	-22.25	-200.05	-28.34	-14.29	16.26	-37.56	-9.14	-2.08	-3.87	-1.68	-1.68	6.32	6.13	-6.79	-13.52
Total unmanaged land	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total																														
Initial area	kha	31268.30	31268.80	31268.80	31268.33	31268.50	31268.50	31268.50	31268.50	31268.50	31268.50	31268.50	31268.50	31268.50	31268.49	31279.63	31368.53	31268.50	31268.50	31268.31	31267.94	31267.94	31267.94	31267.97	31267.52	31267.97	31267.97	31267.97	31267.97	31267.97
Final area	kha	31268.30	31268.80	31268.80	31268.33	31268.50	31268.50	31268.50	31268.50	31268.50	31268.50	31268.50	31268.50	31268.50	31268.49	31279.63	31368.53	31268.50	31268.50	31268.31	31267.94	31267.94	31267.94	31267.97	31267.52	31267.97	31267.97	31267.97	31267.97	31267.97

ANNEX 6.2. KP LULUCF LAND TRANSITION MATRIX

7. KP LULUCF	Unit	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Afforestation and reforestation																														
Remaining afforestation and re	kha	NO	NO	NO	16.08	29.10	41.36	41.89	51.65	69.64	107.21	138.35	190.75	207.13	233.95	246.74	299.79	363.14	439.11	486.30	497.95	558.57	586.46	611.46	641.08	666.05	691.21	707.37	721.32	734.65
Changed to deforestation	kha	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total area at the end of the prev	kha	NO	NO	NO	16.08	29.10	41.36	41.89	51.65	69.64	107.21	138.35	190.75	207.13	233.95	246.74	299.79	363.14	439.11	486.30	497.95	558.57	586.46	611.46	641.08	666.05	691.21	707.37	721.32	734.65
Total area at the end of the curr	kha	NA,NO	NA,NO	16.08	29.10	41.36	41.89	51.65	69.64	107.21	138.35	190.75	207.13	233.95	246.74	299.79	363.14	439.11	486.30	497.95	558.57	586.46	611.46	640.99	666.05	691.21	707.37	721.32	734.65	735.10
Deforestation																														
Remaining deforestation	kha	NO	NO	NO	0.68	1.30	1.66	5.36	5.93	6.61	7.01	7.42	8.00	8.49	8.89	9.61	10.13	10.55	11.24	11.89	12.36	12.96	13.56	14.18	14.82	15.37	15.98	16.47	17.24	17.98
Total area at the end of the prev	kha	NO	NO	NO	0.68	1.30	1.66	5.36	5.93	6.61	7.01	7.42	8.00	8.49	8.89	9.61	10.13	10.55	11.24	11.89	12.36	12.96	13.56	14.18	14.82	15.37	15.98	16.47	17.24	17.98
Total area at the end of the curr	kha	NA,NO	NA,NO	0.68	1.30	1.66	5.36	5.93	6.61	7.01	7.42	8.00	8.49	8.89	9.61	10.13	10.55	11.24	11.89	12.36	12.96	13.56	14.18	14.82	15.37	15.98	16.47	17.24	17.98	31.62
Forest management																														
Changed to deforestation	kha	NO	NO	0.68	0.61	0.36	3.71	0.57	0.67	0.40	0.42	0.58	0.49	0.40	0.72	0.53	0.42	0.69	0.65	0.47	0.60	0.60	0.62	0.64	0.55	0.60	0.49	0.78	0.74	13.64
Remaining forest management	kha	8659.18	8691.32	8677.82	8677.20	8676.85	8673.14	8672.57	8671.89	8671.49	8671.08	8670.50	8670.01	8669.61	8668.89	8668.37	8667.95	8667.26	8666.61	8666.14	8665.54	8664.94	8664.32	8663.68	8663.13	8662.52	8662.03	8661.26	8660.52	8646.88
Total area at the end of the prev	kha	8659.18	8691.32	8678.50	8677.82	8677.20	8676.85	8673.14	8672.57	8671.89	8671.49	8671.08	8670.50	8670.01	8669.61	8668.89	8668.37	8667.95	8667.26	8666.61	8666.14	8665.54	8664.94	8664.32	8663.68	8663.13	8662.52	8662.03	8661.26	8660.52
Total area at the end of the curr	kha	8667.00	8704.14	8677.82	8677.20	8676.85	8673.14	8672.57	8671.89	8671.49	8671.08	8670.50	8670.01	8669.61	8668.89	8668.37	8667.95	8667.26	8666.61	8666.14	8665.54	8664.94	8664.32	8663.68	8663.13	8662.52	8662.03	8661.26	8660.52	8646.88
Cropland management																														
Changed to afforestation and re	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to forest management	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Remaining cropland manageme	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to grazing land manag	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to revegetation	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to wetland drainage an	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total area at the end of the prev	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total area at the end of the curr	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Grazing land management																														
Changed to afforestation and re	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to forest management	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to cropland managem	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Remaining grazing land manage	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to revegetation	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to wetland drainage an	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total area at the end of the prev	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total area at the end of the curr	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Revegetation																														
Changed to afforestation and re	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to forest management	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to cropland managem	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to grazing land manag	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Remaining revegetation	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to wetland drainage an	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total area at the end of the prev	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total area at the end of the curr	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wetland drainage and rewetting																														
Changed to afforestation and re	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to forest management	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to cropland managem	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to grazing land manag	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to revegetation	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Remaining wetland drainage an	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total area at the end of the prev	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total area at the end of the curr	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other																														
Changed to afforestation and re	kha	NA	NA	16.08	13.01	12.26	0.53	9.76	17.99	37.58	31.14	52.40	16.38	26.81	12.79	53.05	63.35	75.97	47.19	11.65	60.62	27.89	25.00	29.53	24.97	25.16	16.17	13.95	13.33	0.45
Changed to deforestation	kha	NA	NA	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Changed to forest management	kha	7.82	12.82	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Changed to cropland managem	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to grazing land manag	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to revegetation	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Changed to wetland drainage an	kha	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Remaining Other	kha	22607.80	22601.80	22573.75	22577.67	22548.65	22548.12	22538.35	22520.37	22482.79	22451.65	22399.25	22382.87	22356.06	22343.25	22290.21	22226.86	22150.90	22103.71	22091.87	22030.87	22002.98	21977.97	21948.39	21923.42	21898.26	21882.09	21868.14	21854.81	21854.37
Total area at the end of the prev	kha	22615.62	22614.62	22589.83	22590.69	22560.91	22548.65	22548.12	22538.35	22520.37	22482.79	22451.65	22399.25	22382.87	22356.05	22343.27	22290.21	22226.86	22150.90	22103.52	22091.49	22030.87	22002.98	21977.91	21948.39	21923.42	21898.26	21882.09	21868.14	21854.81
Total area at the end of the curr	kha	22607.80	22601.80	22573.75	22577.67	22548.65	22548.12	22538.35	22520.37	22482.79	22451.65	22399.25	22382.87	22356.06	22343.25	22290.21	22226.86	22150.90	22103.71	22091.87	22030.87	22002.98	21977.97	21948.39	21923.42	21898.26	21882.09	21868.14	21854.81	21854.37

ANNEX 7. QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance / Quality Control and Verification programme for the Polish annual greenhouse gas inventory has been elaborated and updated if needed. It has been elaborated in line with the 2006 ***IPCC Guidelines for National GHG Inventories***. The QA/QC programme aiming at improving and assuring the high quality of GHG inventories contains tasks, responsibilities as well as time schedule for performance of the QA/QC procedures. Detailed domestic QA/QC plan is a part of QA/QC programme.

Quality Control (QC) activities are carried out by the personnel directly responsible for the inventory and are aimed at keeping its high standards and quality.

Within the national inventory the main activities underlying Quality Control process are conducted using *Tier 1* method and relate to all source/sink categories. *Tier 2* procedures are carried out for main key categories with special attention to the energy sector.

Following the Chapter 6 of the 2006 *IPCC Guidelines for National GHG Inventories*, Quality control (QC) covers routine technical activities carried out with the aim of quality control of national emissions and removals inventories allowing for:

- Maintaining the correctness and completeness of data,
- Elimination of errors and determination of potential deficiencies.

Quality Control activities contain: checks for accuracy of data and estimations acquiring as well as application of approved procedures for calculation of emissions, uncertainty, archiving of information and reporting.

Activities aiming at **quality assurance (QA)** cover procedural system for control carried out by experts not involved directly in elaborating GHG inventory in a given sector. QA activities are conducted over a completed inventory and allow to ensure that national inventory represents top level of emissions and removals assessment at the present knowledge and available data and effectively support quality control (QC).

Verification activities – where possible – include comparisons with external emission analyses estimates and databases conducted by independent bodies or teams. They allow to improve inventory methods and outcomes in both short and long terms.

The Polish inventory is directly based on sectoral activity data and carried out in two main steps. First, calculations are produced around 12 months after the end of the inventoried year (n-1) depending primarily on the availability of required activity data. Initial check of activity data and estimation procedures is then done. When the official statistics are available the revision of data is made and final inventory is produced up to 15 months after given year. Additionally the recalculations of the previous inventories for selected categories are performed because of methodological changes and improvements. The timetable for inventory preparation and QA/QC activities conducted at respective stages of the inventory preparation are presented in Table 1.

The basic elements of QA/QC plan which are to be implemented and co-ordinated by the National Centre for Emission and Management (KOBiZE), the unit responsible for Polish GHG inventory preparation. It follows the 2006 *IPCC Guidelines for National GHG Inventories* recommendations. The main procedures for QA/QC activities are described in the *National Quality Assurance / Quality Control and Verification Programme of the Polish Greenhouse Gas 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 (n – submission year)

Timing	Activity
June -15 December (year n–1)	→ Data and emission factors collection (estimation) → Check for consistency and correctness of the emission data, trends and factors, using all the relevant methods of both QC and verification outlined in the Programme (points 6-8 and 10) → 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 EIONET CDR (required by regulation (EU) No 525/2013 Article 7.1)
15 December – 15 February (year n–2)	→ Emission results and methodology verification based on remarks and comments made by ministerial emission experts (QA methods applied) → Elaboration of final inventory, additional checks and final corrections to the inventory, preparation of NIR and CRF tables (QC and verification methods applied) → Additional CRF and NIR quality upgrading on the basis of EEA control questions and remarks - corrections of any possible mistakes or deficiencies if found (QA methods applied) → Submission to the Ministry of the Environment for acceptance
15 March (year n–2)	→ Emission results and methodology verification based on remarks and comments made by external sectoral experts within inter-ministerial and inter-institutional check of the report (QA methods applied) → Submission of complete National Inventory Report and CRF tables to the EIONET CDR (required by regulation (EU) No 525/2013 Article 7.3)
15 April (year n–2)	→ Submission of GHG inventory for the year n-2 to the UNFCCC Secretariat (CRF and NIR) (required by decision 24/CP.19)

Each IPCC sector undergoes detail QC procedure which is carried out by expert responsible 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.

Procedures for quality assurance of the national inventories cover both actions performed by domestic agencies as well as by foreign (EU, UNFCCC). The National Inventory Report is delivered to the Ministry of Environment, where it is consulted in two stages: internally, among suitable departments, and externally - in inter-ministerial dialogue. In this second stage branch institutes supervised by ministers are engaged to review the inventory.

After including obtained comments and amendments into the NIR, according to recommendations delivered during the inter-ministerial compliance, the Ministry of the Environment initiates the procedure for governmental acceptance of the NIR by the Committee for the European Affairs after which both NIR and underlying CRF tables are conveyed to the UNFCCC. The same report and data are sent earlier to the European Commission pursuant to the timeline determined in the regulation (EU) No 525/2013.

The inventory results and methodology applied for emission estimation are also subject to wide discussions during domestic conferences and seminars. Additionally National Inventory Reports are available, in Polish, at the website of KOBIZE. Broader participation of academic circles in reviewing the overall inventory is planned under the QA procedures. For the time being such reviews were conducted occasionally.

The national inventory results are also verified by the European Union. Since 2012 this verification, being the element of inventory quality control, is performed in a wide range using the *EEA Emission Review Tool (EMRT)* available through the website. This verification is made in February and March after submission of emission results following Article 7.1 of the regulation (EU) No 525/2013. In the given time detail explanations are prepared what is accompanied by additional check of data and calculations. If the problem is acknowledged as solved, such information is set in the communication table. Potential corrections of data resulting from EU verification are introduced into emission inventory.

Two-stage procedures controlling the results of the national inventory submitted in the form of CRF files performed by the UNFCCC Secretariat also constitute important element for quality assurance of the Polish emission inventory. When analysis of questions sent is prepared under the stage 2 of the UNFCCC check, the inventory experts perform additional check of data and results and prepare the response for comments. This is the first step for international review performed by Expert Review Team. The international review of the Polish GHG inventory made on an annual basis under UNFCCC constitutes one of the key elements in the process of further improvement the quality of reported data.

There are also internal deliberations on the usefulness of an idea to engage systemically external reviewers from R&D Institutes, Branch Associations, Industrial Chambers, individual plants as well as independent experts in verification of the inventory assumptions and results. Such a scrutiny should help find cost-utility balance of this kind of an extensive review process.

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 (3.A), manure management (3.B), 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.

Data Management Manual has been elaborated in KOBiZE for the purpose of efficient governance with all important information containing databases, software, worksheets, final reports as well as QA/QC documentation regarding to inventory process. For the purposes of documentation of data and calculations QC the files are archived in electronic and hardcopy forms.

ANNEX 8. UNCERTAINTY ASSESSMENT OF THE 2016 INVENTORY

Uncertainty analysis for the year 2016 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, since submission 2015 was provided uncertainty analysis of emission trend with use of 1998 emission inventory as a base year.

Regarding industrial gases – uncertainty analysis made for HFC, PFC and SF_6 was significantly improved in submission 2017, in response to recommendations of the previous UNFCCC reviews. Previously uncertainty assumptions were applied directly to emission values of each pollutant due to lack of available information. Present calculation model was revised and extended to include uncertainties applied to activity data and emission factors. Uncertainty assessment is now performed taking into account information given on for different subcategories and single f-gases. Uncertainty is also assessed separately for manufacture, operating and decommissioning of f-gases containing equipment. Some of the assumptions for uncertainty of activity data were revised in submission 2018.

Overall results expressed in CO_2 equivalent are estimated using GWP potential given in IPCC 4th Assessment Report. To ensure consistency with the approach taken in the NIR uncertainty assessment model for f-gases covers complete set of categories resulting in emission of gases (2.C *Metal production*, 2.F *Product uses as substitutes for ODS* and 2.G *Other product manufacture and use*). No NF_3 emission sources were identified in Poland thus, it was excluded from the analysis.

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.

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

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

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

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

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

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

- sector 1. *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 2016 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*	5.4%	22.9%	45.6%	15.5%	20.6%	4.5%	**5.8%**
Emission recalculated to CO_2 eq [kt] Including IPCC 4. *LULUCF*	293 014.79	46 940.75	20 752.53	8 955.35	13.21	77.03	369 753.67
Total uncertainty Excluding IPCC 4. *LULUCF*	1.8%	22.9%	48.0%	15.5%	20.6%	4.5%	**3.9%**
Emission recalculated to CO_2 eq [kt] Excluding IPCC 4. *LULUCF*	322 233.95	46 895.92	19 530.00	8 955.35	13.21	77.03	397 705.47

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 Industry* (10%), the most precise values were reported in 1.A *Fuel Combustion* (1-2%).

Low level of uncertainty of national total of CO_2 (5.4%) 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 and Product Use* (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. 22.9% 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 Industry (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 (45.6%) 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

As mentioned in introduction to this annex, uncertainty assessment model for f-gases was redesigned and extended to cover subcategories, f-gases types, and circumstances of occurring of the emission (production, operation and decommissioning of equipment). Results of the analysis are presented by category and by gas in tables below. More details on assumptions applied are given in the detailed table on next pages. Some of the assumptions regarding uncertainty of the activity data were revised to better reflect national circumstances – in result uncertainty of the f-gases slightly increased. According to new model results lowest uncertainty was identified for manufacturing activities and the highest one for decommissioning, what is in line with observation of the national market.

Uncertainty of f-gases by categories	From manufacturing	From stocks	From disposal	Total	Contributing f-gases
TOTAL	**4.55%**	**15.36%**	**13.75%**	**14.72%**	**HFC, PFC, SF_6**
C. *Metal production*	7.07%	-	-	7.07%	SF_6
F. *Product uses as substitutes for ODS*	4.99%	15.44%	13.75%	15.48%	HFC,PFC
G. *Other product manufacture and use*	5.39%	7.07%	-	4.79%	SF_6

Uncertainty of f-gases by gases	From manufacturing	From stocks	From disposal	Total	Contributing categories
TOTAL	**4.55%**	**15.36%**	**13.75%**	**14.72%**	**2.C, 2.F, 2.G**
HFCs	4.99%	15.46%	13.75%	15.50%	2.F
PFCs	2.83%	20.62%	18.03%	20.62%	2.C, 2.F
SF_6	4.79%	7.07%	11.18%	4.54%	2.C, 2.G

Uncertainty introduced into the trend in total national emissions

In submission 2018 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 2016. 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*	2.8%	23.9%	42.4%		5.4%		**4.4%**
Emission recalculated to CO_2 eq [kt] Including IPCC 4. *LULUCF*	454 743.19	70 837.29	29 492.29		147.26		555 220.03
Total uncertainty Excluding IPCC 4. *LULUCF*	2.0%	23.9%	42.6%		5.4%		**4.0%**
Emission recalculated to CO_2 eq [kt] Excluding IPCC 4. *LULUCF*	470 884.68	70 793.13	29 322.00		147.26		571 147.07

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:

	CO_2	CH_4	N_2O
Trend uncertainty with IPCC 4. *LULUCF*	1.31%	2.95%	2.46%
Trend uncertainty without IPCC 4. *LULUCF*	1.17%	2.95%	2.39%

Uncertainty related to estimates 4. *LULUCF* and KP activities

In response to the ERT's recommendation Poland set up model to assess uncertainty of estimates for Kyoto Protocol article 3.3. and 3.4. Methodology used for this assessment were based on the "IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories", but also takes into account additional information given in the chapter 2.4.3 of the "IPCC 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol" and in the chapter 5.2 of the "IPCC Good Practice Guidance for LULUCF".

Assumptions and results of uncertainty analysis for GHG inventory, especially for sector IPCC 4. *LULUCF* were considered as basis for the assumptions applied to KP uncertainty estimates. One of the main assumption of the applied approach was to be consistent not only with uncertainty reporting in sector IPCC 4. *LULUCF*, but also with sector IPCC 3. *Agriculture*. Results of the assessment for KP Article 3.3 and 3.4 for activities selected by Poland were presented in table below.

Assumptions for the main LULUCF category 4.A *Forest Land* were based on the study made among EU countries (Laitat et al., 2000) where reported uncertainty vary between 1-15%. Regarding CO_2 emission factor GPG for LULUCF gives uncertainty varying between 10-50% (Chapter 3.2.1.1.1.4, p.3.50; Chapter 3.2.2.1.1.4, page 3.56). After analysis Poland decided to apply 10% uncertainty for activity data and 30% for CO_2 emission factor. Regarding non-CO_2 emissions GPG for LULUCF suggests to apply 70% uncertainty for emission factors (Chapter 3.2.1.4.2.4, page 3.50), but takin into account national circumstances Poland decide to apply uncertainty 80% and 100% for CH_4 and N_2O emission factors respectively.
In category 4.B Cropland Poland applied default uncertainty for CO_2 emission factor given in GPG for LULUCF, which is 75% (Chapter 3.3.1.1.1.4, page 3.73).

For category 4.C *Grassland* uncertainty for CO_2 emission factor (75%) was applied on the basis of the default data given in table 3.4.2 of the IPCC GPG for LULUCF (Chapter 3.4.1.1.1.2, page 3.109).

Regarding category 4.D *Wetland* – 75% uncertainty of CO_2 emission factor was based on information on default uncertainty for that category given in IPCC GPG for LULUCF (Chapter 3.5.2.1.1.4., page 3.139) 5.E *Settlements* – second contributing category in the LULUCF sector, where following the instruction given in chapter 3.6.2 of IPCC GPG for LULUCF – the same approach as taken in category 4.A *Forest Land* was introduced. Thus applied assumption are 10% for activity data and 30% for emission factors. Regarding Harvested Wood Product reported in category 4.G *Other* – assumptions for the CO_2 emission factor uncertainty (50%) were made on the basis of information given in table 3A.1.4 in the chapter 3a.1.3 (page 3.268) of the IPCC GPG for LULUCF.

KP Reporting	Net CO_2 emissions/ removals	Net CO_2 emissions/ removals uncertainty	CH_4	CH_4 uncertainty	N_2O	N_2O uncertainty	Net CO_2 equivalent emissions/ removals	Net CO_2 equivalent emissions/ removals uncertainty
	(kt)	**(%)**	**(kt)**	**(%)**	**(kt)**	**(%)**	**(kt)**	**(%)**
A. Article 3.3 activities							**2689.57**	**72.99%**
A.1. Afforestation and reforestation[(6)]	-2835.72	31.62%	0.11	80.62%	0.00	100.50%	-2832.82	-31.66%
A.2. Deforestation	5522.30	31.62%	NO	80.62%	0.00	100.50%	5522.39	31.62%
B. Article 3.4 activities							**-37830.88**	**-75.24%**
B.1. Forest management	-37868.99	75.17%	1.46	80.62%	0.01	100.12%	-37830.88	-75.24%

Use of uncertainty analysis results to improve inventory process

Results of uncertainty analysis are evaluated with regard to finding potential for further improvements in the inventory process. To identify areas for potential improvement uncertainty analysis is investigated together with key category analysis – this approach allows to prioritize the needs their importance. As a result of this process Poland identified category 2.F.1 *Refrigeration and air conditioning*, which has potential for future improvement and according to key category analysis has relatively high share in total emission. Depending on the availability of budget selected category will be subject to further investigation.

Planned improvements for next years

- further investigation of data for industrial gases
- revising uncertainty model used for Approach 2 (Monte Carlo analysis)
- extending model for KP art 3.3 and 3.4 uncertainty estimates to cover more detailed input data

GHG inventory 2016 – Uncertainty analysis, part 1, sector IPCC 1. *Energy*

2016	Activity [TJ]	Activity uncertainty [%]	EF CO2 Uncertainty [%]	EF CH4 Uncertainty [%]	EF N2O Uncertainty [%]	CO2 [kt]	CH4 [kt]	N2O [kt]	CO2 Emission uncertainty [%]	CH4 Emission uncertainty [%]	N2O Emission uncertainty [%]	CO2 Emission absolute uncertainty [kt]	CH4 Emission absolute uncertainty [kt]	N2O Emission absolute uncertainty [kt]
TOTAL (without LULUCF)						**322 233.95**	**1 875.84**	**65.54**	**1.8%**	**22.9%**	**48.0%**	5 811.45	430.50	31.49
TOTAL (with LULUCF)						**293 014.79**	**1 877.63**	**69.64**	**5.4%**	**22.9%**	**45.6%**	15 692.88	430.50	31.76
1. Energy						**301 820.80**	**931.53**	**8.18**	**1.9%**	**33.6%**	**12.3%**	**5766.11**	**312.68**	**1.01**
A. Fuel Combustion						**297 929.67**	**152.81**	**8.17**	**1.9%**	**11.4%**	**12.3%**	5755.01	17.42	1.01
1. Energy Industries						162 449.99	4.15	2.52	2.6%	14.9%	30.5%	4277.01	0.62	0.77
Liquid Fuels	64 696	2.0%	1.0%	10.0%	20.0%	4 549.33	0.15	0.03	2.2%	10.2%	20.1%	101.73	0.02	0.01
Solid Fuels	1 519 939	2.0%	2.0%	13.5%	35.0%	151 084.12	1.52	2.17	2.8%	13.6%	35.1%	4273.30	0.21	0.76
Gaseous Fuels	114 199	2.0%	1.0%	17.0%	40.0%	6 406.54	0.11	0.01	2.2%	17.1%	40.0%	143.25	0.02	0.00
Other fossil fuels	4 164	5.0%	5.0%	25.0%	75.0%	410.00	0.12	0.02	7.1%	25.5%	75.2%	28.99	0.03	0.01
Peat	NO					NO	NO	NO						
Biomass	81 665	10.0%	5.0%	24.0%	37.0%	8 726.27	2.24	0.30	11.2%	26.0%	38.3%	975.63	0.58	0.11
2. Manufacturing Industries and Construction						28 842.59	4.21	0.58	2.4%	12.1%	24.7%	687.12	0.51	0.14
Liquid Fuels	32 781	3.0%	1.0%	10.0%	20.0%	2 243.79	0.07	0.01	3.2%	10.4%	20.2%	70.95	0.01	0.00
Solid Fuels	144 536	3.0%	2.0%	13.5%	35.0%	15 245.07	1.27	0.19	3.6%	13.8%	35.1%	549.67	0.18	0.07
Gaseous Fuels	142 806	4.0%	1.0%	17.0%	40.0%	8 011.42	0.14	0.01	4.1%	17.5%	40.2%	330.32	0.02	0.01
Other fossil fuels	26 307	5.0%	5.0%	25.0%	75.0%	3 342.32	0.79	0.11	7.1%	25.5%	75.2%	236.34	0.20	0.08
Peat	NO					NO	NO	NO						
Biomass	65 180	10.0%	5.0%	20.0%	37.0%	7 240.34	1.94	0.26	11.2%	22.4%	38.3%	809.50	0.43	0.10
3. Transport						52 329.80	4.60	1.88	5.7%	10.2%	20.1%	2999.66	0.47	0.38
Liquid Fuels	727 482.76	3.0%	5.0%	10.0%	20.0%	51 434.31	4.49	1.87	5.8%	10.4%	20.2%	2999.11	0.47	0.38
Solid Fuels	NO	3.0%	5.0%	13.5%	35.0%				5.8%	13.8%	35.1%			
Gaseous Fuels	16 020.27	4.0%	5.0%	17.0%	40.0%	895.49	0.06	0.00	6.4%	17.5%	40.2%	57.34	0.01	0.00
Other fossil fuels	NO,NA	10.0%	5.0%	25.0%	75.0%				11.2%	26.9%	75.7%			
Biomass	18 484.83	10.0%	5.0%	24.0%	37.0%	1 308.73	0.06	0.01	11.2%	26.0%	38.3%	146.32	0.01	0.00
4. Other Sectors						54 307.28	139.86	3.20	4.3%	12.4%	16.0%	2314.57	17.40	0.51
Liquid Fuels	123 900.56	4.0%	5.0%	10.0%	20.0%	8 874.33	0.66	2.09	6.4%	10.8%	20.4%	568.23	0.07	0.43
Solid Fuels	345 653.39	4.0%	5.0%	13.5%	35.0%	32 635.92	95.52	0.52	6.4%	14.1%	35.2%	2089.72	13.45	0.18
Gaseous Fuels	227 424.79	4.0%	5.0%	17.0%	40.0%	12 758.53	1.14	0.02	6.4%	17.5%	40.2%	816.94	0.20	0.01
Other fossil fuels	355.00	4.0%	5.0%	25.0%	75.0%	38.50	0.11	0.00	6.4%	25.3%	75.1%	2.47	0.03	0.00
Peat	NO					NO	NO	NO						
Biomass	144 474.69	10.0%	5.0%	24.0%	37.0%	15 995.95	42.44	0.57	11.2%	26.0%	38.3%	1788.40	11.03	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						**3891.13**	**778.72**	**0.00**	**9.2%**	**40.1%**	**71.84%**	357.67	312.20	0.00
1. Solid Fuels						2048.15	677.51		15.0%	46.0%		307.00	311.75	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]	66.48	2.0%		50.0%			620.77			50.0%		0.00	310.63	0.00
ii. Surface Mines [Activity in Mt, EF in kg/t]	60.27	2.0%		50.0%			52.50			50.0%		0.00	26.27	0.00
1. B. 1. b. Solid Fuel Transformation [Activity in Mt, EF in kg/t]	NA					2046.64	0.00		15.0%	25.0%		307.00	0.00	
1. B. 1. c. Other [CO2 Emisson from Coking Gas Subsystem]	687.28	2.0%	10.0%	50.0%		1.51	4.23		10.2%	50.0%		0.15	2.12	
2. Oil and Natural Gas						1842.99	101.21	0.00	10.0%	16.5%	71.84%	183.53	16.70	0.00
1. B. 2. a. Oil												0.00	0.00	
2. Production [Activity in PJ, EFs in kg/PJ]	42.55	2.0%	6.6%	50.0%		0.227	3.15		6.9%	50.0%		0.02	1.57	
3. Transport [Activity in kt]	25 574.15	2.0%	6.6%	50.0%		0.015	0.16		6.9%	50.0%		0.00	0.08	
4. Refining/storage [kt]	1 095.99	2.0%	6.6%	50.0%		NA	1.23		6.9%	50.0%			0.61	
1. B. 2. b. Natural Gas												0.00	0.00	
2. Production [Activity in PJ, EF in kg/PJ]	148.74	2.0%	6.6%	50.0%		0.355	9.95		6.9%	50.0%		0.02	4.98	
3. Processing [Activity in PJ, EF in kg/PJ]	148.74	2.0%	6.6%	50.0%		5.701	4.45		6.9%	50.0%		0.39	2.23	
4. Transmission and storage [Activity in PJ, EF in kg/PJ]	612.67	2.0%	6.6%	50.0%		0.016	8.55		6.9%	50.0%		0.00	4.28	
5. Distribution [Activity in PJ, EF in kg/PJ]	612.67	2.0%	6.6%	50.0%		0.909	19.60		6.9%	50.0%		0.06	9.81	
6. Other leakage [Activity in PJ, EF in kg/PJ]	612.67	2.0%	6.6%	50.0%		0.002	0.45		6.9%	50.0%		0.00	0.22	
1. B. 2. c. Venting - Oil		5.0%	6.6%	50.0%		0.163	0.81		8.3%	50.2%		0.01	0.41	
1. B. 2. c. Venting and flaring - oil [kt]		5.0%	6.6%	50.0%	100.0%	0.029	47.67	0.00	8.3%	50.2%	100.1%			0.00
1. B. 2. c. Venting and flaring - natural gas [10^6 m3]		5.0%	6.6%	50.0%	100.0%	64.139	5.19	0.00	8.3%	50.2%	100.1%			0.00
1. B. 2. d. Other (Process emission from refineries and flaring)			NA			1771.431			10.0%					

GHG inventory 2016 – Uncertainty analysis, part 2, IPCC sector 2. *Industrial processes and product use*

2. Industrial processes and product use						**18 584.91**	**2.04**	**3.26**	**3.5%**	**33.3%**	**40.5%**	647.96	0.68	1.32
A. Mineral Industry						10 393.52			5.7%			589.59	0.00	0.00
1. Cement Production [Activity in kt, EF in t/t]	12 075.30	5.0%	5.0%			6 529.68			7.1%			461.72	0.00	0.00
2. Lime Production [Activity in kt, EF in t/t]	1 974.80	5.0%	10.0%			1 448.05			11.2%			161.90	0.00	0.00
3. Glass production [activity in kt, EFs in t/t]	2 944.39	8.0%	10.0%			471.10			12.8%					
4.a Ceramics [Activity in kt, Ef in t/t]	2 557.43	5.0%	10.0%			132.86			11.2%					
4.b Other uses of soda ash [Activity in kt, EF in t/t]	236.69	10.0%	15.0%			98.21			18.0%			17.70	0.00	0.00
4.d Other [Activity in kt, EF in t/t]	3 894.56	10.0%	15.0%			1 713.61			18.0%			308.92	0.00	0.00
B. Chemical Industry						4 902.81	1.48	2.82	4.3%	45.3%	46.5%	210.69	0.67	1.31
1. Ammonia Production [Activity in kt, EF in t/t]	2 625.76	2.0%	5.0%			3 813.60			5.4%			205.37	0.00	0.00
2. Nitric Acid Production [Activity in kt, EF in t/t]	2 340.06	2.0%	5.0%		60.0%			2.04			60.0%	0.00	0.00	1.22
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]	164.43	2.0%	10.0%		60.0%			0.78			60.0%		0.00	0.47
5. Calcium carbide production [Activity in kt, EF in t/t]	NO					NO								
6. Titanium oxide production [Activity in kt, EF in t/t]	37.97	2.0%	10.0%			NO								
7. Soda ash production [Activity in kt, EF in t/t]	1 383.68	2.0%	10.0%			NO								
8.a Methanol [Activity in kt, EF in t/t]	0.21	2.0%	5.0%	50.0%		0.14	0.00		5.4%	50.0%				
8.b Ethylene [Activity in kt, EF in t/t]	446.82	2.0%	5.0%	50.0%		850.30	1.34		5.4%	50.0%				
8.c. Ethylene Dichloride and Vinyl Chloride Monomer [Activity in kt, EF in t/t]	250.29	2.0%	5.0%	30.0%		73.66	0.01		5.4%	30.1%				
8.d. Ethylene oxide [Activity in kt, EF in t/t]	28.73	2.0%	5.0%	25.0%		24.80	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]	53.56	5.0%	5.0%	20.0%		140.32	0.00		7.1%	20.6%		9.92	0.00	0.00
8.g Other / Styrene [Activity in kt, EF in t/t]	19.80	2.0%		20.0%			0.08			20.1%		0.00	0.02	0.00
C. Metal Industry						2 551.77	0.56		5.2%	18.0%		131.92	0.10	0.00
1. Iron and Steel Production												0.00	0.00	0.00
1.b Pig iron [Activity in kt, EF in t/t]	4 673.68	5.0%	10.0%			766.14			11.2%			85.66	0.00	0.00
1.d Sinter [Activity in kt, EF in t/t]	6 850.46	5.0%	10.0%	20.0%		301.43	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]	5 145.08	5.0%	10.0%			729.29			11.2%			81.54	0.00	0.00
1.f. Electric Furnace Steel [Activity in kt, EF in t/t]	4 015.58	5.0%	10.0%			225.72			11.2%			25.24	0.00	0.00
2. Ferroalloys Production [Activity in kt, EF in t/t]	77.68	5.0%	10.0%	20.0%		310.73	0.08		11.2%	20.6%		34.74	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%			NA							0.00	0.00
6. Lead production [Activity in kt, EF w t/t]	65.73	5.0%	10.0%			34.18			11.2%			3.82		
7. Zinc production [Activity in kt, EF w t/t]	107.15	5.0%	10.0%			184.29			11.2%			20.60		
D. Non-energy Products from Fuels and Solvent Use						736.810			13.9%			102.22	0.00	0.00
1. Lubricant use	221.52					140.66			20.0%					
2. Paraffin Wax Use	145.00					91.52			20.0%					
3.a Solvents use	NE					482.26			20.0%					
3.b Urea used as catalyst	90.95					22.36			20.0%					
G. Other Product Manufacture and Use								0.44			40.3%	0.00	0.00	0.18
3. N2O from product uses [Activity in N2O used, EF in t/t]	0.44	20.0%			35.0%			0.44			40.3%			

GHG inventory 2016 – Uncertainty analysis, part 3, IPCC sector 3. *Agriculture*

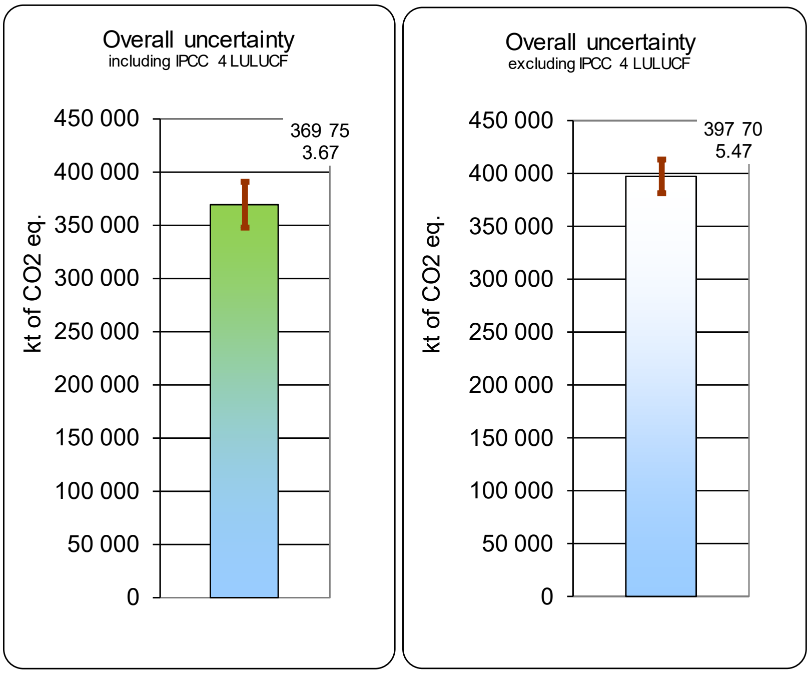
3. Agriculture						**1 040.09**	**555.20**	**50.85**	18.0%	29.4%	61.4%		162.95	31.20
A. Enteric Fermentation							491.09			32.2%			158.32	0.00
1. Cattle													0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2 332.2	5.0%		50.0%			290.70			50.2%			146.08	0.00
Non-dairy young cattle (younger than 1 year) [Activity in 1000 he	1 728.1	5.0%		50.0%			55.49			50.2%			27.88	0.00
Non-dairy young cattle 1-2 years [Activity in 1000 heads, EF in k	1 575.9	5.0%		50.0%			106.04			50.2%				
Non-dairy heifers (older than 2 years) [Activity in 1000 heads, EF	215.5	5.0%		50.0%			10.48			50.2%				
Bulls (olther than 2 years)	87.4	5.0%		50.0%			6.61			50.2%				
2. Sheep [Activity in 1000 heads, EF in kg/head]	239.1	5.0%		50.0%			1.91			50.2%			0.96	0.00
3. Swine [Activity in 1000 heads, EF in kg/head]	10 865.3	5.0%		50.0%			16.30			50.2%			8.19	0.00
4.a Goats [Activity in 1000 heads, EF in kg/head]	44.2	5.0%		50.0%			0.22			50.2%			0.11	0.00
4.b Horses [Activity in 1000 heads, EF in kg/head]	185.5	5.0%		50.0%			3.34			50.2%			1.68	0.00
B. Manure Management							63.13	6.75		61.1%	34.0%		38.60	2.30
1. Cattle													0.00	0.00
Dairy Cattle [Activity in 1000 heads, EF in kg/head]	2 332	5.0%		50.0%	100.0%		28.24	1.36		50.2%	100.1%		14.19	1.37
Non-Dairy Cattle [Activity in 1000 heads, EF in kg/head]	3 607	5.0%		50.0%	100.0%		7.71	0.85		50.2%	100.1%		3.87	0.85
2. Sheep [Activity in 1000 heads, EF in kg/head]	239	5.0%		50.0%	100.0%		0.05	0.01		50.2%	100.1%		0.02	0.01
3. Swine [Activity in 1000 heads, EF in kg/head]	10 865	5.0%		50.0%	100.0%		21.58	0.88		50.2%	100.1%		10.84	0.88
kg/head]	382	5.0%		50.0%	100.0%		0.26	0.01		50.2%	100.1%		0.13	0.01
4.b Rabbits [Activity in 1000 heads, EF in kg/head]	386	5.0%		50.0%	100.0%		0.03	0.01		50.2%	100.1%		0.02	0.01
4.c Goats [Activity in 1000 heads, EF in kg/head]	44	5.0%		50.0%	100.0%		0.01	0.00		50.2%	100.1%		0.00	0.00
4.d Horses [Activity in 1000 heads, EF in kg/head]	185	5.0%		50.0%	100.0%		0.29	0.06		50.2%	100.1%		0.15	0.06
4.e Poultry [Activity in 1000 heads, EF in kg/head]	183 786	5.0%		50.0%	100.0%		4.97	0.13		50.2%	100.1%		2.50	0.13
5.a Indirect emission [emission in kt]	NA							3.43			40.0%			1.37
D. Agricultural Soils								44.06			70.6%			31.12
a. Direct Soil Emissions														0.00
1. Inorganic N fertilizers [Activity in kg N, EF inkg N2O-N/kg N]	1 043 000 000	5.0%			150.0%			16.39			150.1%			24.60
2. Organic N fertilizers [Activity in kg N, EF inkg N2O-N/kg N]	296 174 299	5.0%			150.0%			4.65			150.1%			6.99
3. Urine and dung deposited by grazing animals [Activity in kg N	38 000 323	5.0%			150.0%			1.14			150.1%			1.71
4. Crop residues [Activity in kg N, EF inkg N2O-N/kg N]	300 189 895	5.0%			150.0%			4.72			150.1%			7.08
5. Mineralization/immobilization associated with loss/gain of so	NO	5.0%			150.0%						150.1%			0.00
6. Cultivation of organic soils (i.e. histosols) [Activity in kg N, E	679 000	5.0%			150.0%			8.54			150.1%			12.81
b. Indirect N2O Emissions from managed soils														
1. Atmospheric deposition [Activity in kg N, EF inkg N2O-N/kg	171 134 924	20.0%			150.0%			2.69			151.3%			4.07
2. Nitrogen leaching and run-off [Activity in kg N/yr, EF inkg N2	503 209 355	20.0%			150.0%			5.93			151.3%			8.97
F. Field Burning of Agricultural Residues							0.99	0.04		18.8%	101.4%		0.19	0.04
1. Cereals													0.00	0.00
Wheat [Activity in t of crop production, EF in kg/t dm]	36.917	30.0%		20.0%	150.0%		0.12	0.00		36.1%	153.0%		0.04	0.00
Barley [Activity in t of crop production, EF in kg/t dm]	10.654	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]	5.284	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]	4.625	30.0%		20.0%	150.0%		0.01	0.00		36.1%	153.0%		0.01	0.00
Rye [Activity in t of crop production, EF in kg/t dm]	11.917	30.0%		20.0%	150.0%		0.04	0.00		36.1%	153.0%		0.01	0.00
Triticale [Activity in t of crop production, EF in kg/t dm]	21.721	30.0%		20.0%	150.0%		0.07	0.00		36.1%	153.0%			
Cereals mixed [Activity in t of crop production, EF in kg/t dm]	6.730	30.0%		20.0%	150.0%		0.02	0.00		36.1%	153.0%		0.01	0.00
Millet and buckwheat [Activity in t of crop production, EF in kg/t	0.420	30.0%		20.0%	150.0%		0.00	0.00		36.1%	153.0%			
2 Pulses	0.581	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]	19	30.0%		20.0%	150.0%		0.05	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 i	68	30.0%		20.0%	150.0%		0.20	0.01		36.1%	153.0%		0.07	0.01
All straw and hey [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]	136.56	30.0%		20.0%	150.0%		0.41	0.02		36.1%	153.0%		0.15	0.03
G. Liming						663.34			22.4%					
Limestone CaCO3 [Activity in t, EF in t CO2-C/t]	539 600.41	30.0%	5.0%			237.42			30.4%					
Dolomite CaMg(CO3)2 [Activity in t, EF in t CO2-C/t]	893 539.72	30.0%	5.0%			425.92			30.4%					
H. Urea application	513 746.50	30.0%	5.0%			376.75			30.4%					

GHG inventory 2016 – Uncertainty analysis, part 4, IPCC sector 4. *Land use, land-use change and forestry* and IPCC sector 5. *Waste*

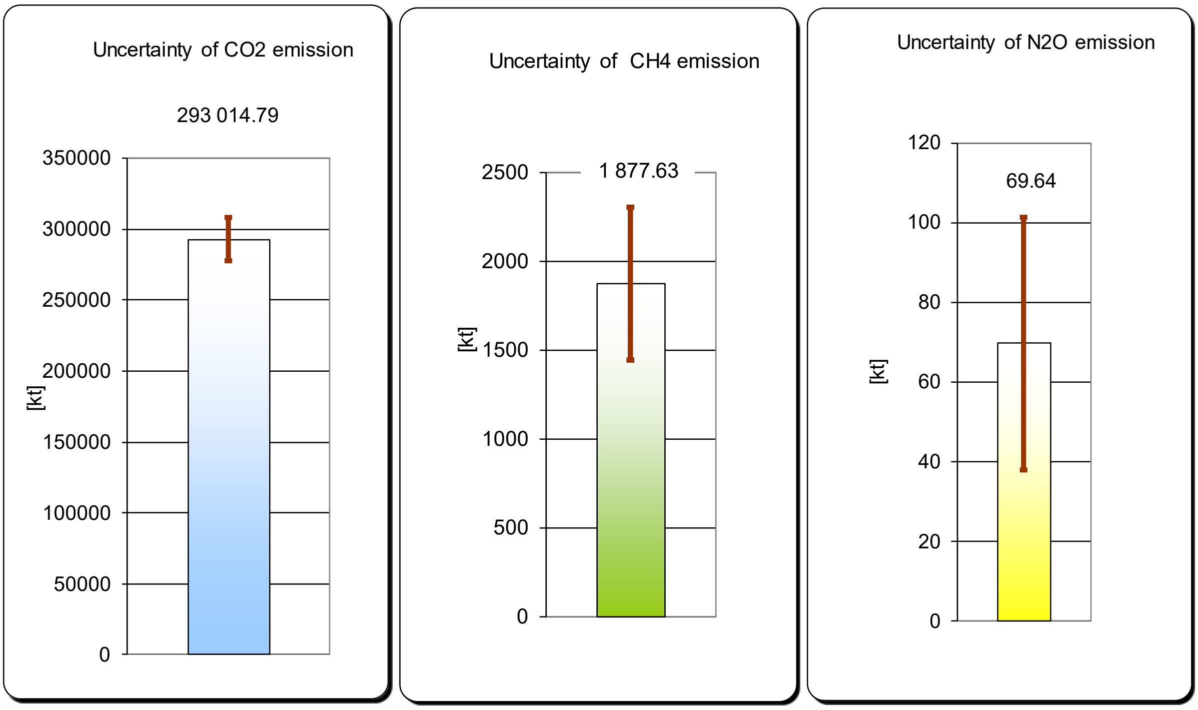
4. Land-Use, land-use change and forestry						**-29 219.16**	**1.79**	**4.10**	49.9%	71.2%	100.3%	-14577.16	1.28	4.113
A. Forest Land [Activity in kha, EF in kt/kha]	9 381.98	10.0%	30.0%	80.0%	100.0%	-36 519.30	1.57	0.01	31.6%	80.6%	100.5%	-11548.42	1.26	0.006
B. Cropland [Activity in kha, EF in kt/kha]	13 979.03	5.0%	75.0%		100.0%	733.07			75.2%		100.1%	551.02	0.00	0.000
C. Grassland [Activity in kha, EF in kt/kha]	4 120.12	5.0%	75.0%	80.0%	100.0%	-940.65	0.22	0.00	75.2%	80.2%	100.1%	0.00	0.18	0.003
D. Wetlands [Activity in kha, EF in kt/kha]	1 371.36	5.0%	75.0%			4 495.22			75.2%			3378.90	0.00	0.000
E. Settlements [Activity in kha, EF in kt/kha]	2 248.29	10.0%	30.0%		100.0%	7 247.04		4.0927	31.6%		100.5%	2291.71	0.00	4.113
F. Other Land [Activity in kha, EF in kt/kha]	84.27	5.0%	75.0%										0.00	0.000
G. Other [Activity in kt C, EF in kt/kha]	NA	5.0%	50.0%			-4 234.53			50.2%			-2127.82		
5. Waste						**788.15**	**387.07**	**3.25**	33.5%	63.8%	120.6%	264.35	246.99	3.92
A. Solid Waste Disposal							359.11			68.6%		0.00	246.44	0.00
1 Managed waste disposal sites [Activity in kt, EF in t/t MSW]	4 255.00	23.0%		100.0%			211.60			102.6%		0.00	217.12	0.00
2 Unmanaged waste disposal sites [Activity in kt, EF in t/t MSW]	NO	23.0%		100.0%			105.61			102.6%		0.00	108.37	0.00
3 Uncategorized waste disposal sites [Activity in kt, EF in t/t MS\	NO	23.0%		100.0%			41.90			102.6%		0.00	43.00	0.00
B. Biological treatment of solid waste							7.94	0.48		104.4%	153.0%	0.00	8.29	0.73
1. Composting [Activity in kt DC(1), EF in kg/kg DC]	1 984.30	30.0%		100.0%	150.0%		7.94	0.48		104.4%	153.0%	0.00	8.29	0.73
2. Anaerobic digestion in biogas installations [Activity in kt DC(1),	NO,NA	30.0%										0.00	0.00	0.00
C. Waste Incineration						788.15	0.00	0.22	33.5%	101.1%	150.7%			
1. Waste incineration [Activity in kt, EF in kg/t waste]	1 153.54	15.0%	30.0%	100.0%	150.0%	788.15	0.00	0.22	33.5%	101.1%	150.7%	264.35	0.00	0.33
2. Open burning of waste [Activity in kt, EF in kg/t waste]	NA													
D. Wastewater treatment and discharge							20.02	2.55		71.1%	150.3%	0.00	14.23	3.84
1. Domestic wastewater [Activity in kt DC(1), EF in kg/kg DC]	1 052.10	10.0%		100.0%	150.0%		9.78	2.55		100.5%	150.3%	0.00	9.83	3.84
2. Industrial wastewater [Activity in kt DC(1), EF in kg/kg DC]	384.25	10.0%		100.0%			10.24			100.5%		0.00	10.29	0.00

F- gases inventory 2016 – Uncertainty analysis for HFC, PFC and SF_6

		Activity data			*Uncertainty of activity data*			Emission factors			Uncertainty of emission factors			Emission in t			Emission in kt of CO2 equivalent				Uncertainty of emission			
		Filled into new manufactured products	In operating systems (average annual stocks)	Remaining in products at decommissioning	Uncertainty of amount filled into new manufactured products	Uncertainty of amount in operating systems	Uncertanty of amount remaining in products at decomissioning	Product manufacturing factor	Product life factor	Disposal loss factor	Uncertainty of product manufacturing factor	Uncertainty of life factor	Uncertainty of disposal loss factor	From manufacturing	From stocks	From disposal	From manufacturing	From stocks	From disposal	Total	From manufacturing	From stocks	From disposal	Total
Total	CO2 equivalent																**350 748.89**	**8 668 292.17**	**26 546.07**	**9 045 587.14**	**4.55%**	**15.36%**	**13.75%**	**14.72%**
C. Metal production																	4 145.45			4 145.45	7.07%			7.07%
3. Production of aluminium														0.00			0.00			0.00	0.00%			0.00%
CF4 [t]	CF4	NO			2%			NO			5%			0.00			0.00			0.00	5.39%			
C2F6 [t]	C2F6	NO			2%			NO			5%			0.00			0.00			0.00	5.39%			
4. Magnesium production(6)																	4 145.45			4 145.45	7.07%			7.07%
SF6 [t]	SF6	0.10			5%			1818.18			5%			0.18			4 145.45			4 145.45	7.07%			7.07%
F. Product uses as substitutes for ODS																	317 973.93	8 624 041.18	26 546.07	8 968 561.19	4.99%	15.44%	13.75%	15.48%
1. Refrigeration and airconditioning [kt of CO2 eq.]																								
Commercial refrigeration [kt of CO2 eq.]																								
HFC-125 [t]	HFC-125	80.84	3145.26	1.69	2%	30%	15%	2.00	15.00	6.96	2%	15%	25%	1.62	471.79	0.12	5 658.89	1 651 262.10	412.24	1 657 333.23	2.83%	33.54%	29.15%	33.42%
HFC-134a [t]	HFC-134a	78.66	3241.69	2.54	2%	30%	15%	0.50	16.57	6.96	2%	15%	25%	0.39	537.15	0.18	562.42	768 122.93	252.64	768 937.99	2.83%	33.54%	29.15%	33.51%
HFC-143a [t]	HFC-143a	113.18	4348.85	2.12	2%	30%	15%	2.00	16.57	18.00	2%	15%	25%	2.26	720.61	0.38	10 118.10	3 221 108.48	1 702.84	3 232 929.42	2.83%	33.54%	29.15%	33.42%
Domestic refrigeration [kt of CO2 eq.]																								
HFC-134a [t]	HFC-134a	NO	90.30	1.61	2%	15%	30%	NO	0.50	27.00	2%	15%	25%	0.00	0.45	0.43	0.00	645.64	620.76	1 266.40	2.83%	21.21%	39.05%	21.99%
Industrial refrigeration [kt of CO2 eq.]																								
Transport refrigeration [kt of CO2 eq.]																								
HFC-32 [t]	HFC-32	0.15	53.96	0.08	5%	20%	30%	4819.15	12.00	22.50	5%	15%	30%	7.19	6.47	0.02	4 853.72	4 370.36	12.10	9 236.17	7.07%	25.00%	42.43%	12.40%
HFC-125 [t]	HFC-125	217.96	809.76	0.88	5%	20%	30%	0.60	12.00	22.50	5%	15%	30%	1.31	97.17	0.20	4 577.19	340 098.99	691.01	345 367.19	7.07%	25.00%	42.43%	24.62%
HFC-134a [t]	HFC-134a	21.22	114.51	0.08	5%	20%	30%	0.60	12.00	22.50	5%	15%	30%	0.13	13.74	0.02	182.07	19 649.92	25.62	19 857.61	7.07%	25.00%	42.43%	24.74%
HFC-143a [t]	HFC-143a	255.17	1007.81	1.04	5%	20%	30%	0.60	12.00	22.50	5%	15%	30%	1.53	120.94	0.23	6 843.78	540 591.70	1 042.99	548 478.47	7.07%	25.00%	42.43%	24.64%
Mobile air-conditioning [kt of CO2 eq.]																								
HFC-134a [t]	HFC-134a	518.71	4286.08	5.02	2%	20%	30%	0.50	10.10	22.50	5%	15%	30%	2.59	432.96	1.13	3 708.78	619 137.28	1 613.65	624 459.71	5.39%	25.00%	42.43%	24.79%
Stationary air-conditioning [kt of CO2 eq.]																								
HFC-32 [t]	HFC-32	NO	4098.77	10.98	2%	50%	15%	NO	5.97	17.99	2%	15%	15%	0.00	244.66	1.97	0.00	165 145.52	1 332.75	166 478.27	2.83%	52.20%	21.21%	51.78%
HFC-125 [t]	HFC-125	1.90	3638.87	25.89	2%	50%	15%	0.50	5.96	18.00	2%	15%	15%	0.01	216.97	4.66	33.24	759 400.11	16 313.07	775 746.42	2.83%	52.20%	21.21%	51.10%
HFC-134a [t]	HFC-134a	1.38	2765.39	7.87	2%	50%	15%	0.50	5.97	17.99	2%	15%	15%	0.01	164.99	1.42	9.83	235 933.72	2 024.24	237 967.79	2.83%	52.20%	21.21%	51.76%
HFC-143a [t]	HFC-143a	0.11	229.17	0.62	2%	50%	15%	0.50	5.94	18.00	2%	15%	15%	0.00	13.62	0.11	2.43	60 883.60	502.18	61 388.20	2.83%	52.20%	21.21%	51.77%
2. Foam blowing agents [kt of CO2 eq.]																								
Closed cells																								
HFC-134a [t]	HFC-134a	NO	NO	NO	5%	10%	15%	NO	NO	NO	2%	10%	30%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.39%	14.14%	33.54%	
HFC-152a [t]	HFC-152a	272.76	125.75	NO	5%	10%	15%	95.00	2.50	NO	2%	10%	30%	259.12	3.14	0.00	32 131.13	389.82	0.00	32 520.95	5.39%	14.14%	33.54%	5.32%
HFC-227ea [t]	HFC-227ea	22.39	149.03	NO	5%	10%	15%	1.00	4.50	NO	2%	10%	30%	0.22	6.71	0.00	720.80	21 593.88	0.00	22 314.68	5.39%	14.14%	33.54%	13.69%
Open cells																								
HFC-134a [t]	HFC-134a	172.06	NO		4%	10%		100.00	NO		5%	10%		172.06	0.00		246 041.03	0.00		246 041.03	6.40%	14.14%		
3. Fire protection [kt of CO2 eq.]																								
HFC-227ea [t]	HFC-227ea	42.72	313.52	NO	2%	20%	10%	1.00	5.00	NO	2%	5%	15%	0.43	15.68	0.00	1 375.58	50 477.23	0.00	51 852.81	2.83%	20.62%	18.03%	20.07%
HFC-236fa [t]	HFC-236fa	9.12	53.01	NO	2%	20%	10%	1.00	5.00	NO	2%	5%	15%	0.09	2.65	0.00	894.67	26 001.23	0.00	26 895.90	2.83%	20.62%	18.03%	19.93%
C4F10 [t]	C4F10	NO	29.82	NO	2%	20%	10%	NO	5.00	NO	2%	5%	15%	0.00	1.49	0.00	0.00	13 208.11	0.00	13 208.11	2.83%	20.62%	18.03%	20.62%
4. Aerosols [kt of CO2 eq.]																								
Metered dose inhalers																								
HFC-134a [t]	HFC-134a	NO	87.80			30%		NO	100.00		2%	5%		0.00	87.80		0.00	125 555.92		125 555.92	2.00%	30.41%		
Other (please specify - one row per substance)																								
Technical aerosols																								
HFC-134a [t]	HFC-134a	0.36	NO		5%	30%		50.00	NO		2%	5%		0.18	0.00		260.26	0.00		260.26	5.39%	30.41%		
5. Solvents [kt of CO2 eq.]																								
HFC-43-10mee [t]	HFC-43-10mee	NO	0.28	NO		5%	10%	NO	100.00	NO	5%	10%	30%	0.00	0.28	0.00	0.00	464.67	0.00	464.67	5.00%	11.18%	31.62%	11.18%
HFC-365mfc [t]	HFC-365mfc	NO	NO	NO				NO	NO	NO	5%	10%	30%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00%	10.00%	30.00%	
G. Other product manufacture and use																	28 629.50	44 251.00		72 880.50	5.39%	7.07%		4.79%
1. Electrical equipment [kt of CO2 eq.]																								
SF6 [t]	SF6	20.93	97.04	NO	5%	5%	10%	6.00	2.00	NO	2%	5%	5%	1.26	1.94	0.00	28 629.50	44 251.00	0.00	72 880.50	5.39%	7.07%	11.18%	4.79%

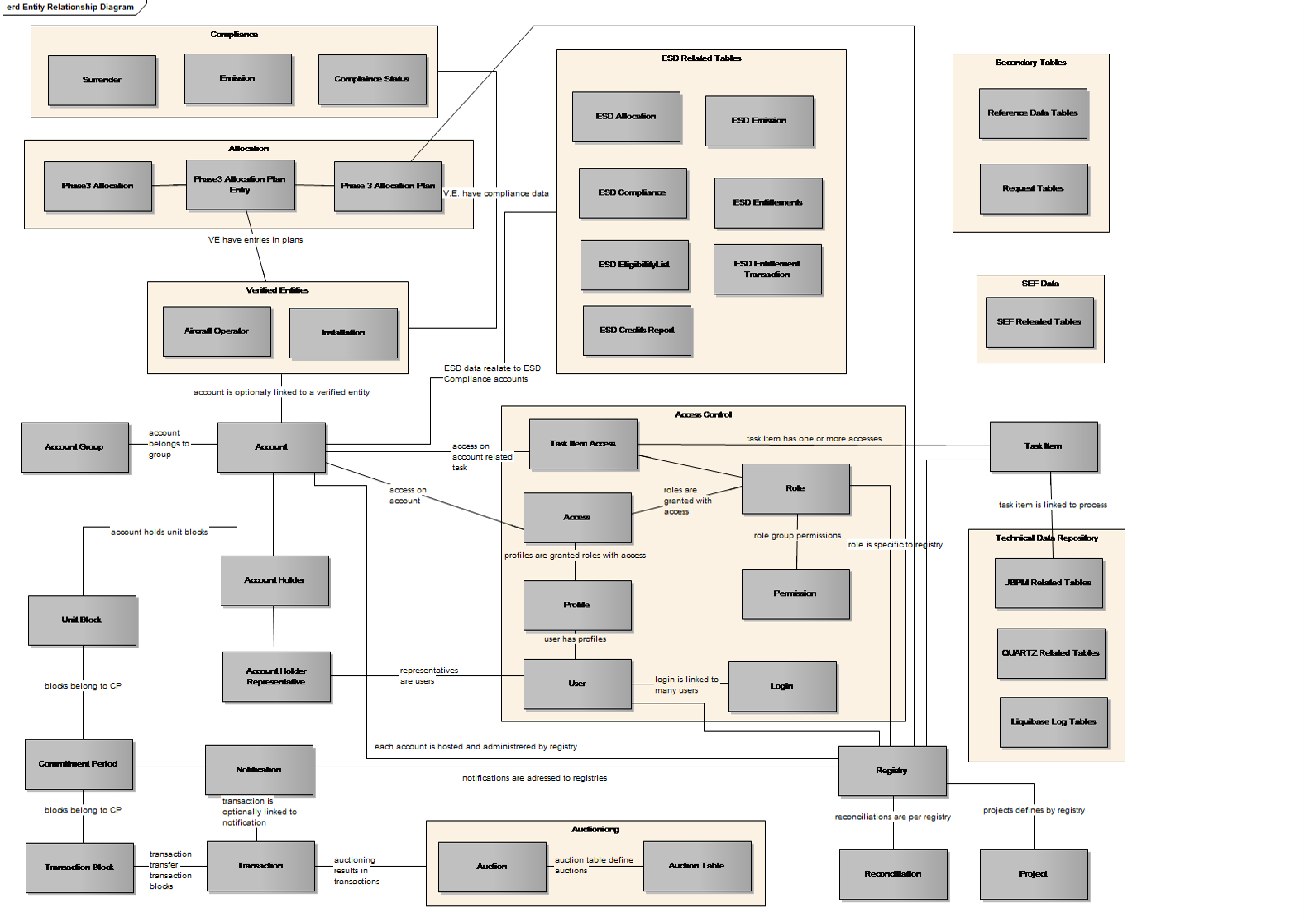


Overall emission results for 2016 including and excluding IPCC 4. *LULUCF* with uncertainties bars



Emission results for 2016 including IPCC 4. *LULUCF* with uncertainties bars

ANNEX 9. ADDITIONAL INFORMATION ON NATIONAL REGISTRY


erd Entity Relationship Diagram
Compliance
Surrender
Emission
Compliance Status
Allocation
Phase3 Allocation
Phase3 Allocation Plan Entry
Phase 3 Allocation Plan
V.E. have compliance data
VE have entries in plans
Verified Entities
Aircraft Operator
Installation
ESD Related Tables
ESD Allocation
ESD Emission
ESD Compliance
ESD Entitlements
ESD EligibilityList
ESD Entitlement Transaction
ESD Credits Report
Secondary Tables
Reference Data Tables
Request Tables
SEF Data
SEF Releated Tables
ESD data realate to ESD Compliance accounts
account is optionaly linked to a verified entity
Account Group
account belongs to group
Account
access on account related task
access on account
account holds unit blocks
Account Holder
Account Holder Representative
representatives are users
Access Control
Task Item Access
task item has one or more accesses
Task Item
Role
roles are granted with access
Access
role group permissions
role is specific to registry
profiles are granted roles with access
Permission
Profile
user has profiles
User
login is linked to many users
Login
task item is linked to process
Technical Data Repository
JBPM Related Tables
QUARTZ Related Tables
Liquibase Log Tables
Unit Block
blocks belong to CP
each account is hosted and administrered by registry
Commitment Period
Notification
notifications are adressed to registries
Registry
blocks belong to CP
transaction is optionally linked to notification
Auctioniong
reconciliations are per registry
projects defines by registry
Transaction Block
transaction transfer transaction blocks
Transaction
auctioning results in transactions
Auction
auction table define auctions
Auction Table
Reconciliation
Project

Changes from EUCR v8.0.7-v8.0.8

EUCR v FAT REPORT

Contract:	FC CLIMA.B.1/FRA/2012/0007, SC11
File location:	

Status information

Security classification:	Public	State :	FINAL
Current version number:	0.10	Date of first issue:	23-1-2017
Prepared by:	Unisystems	Date:	23-1-2017
Verified by:	Unisystems	Date:	23-1-2017
Approved by:	Unisystems	Date:	23-1-2017

Circulation / distribution list

Name	Address	I/A	Name	Address	I/A
CLIMA		A	UNSCONS		I/A

Document change record

Version	Date	Description	Affected sections
0.10	23-1-2017	Initial version	

PURPOSE:
FAT Report of v

FAT REPORT STRUCTURE:
Report includes:
* the execution status of each test case in FAT testing.
* the list of opened issues

Issue Type	UNS Jira ID	CLIMA Jira ID	Feature	Summary	Description	Test Cases	EXISTS IN PRODUCTION	SCOPE	PRIORITY	DESIGN STATUS	FAT RELEASE 23/01/2017 EXECUTION STATUS
Improvement	EUCR-3017	SDB-3499	A screen error prohibits the ITL Notification "Reversal of Storage" to be submitted; this is now fixed.	Not possible to fulfil a Reversal of Storage notification	- Go to ITL Notifications - Select notification 1027811613 and click Fulfil - Select "Cancellation" and click Next - Red screen error displayed Description Following the ongoing DES Annex H testing, we need to fulfil an ITL notification (Reversal of Storage). After selecting "Cancellation", a red screen error is displayed. Could you please investigate? The following legacy issues were noted during regression testing: Note1: AccountType, cp and check digits fields of transferring account are not validated by the system on the screen. The account's holdings are retrieved based on Registry Code and account identifier only. Note2: If the fields of transferring account are not correctly provided, the respective validation message is not fully formatted; it is in the form: "mainForm:transferringAccountCheckDigits: Validation Error: Value is required.mainForm:transferringAccountCheckDigits: Validation Error: Value is required". Note3: When a replacement is performed for a number of units (eg 2 LCER) then during transaction approval these units are displayed as doubled (4 LCER) in the authorizer's screen.	Execute UC_IN_006_TC_01: FULFIL REVERSAL OF STORAGE TRANSACTION specified in TC.16 ITL Notifications Test Cases. Note1: This ITL Notification was successfully fulfilled only as a cancellation for CP1 (PT657); replacement for CP1 was terminated. Note2: Using Soap UI the notification was not generated in EUCR, because CDM registry is missing in our environment. Note3: This issue is pending ITL feedback in order to generate this ITL notification programmatically. Note4: Testing proceeded using an ITL notification already stored in the system. Note5: During CP2 testing, issue EUCR-3125 was encountered; that issue was not implemented, as requested by CLIMA.	YES	EUCR	HIGH	DESIGNED	PASSED
Bug	EUCR-3018	SDB-3501	A screen error prohibits the ITL Notification "Non submission of certification report" to be submitted; this is now fixed.	Not possible to fulfil ITL notification - Non Submission Of Certification Report	Go to ITL Notifications - Search for notification 1027811710 and click Fulfil - Select Cancellation and click Next - Enter the transferring account RO-100-16821-0-39. Not possible to enter the acquiring account. Click Apply - Unrecoverable error RO-2396DA08-25/08/2016 12:35:19 displayed Description Following the on-going DES Annex H testing, we need to fulfil an ITL notification (Non Submission Of Certification Report). After selecting "Cancellation", a red screen error is displayed. Could you please investigate? The following legacy issues are noted during regression testing: Note1: AccountType, cp and check digits fields of transferring account are not validated when retrieving the units. The account's holdings are retrieved based on Registry Code and account identifier. Note2: If the fields of transferring account are not filled then the error message is in the form: "mainForm:transferringAccountCheckDigits: Validation Error: Value is required.mainForm:transferringAccountCheckDigits: Validation Error: Value is required" is produced and the same applies for the other fields of transferring account. Note3: When a replacement is performed for a number of units (egg 2 LCER) then during transaction approval these units are displayed as doubled (4	Execute UC_IN_007_TC_01: FULFIL NON SUBMISSION OF CERTIFICATION REPORT TRANSACTION specified in TC.16 ITL Notifications Test Cases (PT659 for cancellation) Note1: The ITL notification was generated from SOAP UI; cancellation was successful (PT665) and replacement was successful (PT660) for CP1. Note2: The ITL notification was generated from SOAP UI; cancellation was successful (PT670) and replacement was successful (PT672) for CP2. Note3: If the units selected belong to a project different than the one defined from the Notification then the transaction is terminated with response code "5171: For ICER cancellation transactions upon Reversal of Storage or a lack of a Certification report, the Project ID for ICERs to be replaced must be consistent with the Project ID contained in the replacement notification". Note4: During CP2 testing, issue EUCR-3125 was encountered; that issue was not implemented as requested by CLIMA.	YES	EUCR	HIGH	DESIGNED	PASSED

Issue Type	UNS Jira ID	CLIMA Jira ID	Feature	Summary	Description	Test Cases	EXISTS IN PRODUCTION	SCOPE	PRIORITY	DESIGN STATUS	FAT RELEASE 23/01/2017 EXECUTION STATUS
Improvement	EUCR-3075	TST-1416	When having logged in via both GSM and tokens, the stacktrace is logged; this is not needed; this is now fixed.	Stacktrace in logs	We are seeing the following exception in the logs, this clutters the production logs. The change would be to catch this exception and just log a message, i.e. instead of a stacktrace, just a log message. ####<Sep 19, 2016 9:25:01 AM MEST> <Error> <HTTP> <clieuc1p.cc.cec.eu.int> <EUCR_PRODmanaged1> <[ACTIVE] ExecuteThread: '0' for queue: 'weblogic.kernel.Default (self-tuning)'> <<WLS Kernel>> <> <> <1474269901736> <BEA-101017> <[ServletContext@3943391[app:eucr-frontend module:euregistry path:/euregistry spec-version:2.5 version:7.0.8]] Root cause of ServletException. eu.europa.ec.clima.eucr.security.authentication.exceptions.MultipleAuthorizationMethodsException: The privileged user with EID [npulkeai-30-de1799e0-c8dc-4edc-9d14-2b727e8e7467] is logged at ECAS level with both GSM and Token at eu.europa.ec.clima.eucr.security.authentication.impl.AuthenticationFilterHelper.validateEucrUser(AuthenticationFilterHelper.java:174) at eu.europa.ec.clima.eucr.security.authentication.impl.AuthenticationFilterHelper.authenticate(AuthenticationFilterHelper.java:100) at eu.europa.ec.clima.eucr.security.authentication.filter.PostAuthenticationFilter.doFilter(PostAuthenticationFilter.java:64) at weblogic.servlet.security.internal.AuthFilterChain.doFilter(AuthFilterChain.java:37) at eu.cec.digit.ecas.client.Client.processAuthenticatedUs	# Login as "nadmin1" user, using GSM number as 2nd authentication factor. # After return to EUCR, click on "Logout" # At ECAS, Do NOT click on "LOG ME OUT" # Open another browser tab and use "nadmin1" user to login , using Token as 2nd authentication factor. After step 4, login fails in EUCR and an Authentication Error is thrown In the Weblogic administration log file (AdminServer.log) the message "The privileged user with EID [nadmin1-30-00000000-0000-0000-0000-000000000000] is logged at EU login level with both GSM and Token" is displayed with no stacktrace. The same message is logged in EUCR logs:eucr_auth_provider.log,authentication.log In the context of this issue a new version of authentication provider was required and consequently the following regression tests were repeated. Regression testing: # EUCR-2990 All test cases to check Last Name/First Name allowed characters and search options # EUCR-2899 All test cases included for mobile number length # EUCR-2898 All test cases for included using wildcard in user search	YES	EUCR	HIGH	DESIGNED	PASSED
Bug	EUCR-3087	ETS-10457, ETS-10467	Enable voluntary cancellations from Former OHA; this is now fixed.	Voluntary cancellation not possible from former OHA (KYOTO 120)	There is no option in the case of former OHAs to perform voluntary cancellation in transaction selection part of the UR.	Refer to attachment "EUCR-3087 testing". Note1: All types of cancellation were tested on Former OHA. Note2: Only Voluntary and Mandatory cancellations are approved by ITL from a Former OHA. Note3: For full set of regression tests, please refer to tab "EUCR-3087 regression testing" in this document	YES	EUCR	HIGH	DESIGNED	PASSED

Issue Type	UNS Jira ID	CLIMA Jira ID	Feature	Summary	Description	Test Cases	EXISTS IN PRODUCTION	SCOPE	PRIORITY	DESIGN STATUS	FAT RELEASE 23/01/2017 EXECUTION STATUS
Bug	EUCR-3099	TST-1446, ETS-10522	When an account closure request is submitted and not yet approved and another closure request is submitted, the warning message appears empty; this is now fixed.	Empty yellow bar with no error message is displayed during closing ETS account while another request is pending	1. Go to EUCR/BG 2. Submit the request for removing an AR from the account 3. Try to close the account Actual Result: Empty yellow bar with no error message is displayed	*Case of OHA-registry PT* 1. Select an OHA account (10001790) without quantity and status OPEN 2. Select "close" from "Account Main" tab 3. Result: Your account closure request has been submitted under identifier 514600. 4. Repeat steps 1,2 5. Check that the warning message appears: "Only one account management request can be active for one account at any given time. There is a request attached to this account which has not yet been completed. Its Request ID is 514600. You can check your task list to see who is able to approve or to reject this task. You may also be able to reject the request by yourself, if no longer needed." instead of empty yellow bar 6. Perform rejection of the request *Regression testing:* 1. Close again the same account 2. Approve as another NA 3. The account closes normally. *Case of Party Holding account-registry PT* 1. Create a new account (10003671) 2. Select "close" from "Account Main" tab 4. Repeat steps 1 and 2. 5. Check that the message has been corrected. instead of empty yellow bar.Message should be the same as the one that was described in previous cases *Case of an ESD account-registry ESD* 1. Select an ESD account with zero balance (10001867) 2. Select "close" from "Account Main" tab 3. Result: Your account closure request has been submitted under identifier 514605. 4. Select "close" from "Account Main" tab 5. Check that the message has been corrected. instead of empty yellow	YES	EUCR	HIGH	DESIGNED	PASSED
Improvement	EUCR-3102	TST-1447	Voluntary cancellation was constrained by end of carry-over; this is now fixed.	Voluntary cancellation is not constrained by end-of-carry over	Voluntary cancellation is not constrained by end-of-carry over This is part of EUCR-3101. Specified on 24/11/2016.	*A. Voluntary cancellation before carry-over should complete normally* A1.Update the parameter carry.over.end.date in configuration file eucr-configuration.properties to 31/03/2021 A2.Perform Voluntary cancellation for PHA 643 from PT registry A3.Check that the transaction is completed successfully *B. Voluntary cancellation after carry-over should complete normally* B1.Update the parameter carry.over.end.date in configuration file eucr-configuration.properties to e 31/03/2015 B2.Perform Voluntary cancellation for account 10000505 from PT registry B3.Check that the transaction is completed successfully *C. Voluntary cancellation equal to carry-over should complete normally* C1.Update the parameter carry.over.end.date in configuration file eucr-configuration.properties to the date (29-03-2019) C2.Perform Voluntary cancellation for account PHA 643 from PT registry C3.Check that the transaction is completed successfully Notes on regression testing: Note1:The above test cases used CP2 units. Note2:The same tests (before,after and equal) were performed to account 643 for registry PT for CP1 units, after updating EUTL's commitment_period_code.trueup_end_date to 31/12/2025	YES	EUCR	HIGH	DESIGNED	PASSED

Issue Type	UNS Jira ID	CLIMA Jira ID	Feature	Summary	Description	Test Cases	EXISTS IN PRODUCTION	SCOPE	PRIORITY	DESIGN STATUS	FAT RELEASE 23/01/2017 EXECUTION STATUS
Improvement	EUCR-3103	ETS-10518	Screenshots additions concerning EU Login; this is now fixed.	Replacement of ECAS with EU login - screenshots	Authentication Error - Replace ECAS screenshot. Change of second authentication method without logging out from EU Login. page reference: #610 (see UCS.01 - Basic Functionalities v2.70.doc, Figure 9-7: Warning screen in case user logged in with both token and GSM) First time user page - delete ECAS logo. Page reference: #002 (see UCS.01 - Basic Functionalities v2.70.doc, Figure 9-3: First time user page)	*First Time user screen:Test Scenario1* 1. Navigate to EUCR and click on "First time user" button 2. Check that screenshot has changed according to the Use Case 3. Select the option "Login" and proceed with login using any user credentials *First Time user screen:Test Scenario2* 1. Use "First time user" button 2. *Check that screenshot has changed according to the Use Case 3. Select the option "Create an EU login account" and check that you are redirected to EU login *Warning screen in case user logged in with both token and GSM:Test Scenario3* 1. Login as "nadmin1" user, using GSM as authentication 2. After redirection to Registry home page, click on "Logout" 3. At the redirected page of EU login, Do NOT click on "LOG ME OUT" 4. Open another browser window and use the same "nadmin1" user to login , using his Token 5. Check that screenshot has changed according to Use the Case	YES	EUCR	HIGH	DESIGNED	PASSED
Improvement	EUCR-3104	TST-1450	Enable voluntary, mandatory cancellations from PersonHA; this is now fixed.	Person Account in National Registry (KYOTO 121) should be able to perform Voluntary Canc, Mand Canc and no other cancellation		*TEST SCENARIO A: Person Account in National Registry should be able to perform Voluntary Cancellation, Mandatory Cancellation and no other cancellation* A1: Select 636 account for PT registry A2: Propose Transaction A3: Check that the options for proposing cancellations are only: Voluntary cancellation and Mandatory cancellation-Pass *TEST SCENARIO B: Former OHA should be able to perform Voluntary Cancellation, Mandatory Cancellation and no other cancellation* B1: Select 360 account for GB registry B2: Propose Transaction B3: Check that the options for proposing cancellations are only: Voluntary cancellation and Mandatory cancellation Regression testing: *TEST SCENARIO C: Check that other account types (OHA) are not effected* C1: Select 10000505 account for PT registry C2: Propose Transaction C3: Check that in this case the options for proposing cancellations are all cancellations including Art 3.7 Cancellation, Ambition Increase Cancellation	YES	EUCR	HIGH	DESIGNED	PASSED
Bug	EUCR-3105	TST-1448	When cancelling all the unit blocks of an account then screen error occurs; this is now fixed.	Red screen appears during voluntary and mandatory cancellation of ALL KP units	If I propose a cancellation and the last unit block is consumed, after ECAS validation there is a red screen error.	*Test Scenario A: Cancel 1 unit block*. # The account has 1 unit block as a total balance and I propose for voluntary cancelation this unit block → (660 account for Romania) # The transaction is submitted normally *Test Scenario B: Cancel all unit blocks of different types*. # The account has 5000000 AAU (not subject to SOP) and 50 RMU unit blocks of two different types as a total balance and I propose for cancelation these unit blocks (BE account 135) # The transaction is submitted normally *Test Scenario C: Cancel all unit blocks of different types*. # The account has 199,997 CER unit blocks and 100,000 ERU from AAU as a total balance and I propose for mandatory cancelation all these unit blocks (LV account 550) # The transaction is submitted normally	YES	EUCR	HIGH	DESIGNED	PASSED

Issue Type	UNS Jira ID	CLIMA Jira ID	Feature	Summary	Description	Test Cases	EXISTS IN PRODUCTION	SCOPE	PRIORITY	DESIGN STATUS	FAT RELEASE 23/01/2017 EXECUTION STATUS

Bug	EUCR-3109	ETS-10570	Occasionally some units were shown as ESD used; this is now fixed.	All Units on National Holding Accounts of Austrian Kyoto-Protocol-Registry marked as ESD-used	All Units on National Holding Accounts of Austrian Kyoto-Protocol-Registry marked as ESD-used	*Test scenario A: Units not used ineligible (in negative list) appear correctly*
						A1. Navigate to a PHA (PT643 in our FAT).
						A2. View the account's holdings
						A3. Ensure the account has some CP1 KP units
						A4. Note the project_id (GR1 in our case)
						A5. Ensure the project is not in a negative list
						A6. Query the account's CER GR1 units and ensure they are not ESD used
						The column 'ESD used' in the holdings screen must be null:
						
						`select * from unit_block`
						`where account_id = (select account_id from account`
						`where identifier = 643)`
						`and unit_type = 'CER'`
						`and project_id = 1;`
						
						A7. Connect as CA in EU and navigate to View ICH Lists
						A8. Insert project GR1 in Art58.1 Negative List
						A9. Return to the screen of step A2 and ensure the project's units appear as Ineligible not ESD used.
						
						Test scenario B: Not used ineligible (not in negative list) appear correctly
						Repeat scenario B but in advance:
						B1. Connect as CA in EU, navigate to View ICH lists and delete the project GR1 from all lists
						B2. Navigate to the screen of step A2 and ensure the project's units appear as Ineligible not ESD used.
						
						Test scenario C: Not used ineligible (in positive list) appear correctly
						Repeat scenario B but in advance:
						C1. Connect as CA in EU, navigate to View ICH lists and add the project GR1 in General Positive list
						C2. The screen of step A2 and ensure the project's units appear as Ineligible not ESD used.
							YES	EUCR	HIGH	DESIGNED	PASSED

Bug	EUCR-3114	TST-1459	Cancellation confirmation page missed the page reference; this is now fixed.	Missing page reference in confirmation page of Cancellation	Login as NA Propose and sign any type of Cancellation. On the bottom-right of the confirmation screen, a missing page reference appears, as in the attached image.	Scenario A. Propose and approve a voluntary cancellation for account 643 PT A1. Ensure in the confirmation screen bottom-right corner a page reference exists. Repeat scenario A for mandatory cancellation Repeat scenario A for ambition increase cancellation Repeat scenario A for Art 3.7 cancellation Ensure that in all cancellation confirmation pages a reference number is displayed in the lower right corner.	YES	EUCR	HIGH	DESIGNED	PASSED
Bug	EUCR-3123		Text correction in ITL Notifications screen; this is now fixed.	ITL Notifications- Change literal from Reserval of Storage to Reversal of Storage	The ITL notification "Reversal of Storage" appears as "Reserval of Storage" in the drop-down list of ITL Notifications.	1. Connect as NA 2. Navigate to menu Kyoto Protocol -> ITL Notifications 3. Click on the drop-down list named "Type" 4. Ensure a type of "Reversal of Storage" exists and is written as such.	YES	EUCR	HIGH	DESIGNED	PASSED
									Total	12	

	TOTAL	PERCENTAGE
PASSED	12	100%
TOTAL	12	100%

KYOTO_acct_type_code	KYOTO_acct_type_description	ets_account_type_code	ETS account type code description	Description	Identifier in FAT	Allowed in EUTL 8.0.6 rule 7031	Allowed in EUCR 8.0.7	Allowed in EUCR 8.0.8	Voluntary Cancellation	Mandatory Cancellation	Art 3.7 Cancellation	Ambition Increase Cancellation	Comments
120	Operator Holding Account	0	None	Former OHA	360, GB	Yes	**NO**	**YES**	GB228	GB230	changed-there is no option	changed-there is no option	ETS-10457 and ETS-10467 requested to allow voluntary cancellations from fOHA. Since ITL does not allow art37 cancellation or amb increase cancellation from non-KYOTO-100 accounts, these options are hidden in EUCR 808 for fOHA.
100	Holding Account	8	Person Holding Account	Person Holding in K	550,LV	Yes	YES		EU1360098	EU1360099		EU1360100 terminated	Some regressions were performed. Not modified for EUCR 808
100	Holding Account	0	None	PHA	643,PT	Yes	YES		PT588	PT589	PT614	PT618 completed	Some regressions were performed. Not modified for EUCR 808
100	Holding Account	7	Operator Holding Account	OHA	10000505,PT	Yes	YES		EU1360078	EU1360092	no records for units	EU1360110	Some regressions were performed. Not modified for EUCR 808
100	Holding Account	12	Trading Account	Trading	10000954, PT	Yes	YES		EU1360084	EU1360085			Some regressions were performed. Not modified for EUCR 808
100	Holding Account	9	Aircraft Operator Account	AOHA	635,PT	Yes	YES		EU1360093	EU1360094			Some regressions were performed. Not modified for EUCR 808
121	Person Holding Account	0	None	Person account Nat	636,PT	Yes	YES		PT591	PT592	changed-there is no option	changed-there is no option	TST-1450 requested to allow voluntary cancellations from PeHA National Registry. Since ITL does not allow art37 cancellation or amb increase cancellation from non-KYOTO-100 accounts, these options are hidden here.
100	Holding Account	25	ESD Compliance account	ESD compliance acc	AT, 1000149	NO	NO		NO	NO	NO	NO	Ensured no cancellation of any kind is possible
230	VOLUNTARY_CANCELLATION_ACCOUNT	0	Cancellation account	Cancellation accour	10221, GR	NO	NO		NO	NO	NO	NO	Ensured no cancellation of any kind is possible
300	RETIREMENT_ACCOUNT	0	Retirement account	Retirement account	10088, GR	NO	NO		NO	NO	NO	NO	Ensured no cancellation of any kind is possible
			ETS clearing account			NO	NO	NO	NO	NO	NO	NO	Ensured no cancellation of any kind is possible
			ESD clearing account			NO	NO	NO	NO	NO	NO	NO	Ensured no cancellation of any kind is possible

Additional regression tests:		
Internal transfer	OHA->OHA	EU1360014
External transfer	GB->JP	JP3321
External transfer	JP->GR	JP900829
Retirement		GB232

Issue Type	Summary	Description	Test Cases	Component	Version	Status
Bug	Voluntary cancellation not possible from former OHA (KYOTO 120)	There is no option in the case of former OHAs to perform voluntary cancellation in transaction selection part of the UR.	Note1: All types of cancellation were tested on Former OHA. Note2: Only Voluntary and Mandatory cancellations are approved by ITL from a Former OHA.	EUCR	EUCR v8.0.8	PASSED
Bug	Empty yellow bar with no error message is displayed during closing ETS account while another request is pending	1. Go to EUCR/BG 2. Submit the request for removing an AR from the account 3. Try to close the account Actual Result: Empty yellow bar with no error message is displayed	*Case of OHA-registry PT* 1. Select an OHA account (10001790) without quantity and status OPEN 2. Select "close" from "Account Main" tab 3. Result: Your account closure request has been submitted under identifier 514600. 4. Repeat steps 1,2 5. Check that the warning message appears: "Only one account management request can be active for one account at any given time. There is a request attached to this account which has not yet been completed. Its Request ID is 514600. You can check your task list to see who is able to approve or to reject this task. You may also be able to reject the request by yourself, if no longer needed." instead of empty yellow bar 6. Perform rejection of the request *Regression testing:* 1. Close again the same account 2. Approve as another NA 3. The account closes normally. *Case of Party Holding account-registry PT* 1. Create a new account (10003671) 2. Select "close" from "Account Main" tab 4. Repeat steps 1 and 2. 5. Check that the message has been corrected. instead of empty yellow bar.Message should be the same as the one that was described in previous cases *Case of an ESD account-registry ESD* 1. Select an ESD account with zero balance (10001867) 2. Select "close" from "Account Main" tab 3. Result: Your account closure request has been submitted under identifier 514605. 4. Select "close" from "Account Main" tab 5. Check that the message has been corrected. instead of empty yellow bar-Message should be the same as the one that was described in previous cases	EUCR	EUCR v8.0.8	PASSED

Issue Type	Summary	Description	Test Cases	Component	Version	Status
Improvement	Voluntary cancellation is not constrained by end-of-carry over	Voluntary cancellation is not constrained by end-of-carry over This is part of EUCR-3101. Specified on 24/11/2016.	*A. Voluntary cancellation before carry-over should complete normally* A1.Update the parameter carry.over.end.date in configuration file eucr-configuration.properties to 31/03/2021 A2.Perform Voluntary cancellation for PHA 643 from PT registry A3.Check that the transaction is completed successfully *B. Voluntary cancellation after carry-over should complete normally* B1.Update the parameter carry.over.end.date in configuration file eucr-configuration.properties to e 31/03/2015 B2.Perform Voluntary cancellation for account 10000505 from PT registry B3.Check that the transaction is completed successfully *C. Voluntary cancellation equal to carry-over should complete normally* C1.Update the parameter carry.over.end.date in configuration file eucr-configuration.properties to the date (29-03-2019) C2.Perform Voluntary cancellation for account PHA 643 from PT registry C3.Check that the transaction is completed successfully	EUCR	EUCR v8.0.8	PASSED
Improvement	Replacement of ECAS with EU login - screenshots	Authentication Error - Replace ECAS screenshot. Change of second authentication method without logging out from EU Login. page reference: #610 (see UCS.01 - Basic Functionalities v2.70.doc, Figure 9-7: Warning screen in case user logged in with both token and GSM) First time user page - delete ECAS logo. Page reference: #002 (see UCS.01 - Basic Functionalities v2.70.doc, Figure 9-3: First time user page)	*First Time user screen:Test Scenario1* 1. Navigate to EUCR and click on "First time user" button 2. Check that screenshot has changed according to the Use Case 3. Select the option “Login” and proceed with login using any user credentials *First Time user screen:Test Scenario2* 1. Use “First time user” button 2. *Check that screenshot has changed according to the Use Case 3. Select the option “Create an EU login account” and check that you are redirected to EU login *Warning screen in case user logged in with both token and GSM:Test Scenario3* 1. Login as "nadmin1" user, using GSM as authentication 2. After redirection to Registry home page, click on "Logout" 3. At the redirected page of EU login, Do NOT click on "LOG ME OUT" 4. Open another browser window and use the same "nadmin1" user to login , using his Token 5. Check that screenshot has changed according to Use the Case	EUCR	EUCR v8.0.8	PASSED

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Improvement	Person Account in National Registry (KYOTO 121) should be able to perform Voluntary Canc, Mand Canc and no other cancellation		*TEST SCENARIO A: Person Account in National Registry should be able to perform Voluntary Cancellation, Mandatory Cancellation and no other cancellation* A1: Select 636 account for PT registry A2: Propose Transaction A3: Check that the options for proposing cancellations are only: Voluntary cancellation and Mandatory cancellation- Pass *TEST SCENARIO B: Former OHA should be able to perform Voluntary Cancellation, Mandatory Cancellation and no other cancellation* B1: Select 360 account for GB registry B2: Propose Transaction B3: Check that the options for proposing cancellations are only: Voluntary cancellation and Mandatory cancellation Regression testing: *TEST SCENARIO C: Check that other account types (OHA) are not effected* C1: Select 10000505 account for PT registry C2: Propose Transaction C3: Check that in this case the options for proposing cancellations are all cancellations including Art 3.7 Cancellation, Ambition Increase Cancellation	EUCR	EUCR v8.0.8	PASSED
Bug	Red screen appears during voluntary and mandatory cancellation of ALL KP units	If I propose a cancellation and the last unit block is consumed, after ECAS validation there is a red screen error.	*Test Scenario A: Cancel 1 unit block*. # The account has 1 unit block as a total balance and I propose for voluntary cancelation this unit block → (660 account for Romania) # The transaction is submitted normally *Test Scenario B: Cancel all unit blocks of different types*. # The account has 5000000 AAU (not subject to SOP) and 50 RMU unit blocks of two different types as a total balance and I propose for cancelation these unit blocks (BE account 135) # The transaction is submitted normally *Test Scenario C: Cancel all unit blocks of different types*. # The account has 199,997 CER unit blocks and 100,000 ERU from AAU as a total balance and I propose for mandatory cancelation all these unit blocks (LV account 550) # The transaction is submitted normally	EUCR	EUCR v8.0.8	PASSED

Issue Type	Summary	Description	Test Cases	Component	Version	Status
Bug	All Units on National Holding Accounts of Austrian Kyoto-Protocol-Registry marked as ESD-used	All Units on National Holding Accounts of Austrian Kyoto-Protocol-Registry marked as ESD-used	*Test scenario A: Units not used ineligible (in negative list) appear correctly* A1. Navigate to a PHA (PT643 in our FAT). A2. View the account's holdings A3. Ensure the account has some CP1 KP units A4. Note the project_id (GR1 in our case) A5. Ensure the project is not in a negative list A6. Query the account's CER GR1 units and ensure they are not ESD used The column 'ESD used' in the holdings screen must be null: A7. Connect as CA in EU and navigate to View ICH Lists A8. Insert project GR1 in Art58.1 Negative List A9. Return to the screen of step A2 and ensure the project's units appear as Ineligible not ESD used. *Test scenario B: Not used ineligible (not in negative list) appear correctly* Repeat scenario B but in advance: B1. Connect as CA in EU, navigate to View ICH lists and delete the project GR1 from all lists B2. Navigate to the screen of step A2 and ensure the project's units appear as Ineligible not ESD used. *Test scenario C: Not used ineligible (in positive list) appear correctly* Repeat scenario B but in advance: C1. Connect as CA in EU, navigate to View ICH lists and add the project GR1 in General Positive list C2. The screen of step A2 and ensure the project's units appear as Ineligible not ESD used. *Test scenario D: Some units are ESD used* D1. From the query of step A5 update one unit block and set it ESD used D2. Ensure in screen A2 that one unit of GR1 appears as ESD used only D3. From the query of step A5 update two unit blocks and set them ESD used D4. Ensure in screen A2 that two units of GR1 appear as ESD used only D5. From the query of step A5 update all unit blocks and set them ESD used D6. Ensure in screen A2 all units of GR1 appear as ESD used only *Test scenario E: Units of CP2 are shown as eligible-ineligible or ESD used depending on the case* E1. Navigate to a PHA (PT643 in our FAT). E2. View the account's holdings and the project numbers of CP2 units E3. Insert project of JP500 which is eligible in Art58.1 to Negative List	EUCR	EUCR v8.0.8	PASSED
Bug	Missing page reference in confirmation page of Cancellation	Login as NA Propose and sign any type of Cancellation. On the bottom-right of the confirmation screen, a missing page reference appears, as in the attached image.	Scenario A. Propose and approve a voluntary cancellation for account 643 PT A1. Ensure in the confirmation screen bottom-right corner a page reference exists. Repeat scenario A for mandatory cancellation Repeat scenario A for ambition increase cancellation Repeat scenario A for Art 3.7 cancellation Ensure that in all cancellation confirmation pages a reference number is displayed in the lower right corner.	EUCR	EUCR v8.0.8	PASSED
Bug	ITL Notifications-Change literal from Reserval of Storage to Reversal of Storage	The ITL notification "Reversal of Storage" appears as "Reserval of Storage" in the drop-down list of ITL Notifications.	1. Connect as NA 2. Navigate to menu Kyoto Protocol -> ITL Notifications 3. Click on the drop-down list named "Type" 4. Ensure a type of "Reversal of Storage" exists and is written as such.	EUCR	EUCR v8.0.8	PASSED