NATIONAL GREENHOUSE GAS INVENTORY REPORT OF THE CZECH REPUBLIC

SUBMISSION UNDER THE UNFCCC AND UNDER THE KYOTO PROTOCOL

REPORTED INVENTORIES 1990-2014

The present report is the official inventory submission of Czech Republic for the year 2016 under the UNFCCC and for the years 2015 and 2016 under the Kyoto Protocol

Prague

June 2016

In 2015, the Czech Republic made an inventory submission under UNFCCC, but not under the Kyoto Protocol because the CRF Reporter could not deliver CRF tables for Kyoto Protocol LULUCF activities without errors. The present report is the official inventory submission of the Czech Republic for the year 2016 under the UNFCCC and for the years 2015 and 2016 under the Kyoto Protocol, in spite of the remaining deficiencies in the CRF Reporter and underlying CRF tables. The Czech Republic should not be held liable for errors caused by the CRF Reporter in the review of the submitted information.

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Executive Summary

ES 1 Background information on greenhouse gas (GHG) inventories and climate change

As a Party to the United Nations Framework Convention on Climate Change (UNFCCC), the Czech Republic is required to prepare and regularly update national greenhouse gas (GHG) inventories. In addition, as a result of membership in the European Union, the Czech Republic must also fulfil its reporting requirements concerning GHG emissions and removals following from the Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 may 2013. This edition of National Inventory Report (NIR) deals with national greenhouse gas inventories for the period 1990 to 2014 with specific accent on the latest year 2014 while keeping track of already performed/planned changes according to the previous versions.

Inventories of emissions and removals of greenhouse gases were prepared in accord with the IPCC methodology: IPCC 2006 Guidelines, IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC, 2003). Application of this general methodology on country specific circumstances is described in category-specific chapters. When a method used to estimate emissions is improved or when some gaps are identified, a need to recalculate the whole time series may arise in order to maintain consistency. This means that data presented this year can be changed in the next submission.

The National Inventory Report is elaborated in accordance with the UNFCCC reporting guidelines (UNFCCC, 2013). However, Annex I Parties that are also Parties to the Kyoto Protocol are also required to report supplementary information required under Article 7.1 of the Kyoto Protocol that is specified by Decision 15/CPM.1. However, this inventory doesn't include submission under KP. Therefore no information about KP LULUCF is provided. The information related to KP LULUCF will be provided in next submission.

The both parts of the National Inventory Report, together with the data output - Common Reporting Format (CRF) Tables, are submitted annually by 15th March. This year the submission contain corrected CRF tables as well, where are clearly indicated problems caused by CRF Reporter. Data presented in NIR are developed based on the corrected one.

The structure of this report follows new methodical handbook published by the Secretariat "Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention" (UNFCCC, 2013).

ES 2 Summary of national emission and removal related trends

ES 2.1 GHG inventory

In 2014, the most important GHG in the Czech Republic was CO_2 contributing 81.81% to total national GHG emissions and removals expressed in kt CO_2 eq., followed by CH_4 10.71% and N_2O 5.11%. PFCs, HFCs, SF_6 and NF_3 contributed for 2.53% to the overall GHG emissions in the country.

Tab. ES 1 provides data on GHG emissions in comparison of overall trend from 1990 to 2014. For overview of GHG emissions and removals by categories please see chapter ES 3.

Tab. ES 1 GHG emission/removal overall trends

	Base year (1990)	2014	Base year (1990)	2014	trend
	[kt CO_2 eq.]		%		
CO_2 emissions without net CO_2 from LULUCF	161 668.42	101 154.38	82.76	81.81	-37.43
CO_2 emissions with net CO_2 from LULUCF	155 062.57	93 276.23	82.10	80.51	-39.85
CH_4 emissions without CH_4 from LULUCF	22 445.73	13 238.52	11.49	10.71	-41.02
CH_4 emissions with CH_4 from LULUCF	22 563.03	13 311.83	11.95	11.49	-41.00
N_2O emissions without N_2O from LULUCF	11 145.43	6 323.70	5.71	5.11	-43.26
N_2O emissions with N_2O from LULUCF	11 165.96	6 335.87	5.91	5.47	-43.26
F-gases	85.22	2 934.09	0.05	2.53	
Total (without LULUCF)	**195 344.80**	**123 650.70**			**-36.70**
Total (with LULUCF)	**188 876.77**	**115 858.02**			**-38.66**
Total (without LULUCF, with indirect)	**199 262.18**	**125 884.98**			**-36.82**
Total (with LULUCF, with indirect)	**192 794.16**	**118 092.30**			**-38.75**

Over the period 1990 - 2014 CO_2 emissions and removals decreased by 37% (excl. LULUCF), CH_4 emissions decreased by 41% during the same period mainly due to lower emissions from 1 Energy, 3 Agriculture and 5 Waste; N_2O emissions decreased by 43.26% over the same period due to emission reduction in 3 Agriculture and despite increase from the 1.A.3 Transport category. Emissions of HFCs and PFCs increased by orders of magnitude, whereas SF_6 emissions kept steady trend over the whole period.

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

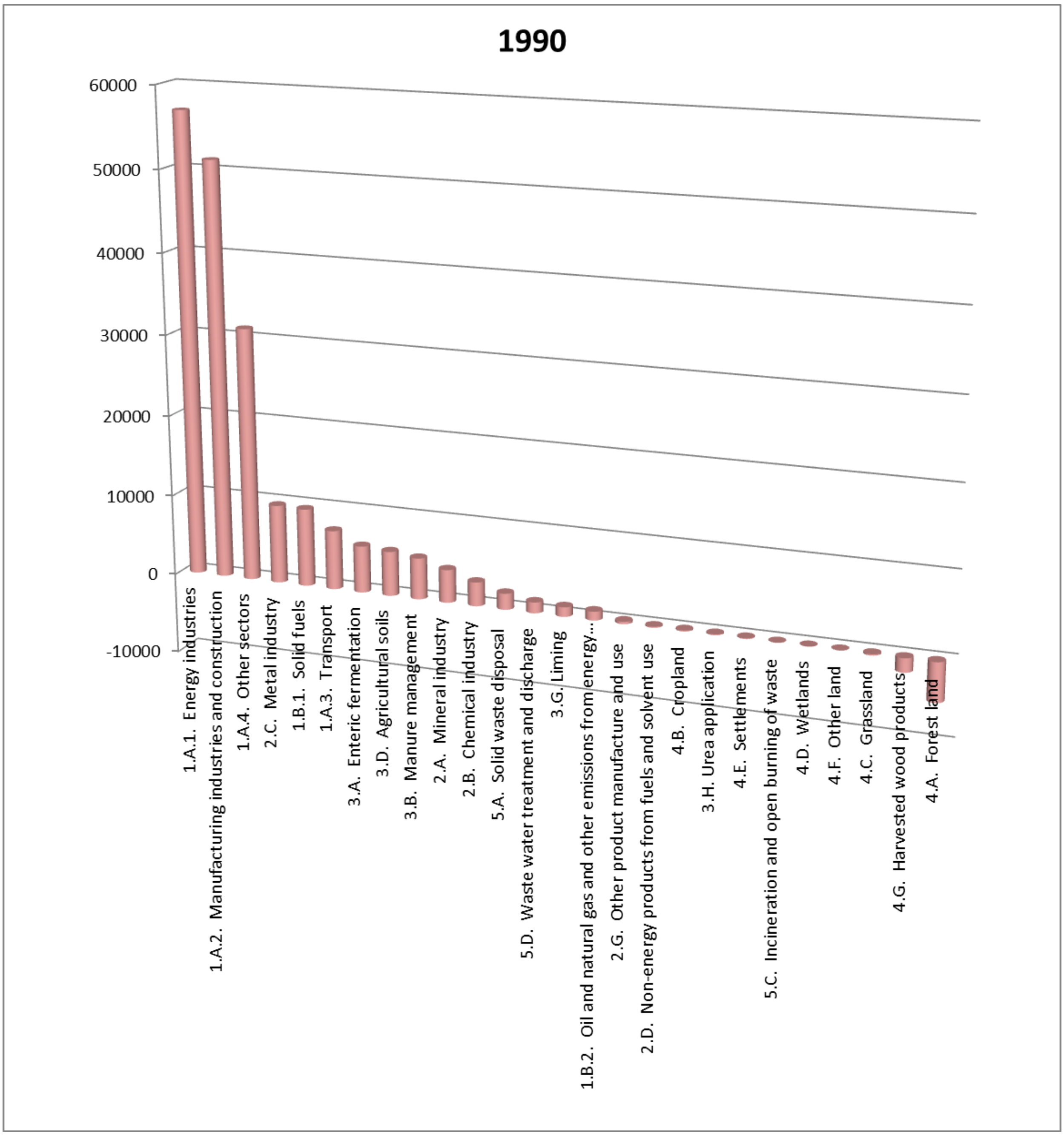


Fig. ES 1 Sources and sinks of greenhouse gases in 1990 (kt CO_2 eq.)

ES 3.1 GHG inventory

Tab. ES 2 Overview of GHG emission/removal trends by CRF categories

	Base year	2014	2014	2014	Trend
	kt CO_2 eq.	kt CO_2 eq.	Total share [%]	Sectoral share [%]	%
1. Energy	157265.99	95026.02	82.02	100.00	-39.58
A. Fuel combustion (sectoral approach)	146607.77	91063.04	78.60	95.83	-37.89
1. Energy industries	56912.49	53151.11	45.88	55.93	-6.61
2. Manufacturing industries and construction	51223.91	10037.80	8.67	10.58	-80.40
3. Transport	7284.03	17157.13	14.83	18.08	135.54
4. Other sectors	31187.34	10374.80	8.96	10.93	-66.73
5. Other	NO	342.20	0.30	0.36	
B. Fugitive emissions from fuels	10658.22	3962.98	3.42	4.18	-62.82
1. Solid fuels	9576.11	3331.17	2.88	3.51	-65.21
2. Oil and natural gas and other emissions from energy production	1082.12	631.81	0.55	0.67	-41.61
C. CO_2 transport and storage	NO	NO	NO	NO	
2. Industrial Processes	17087.65	15283.26	13.21	100.00	-10.56
A. Mineral industry	4058.64	2543.48	2.20	16.64	-37.33
B. Chemical industry	2944.23	2372.84	2.05	15.53	-19.41
C. Metal industry	9667.79	7092.70	6.13	46.41	-26.64
D. Non-energy products from fuels and solvent use	125.56	116.64	0.10	0.76	-7.10
E. Electronic industry	NO,NE	20.01	0.02	0.13	
F. Product uses as ODS substitutes	IE,NO	2835.27	2.45	18.55	
G. Other product manufacture and use	291.43	302.32	0.26	1.98	3.74
H. Other	NO	NO	NO	NO	
3. Agriculture	17615.91	8287.16	7.16	100.00	-52.96
A. Enteric fermentation	5754.89	2817.27	2.43	34.00	-51.05
B. Manure management	5082.03	2080.21	1.80	25.10	-59.07
C. Rice cultivation	NO	NO	NO	NO	
D. Agricultural soils	5492.63	3182.35	2.75	38.40	-42.06
E. Prescribed burning of savannas	NO	NO	NO	NO	
F. Field burning of agricultural residues	NO	NO	NO	NO	
G. Liming	1177.82	150.29	0.13	1.81	-87.24
H. Urea application	108.53	57.03	0.05	0.69	-47.45
I. Other carbon-containing fertilizers	NO	NO	NO	NO	
J. Other	NO	NO	NO	NO	
4. Land use, land-use change and forestry	-6468.02	-7792.68	-6.73	100.00	20.48
A. Forest land	-4838.96	-7310.63	-6.32	93.81	51.08
B. Cropland	120.62	17.14	0.01	-0.22	-85.79
C. Grassland	-145.34	-569.10	-0.49	7.30	291.57
D. Wetlands	21.51	26.76	0.02	-0.34	24.44
E. Settlements	85.09	127.60	0.11	-1.64	49.96
F. Other land	0.00	8.55	NO	NO	
G. Harvested wood products	-1712.95	-94.13	-0.08	1.21	-94.50
H. Other	NO	NO	NO	NO	
5. Waste	3375.25	5054.26	4.36	100.00	49.74
A. Solid waste disposal	1979.27	3330.79	2.87	66.00	68.28
B. Biological treatment of solid waste	NE,IE	654.29	0.56	12.95	
C. Incineration and open burning of waste	23.57	134.13	0.12	2.65	469.09
D. Waste water treatment and discharge	1372.41	935.05	0.81	18.50	-31.87
E. Other	NO	NO	NO	-	-
Total CO_2 equivalent emissions without land use, land-use change and forestry	**195344.80**	**123650.70**	**-**	**-**	**-36.70**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**188876.77**	**115858.02**	**100.00**	**-**	**-38.66**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**199262.18**	**125884.98**	**-**	**-**	**-36.82**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**192794.16**	**118092.30**	**-**	**-**	**-38.75**

In 2014, 95 026.02 kt CO_2 eq., that are 82.02% of national total emissions (including 4 Land Use, Land-Use Change and Forestry) arose from 1 Energy; 95.83% of these emissions arise from fuel combustion activities. The most important sub-category of 1 Energy with 55.93% of total sectoral emissions in 2014 is 1.A.1 Energy Industries, 1.A.2 Manufacturing Industries and Construction responses for 10.58% and 1.A.3 Transport for 18% of total sectoral emissions. From 1990 to 2014 emissions from 1 Energy decreased by 39.6%.

2 Industrial Processes is the second largest category with 13.21% of total GHG emissions (including 4 Land Use, Land-Use Change and Forestry) in 2014 (15 283.26 kt CO_2 eq.); the largest sub-category is 2.C Metal Production with 46.41% of sectoral share. From 1990 to 2014 emissions from 2 Industrial Processes decreased by 10.56%.

3 Agriculture is the third largest category in the Czech Republic with 7.16% share of total GHG emissions (including 4 Land Use, Land-Use Change and Forestry) in 2014 (8 287.16 kt CO_2 eq.); 38.40% of these emissions arose from 3.D Agricultural Soils. From 1990 to 2014 emissions from 3 Agriculture decreased by 52.96%.

4 Land Use, Land-Use Change and Forestry is the only category where removals exceed emissions. Net removals from this category increased from 1990 to 2014 by 20.48% to -7 792.68 kt CO_2 eq.

4.36% of the national total GHG emissions (including 4 Land Use, Land-Use Change and Forestry) in 2014 arose from 5 Waste. 68.28% share of GHG emissions arose from 5.A Solid waste disposal. Emissions from 5 Waste increased from 1990 to 2014 by 49.74% to 5 054.26 kt CO_2 eq.

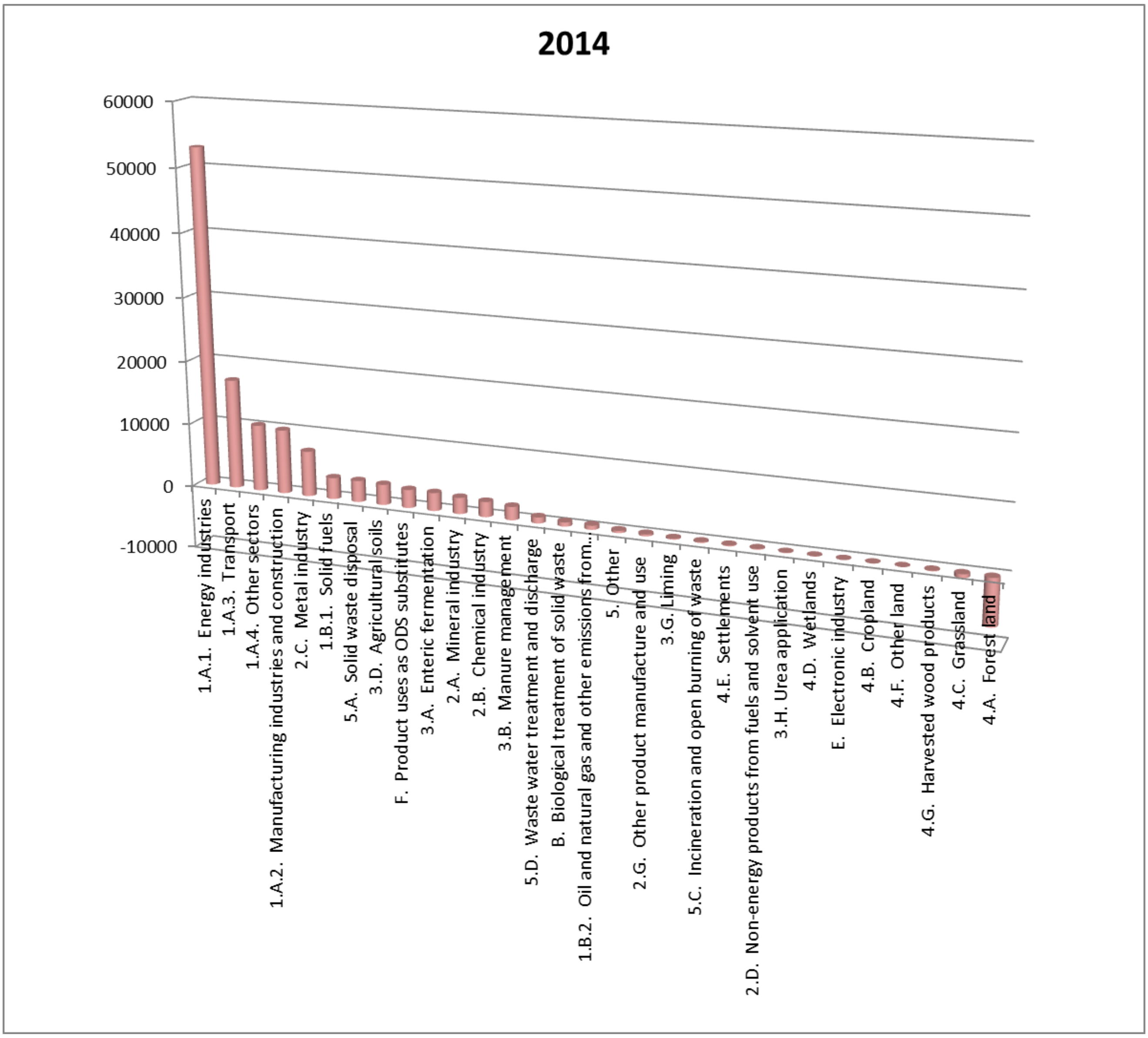


Fig. ES 2 Sources and sinks of greenhouse gases in 2014 (kt CO_2 eq.)

ES 3.2 KP-LULUCF activities

The following information is related to the submission in 2015 as well as to the submission in 2016.

Emission and removals estimates of GHGs for the KP LULUCF activities and HWP contribution for the years 2013-2014 are presented in Tables ES 4 to 6.

Tab. ES 3 Overview of KP-LULUCF article 3.3 activities

A. Article 3.3 activities	**Unit**	**2013**	**2014**
A.1. Afforestation and Reforestation			
CO_2 emissions/removals	Gg	-492.61	-549.76
CH_4	Gg	NO	NO
N_2O	Gg	NO	NO
Net CO_2 equivalent emissions/removals	Gg CO_2 eq.	-492.61	-549.76
A.2. Deforestation			
CO_2 emissions/removals	Gg	233.89	230.86
CH_4	Gg	NO	NO
N_2O	Gg	0.00	0.00
Net CO_2 equivalent emissions/removals	Gg CO_2 eq.	234.27	231.19

**0.00 represents a non-zero value lower than 0.005*

Tab. ES 4 Overview of KP-LULUCF article 3.4 activities

B. Article 3.4 activities	**Unit**	**2013**	**2014**
B.1. Forest Management			
CO_2 emissions/removals	Gg	-6 341.64	-6 266.58
CH_4	Gg	2.59	2.88
N_2O	Gg	0.02	0.02
Net CO_2 equivalent emissions/removals	Gg CO_2 eq.	-6 271.55	-6 188.05

Tab. ES 5 Overview of KP-LULUCF estimates of HWP contribution

Harvested Wood Products	**Unit**	**2008**	**2009**
HWP contribution			
CO_2 emissions/removals	Gg	-133.95	-94.13
CH_4	Gg	NO	NO
N_2O	Gg	NO	NO
Net CO_2 equivalent emissions/removals	Gg CO_2 eq.	-133.95	-94.13

ES 4 Other information

ES 4.1 Overview of emission estimates and trends of precursor gases + NH_3

Emission estimates of indirect GHGs and SO_2 for the period from 1990 to 2014 are presented in Tab. ES 3.

Tab. ES 6 Indirect GHGs and SO_2 for 1990 to 2014 [kt]

	NO_X	CO	NMVOC	SO_X (as SO_2)	NH_3
1990	738.52	1068.64	300.70	1870.91	NE
1991	723.47	1153.04	272.97	1767.49	NE
1992	699.43	1158.25	257.47	1554.42	NE
1993	684.06	1189.87	233.04	1466.04	NE
1994	441.29	1070.90	255.31	1284.80	NE
1995	418.85	927.52	215.35	1090.23	NE
1996	437.65	960.26	265.16	931.11	NE
1997	461.65	976.05	271.86	977.45	NE
1998	408.21	802.10	267.15	438.27	NE
1999	375.14	720.96	247.17	264.35	NE
2000	339.09	808.26	255.39	224.54	4.40
2001	339.67	834.32	254.72	223.85	4.43
2002	329.32	807.50	243.57	219.98	4.57
2003	329.89	840.59	240.24	215.59	4.86
2004	327.61	814.81	230.68	211.54	4.79
2005	320.54	773.11	223.34	208.26	4.91
2006	313.44	761.32	218.30	203.29	4.99
2007	311.59	784.64	212.14	208.78	5.09
2008	294.00	711.35	200.04	168.71	5.14
2009	272.20	660.23	189.23	165.87	5.06
2010	262.03	692.74	185.43	160.39	4.85
2011	248.02	610.95	169.23	160.53	4.83
2012	234.62	611.93	163.99	154.82	4.71
2013	222.35	617.45	161.60	138.03	4.53
2014	211.59	558.05	152.21	127.08	4.46
Trend [%]	**-71.35%**	**-47.78%**	**-49.38%**	**-93.21%**	**1.21%**
NEC	**286**	**-**	**220**	**265**	**101**

[1]NEC - National Emission Ceilings according to Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001

Emissions of indirect greenhouse gases decreased from the period from 1990 to 2014: for NO_X by 71.35%, for CO by 47.78%, for NMVOC by 49.38% and for SO_2 by 93.21%. The most important emission source for indirect greenhouse gases and SO_2 are fuel combustion activities, for details see chapter 9 in Part1: Annual inventory report.

Part 1: Annual inventory submission

1 Introduction

1.1 Background information on GHG inventories and climate change

1.1.1 Climate change

Greenhouse gases (i.e. gases that contribute to the greenhouse effect) have always been present in the atmosphere, but in recent history the concentrations of a number of them are increasing as a result of human activity. Over the past century, the atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and halogenated hydrocarbons, i.e. greenhouse gases, have increased as a consequence of human activity. Greenhouse gases prevent the radiation of heat back into space and cause warming of the climate. According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2014), the atmospheric concentrations of CO_2 have increased by 40%, primarily from fossil fuels emissions and secondarily from net land use change emissions. CH_4 concentrations increased by 150% and N_2O concentrations have risen by 20%, compared with the pre-industrial era. Ground-level ozone also contributes to the greenhouse effect. The amount of ozone formed in the lower atmosphere has increased as a result of emissions of nitrogen oxides, hydrocarbons and carbon monoxide.

Relatively new, man-made greenhouse gases that are entering the atmosphere cause further intensification of the greenhouse effect. These include, in particular, a number of substances containing fluorine (F-gases), among them HFCs (hydrofluorocarbons). HFCs are used instead of ozone-layer-depleting CFCs (freons) in refrigerators and other applications, and their emissions are on rapid increase. Compared with carbon dioxide, all the other greenhouse gases occur at low (CH_4, N_2O) or very low concentrations (F-gases). On the other hand, these substances are more effective (per molecule) as greenhouse gases than carbon dioxide, which is the main greenhouse gas.

The threat of climate change is considered to be one of the most serious environmental problems faced by humankind. The globally averaged land and ocean surface temperature has risen by about 0.85 °C in the period 1880 to 2012 according to the IPCC 5AR. The increase of the average surface temperature of the Earth, together with the increase in the surface temperature of the oceans and the continents, will lead to changes in the hydrologic cycle and to significant changes in the atmospheric circulation, which drives rainfall, wind and temperature on a regional scale. This will increase the risk of extreme weather events, such as hurricanes, typhoons, tornadoes, severe storms, droughts and floods.

In consequence of scientific indications that human activities influence the climate and an increasing public awareness about local and global environmental issues during the middle of the 1980s, climate change became part of the political agenda. The *Intergovernmental Panel on Climate Change* (IPCC) was established in 1988 and, two years later, it concluded that anthropogenic climate change is a global threat and asked for an international agreement to deal with the problem. The *United Nations* started negotiations to create a *UN Framework Convention on Climate Change* (UNFCCC), which came into force in 1994. The long-term goal consisted in stabilizing the amount of greenhouse gases in the atmosphere at a level where harmful anthropogenic climate changes are prevented. Since UNFCCC came into force, the Framework Convention has evolved and a Conference of the Parties (COP) is held every year. The most important addition to the Convention was negotiated in 1997 in Kyoto, Japan. The *Kyoto Protocol* established binding obligations for the Annex I countries (including all EU member states and other industrialized countries). Altogether, the emissions of greenhouse gases by these countries should be at least 5% lower during 2008-2012 compared to the base year of 1990 (for fluorinated greenhouse gases, 1995 can be used as a base year). In 2001 the Czech Republic ratified the *Kyoto Protocol* and it came into force on February 16, 2005, even though it has not been ratified by the United States.

Under the *Kyoto Protocol,* the Czech Republic is committed to decrease its emissions of greenhouse gases in the first commitment period, i.e. from 2008 to 2012, by 8% compared to the base year of 1990 (the base year for F-gases is 1995). During the second commitment period (CP2) of Kyoto Protocol, the EU, its member states and Iceland should reduce average annual emissions during 2013 - 2020 by 20% compared to base year.

1.1.2 Greenhouse gas inventories

Annual monitoring of greenhouse gas emissions and removals is one of the obligations following from the *UN Framework Convention on Climate Change* and its *Kyoto Protocol*. In addition, as a result of membership in the European Union, the Czech Republic must also fulfil its reporting requirements concerning GHG emissions and removals following 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. This Decision also requires establishing a National Inventory System (NIS) pursuant to the *Kyoto Protocol* (Art. 5.1) from December 2005.

The *Czech Hydrometeorological Institute* (CHMI) was appointed in 1995 by the *Ministry of Environment* (MoE), which is the founder and supervisor of CHMI, to be the institution responsible for compiling GHG inventories. Thereafter, CHMI has been the official provider of Czech greenhouse gas emission data. The role of CHMI was improved following implementation of NIS in 2005, when CHMI was designated by MoE as the coordinating institution of the official national GHG inventory.

The inventory covers anthropogenic emissions of direct greenhouse gases CO_2, CH_4, N_2O, HFC, PFC, SF_6, NF_3 and indirect greenhouse gases NO_X, CO, NMVOC, NH_3 and SO_2. Indirect means that they do not contribute directly to the greenhouse effect, but that their presence in the atmosphere may influence the climate in various ways. As mentioned above, ozone (O_3) is also a greenhouse gas that is formed by the chemical reactions of its precursors: nitrogen oxides, hydrocarbons and/or carbon monoxide.

The obligations of the *Kyoto Protocol* have led to an increased need for international supervision of the emissions reported by the parties. The Kyoto Protocol therefore contains rules for how emissions should be estimated, reported and reviewed. Emissions of the direct greenhouse gases CO_2, N_2O, CH_4, HFCs, PFCs, SF_6 and NF_3 are calculated as CO_2 equivalents and added together to produce a total. Together with the direct greenhouse gases, also the emissions of NO_X, CO, NMVOC, NH_3 and SO_2 are reported to UNFCCC. These gases are not included in the obligations of the Kyoto Protocol. The emission estimates and removals are reported by gas and by source category and refer to 2014. Full time series of emissions and removals from 1990 to 2014 are included in the submission.

Inventories of emissions and removals of greenhouse gases were prepared according to the IPCC methodology: *2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006)*; application of this general methodology under country-specific circumstances will be described in the sector-specific chapters. Since this submission the inventory was prepared using new updated methodology. Ale changes were conducted in the whole time-series. Details of specific changes are provided in specific chapters in this report. When a method used to estimate emissions is improved or when some gaps are identified, a need to recalculate the whole time series may arise in order to maintain consistency. This means that data presented this year can change in the next submission.

The 19. Conference of Parties agreed on Decision 24/CP.19 “Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention”, which establishing reporting requirements. This report attempts to follow this methodical handbook.

The current data submission (2016) for the EU contains all the data sets for 1990 - 2014 in the form of the official UNFCCC software called CRF Reporter. Since submission reported in 2015 the CRF Reporter was updated based on the new methodology in scope of different categorization and QWPs. The current version of CRF Reporter is web-based software, which is not considered fully reliable, especially concerning KP LULUCF tables. Additionally, current version of CRF Reporter is adding digits after decimal point during importing of tables, as well as it doesn’t show appropriate notation keys in sum categories. The Party would like to note, that all subcategories are filled up with data, or appropriate notation keys. Since official exported CRF tables are for few categories not calculated correctly, the NIR also contains additional Annex, where the corrected values are displayed.

This submission also contains relevant Annex regarding Dec. 529/2014 (Annex 6).

1.2 A description of the national inventory arrangements

1.2.1 Institutional, legal and procedural arrangements

The National Inventory System (NIS), as required by the *Kyoto Protocol* (Article 5.1) and by Regulation No. 525/2013/EC, has been in place since 2005. As approved by the *Ministry of Environment* (MoE), which is the single national entity with overall responsibility, the founder of CHMI and its superior institution.

The *Czech Hydrometeorological Institute* (CHMI), under the supervision of the *Ministry of the Environment*, is designated as the coordinating and managing organization responsible for the compilation of the national GHG inventory and reporting its results. The main tasks of CHMI consist in inventory management, general and cross-cutting issues, QA/QC, communication with the relevant UNFCCC and EU bodies, etc. Mrs. Eva Krtková is the responsible person at CHMI.

Sectoral inventories are prepared by sectoral experts from sector-solving institutions, which are coordinated and controlled by CHMI:

- KONEKO marketing Ltd. (KONEKO), Prague, is responsible for compilation of the inventory in sector 1. Energy, for stationary sources including fugitive emissions
- Transport Research Centre (CDV), Brno, is responsible for compilation of the inventory in sector 1. Energy, for mobile sources
- Czech Hydrometeorological Institute (CHMI), Prague, is responsible for compilation of the inventory in sector 2. Industrial Processes and Product Use
- Institute of Forest Ecosystem Research Ltd. (IFER), Jilove u Prahy, is responsible for compilation of the inventory in sectors 3. Agriculture and 4. Land Use, Land Use Change and Forestry
- Charles University Environment Centre (CUEC), Prague, is responsible for compilation of the inventory in sector 5. Waste.

Official submission of the national GHG Inventory is prepared by CHMI and approved by the *Ministry of Environment*. Moreover, the MoE secures contacts with other relevant governmental bodies, such as the *Czech Statistical Office*, the *Ministry of Industry and Trade* and the *Ministry of Agriculture*. In addition, the MoE provides financial resources for the NIS performance to the CHMI, which annually concludes contracts with sector-solving institutions.

More detailed information about NIS is given in the *Initial Report* (MoE, 2006) and in the 6th *National Communication* (MoE, 2014).

1.2.2 Overview of inventory planning, preparation and management

UNFCCC, the *Kyoto Protocol* and the EU greenhouse gas monitoring mechanism require the Czech Republic to annually submit a *National Inventory Report* (NIR) and *Common Reporting Format* (CRF) tables. The annual submission contains emission estimates for the second but last year, so the 2015 submission contains estimates for the calendar year of 2014. The organisation of the preparation and reporting of the Czech greenhouse gas inventory and the duties of its institutions are detailed in the previous section (1.2.1).

The preparation of the inventory includes the following three stages:

- inventory planning
- inventory preparation
- inventory management.

During the first stage, specific responsibilities are defined and allocated: as mentioned before, CHMI coordinates the national GHG inventory, including the planning period. Within the inventory system, specific responsibilities, “sector-solving institutions”, are defined for the different source categories, as well as for all activities related to the preparation of the inventory, including QA/QC, data management and reporting.

During the second stage, the inventory preparation process, experts from sector-solving institutions collect activity data, emission factors and all the relevant information needed for final estimation of emissions. They also have specific responsibilities regarding the choice of methods, data processing and archiving. As part of the inventory plan, the NIS coordinator approves the methodological choice. Sector-solving institutions are also responsible for performing Quality Control (QC) activities that are incorporated in the QA/QC plan, (see Chapter 1.2.3). All data collected, together with emission estimates, are archived (see below) and documented for future reconstruction of the inventory.

In addition to the actual emission data, the background tables of the CRF are filled in by the sectoral experts, and finally QA/QC procedures, as defined in the QA/QC plan, are performed before the data are submitted to the UNFCCC.

For the inventory management, reliable data management to fulfil the data collecting and reporting requirements is necessary. As mentioned above, data are collected by the experts from the sector solving institutions and the reporting requirements increase rapidly and may change over time. The data and calculation spreadsheets are stored in a central network server at CHMI, which is regularly backed up to ensure data security. The inventory management includes a control system for all documents and data, for records and their archives, as well as documentation on QA/QC activities (see Chapter 1.2.3).

1.2.3 Quality assurance, quality control and verification plan

In the “in-country review” in October of 2009, the original QA/QC plan was considered inadequate and thus it was necessary to immediately establish a new conception of the QA/QC plan, an outline of which is presented in this chapter.

The QA/QC system is an integral part of the national system. It ensures that the greenhouse gas inventories and reporting are of high quality and meet the criteria of transparency, consistency, comparability, completeness, accuracy and timeliness set for the annual inventories of greenhouse gases.

The objective of the National Inventory System (NIS) is to produce high-quality GHG inventories. In the context of GHG inventories, high quality provides that both the structures of the national system (i.e. all institutional, legal and procedural arrangements) for estimating GHG emissions and removals and the inventory submissions (i.e. outputs, products) comply with the requirements, principles and elements arising from UNFCCC, the *Kyoto Protocol*, the IPCC guidelines and the EU GHG monitoring mechanism (Regulation No 525/2013/ of the European Parliament and of the Council).

Annex A5. 4 provides general form for QC procedures which is used in CR by each sectoral expert. Possible findings are examined and if possible corrected or included in Improvement plan for future submissions.

This year the meeting with Slovak National Inventory team in order to discuss difficulties in processing GHG inventories in both teams was held. Several general issues were discussed, for instance improving the cooperation in the field of QA/QC. Further information and potential problems concerning Agriculture and LULUCF sectors were conferred. Similar bilateral meeting will be held next year (2016) in May.

1.2.3.1 CHMI as a coordinating institution of QA/QC activities

The NIS coordinator (NIS manager) from the *Czech Hydrometeorological Institute* (CHMI) controls and facilitates the quality assurance and quality control (QA/QC) process and nominates QA/QC guarantors from all sector-solving institutions. The NIS coordinator cooperates with the archive administrator on implementation and documentation of all the QA/QC procedures.

The Czech NIS team, which consists of involved experts from CHMI and experts from sector-solving institutions, cooperates in addressing QA/QC issues and in development and improvement of the QA/QC plan. QA/QC issues are discussed regularly (about four times a year) by the CHMI experts and the sectoral expert at bilateral meetings. At least once a year, a joint meeting of all the involved experts is organised by CHMI (by the NIS coordinator). The work of the Czech inventory team is regularly checked (at least three times a year) by the *Ministry of the Environment* (MoE) during supervisory days. At these times, the NIS coordinator provides MoE with information about all QA/QC activities and discusses the potential for any further improvements. MoE also annually approves the QA/QC plan prepared by CHMI in cooperation with the sector-solving institutions.

An electronic quality manual including e.g. guidelines, plans, templates and checklists has been developed by CHMI and is available to all participants in the national inventory system via the Internet (FTP server of NIS). All the relevant documentation concerning QA/QC activities is archived centrally at CHMI.

In addition to consideration of the special requirements of the guidelines concerning greenhouse gas inventories, the development of the inventory quality management system follows the principles and requirements of the ISO 9001 standard. ISO 9001 certification was awarded to CHMI in March 2007.

The CHMI ISO 9001 working manual encompasses the NIS segment, which is obligatory for the relevant experts at CHMI and is also recommended for experts from the sector-solving institutions. The NIS segment is developed in the form of flow-charts (diagrams) and consists of three sub-segments: (i) Planning and management of GHG inventories (ii) Preparation of sectoral inventories (iii) Compilation of data and text outputs.

In this way, the NIS segment defines the rules for cooperation between CHMI as coordinating institution and the experts from the sector-solving institutions. This involves the phase of inventory planning (including QA/QC procedures) and provides instructions for the inventory compilation and for preparation of data and text outputs (CRF Tables, NIR). All the main principles mentioned above are also incorporated into the regular contracts between the CHMI and the sector-solving institutions, which are renewed annually.

QA/QC plan is regularly updated. This years' amendment was focused mainly on documentation of performed QA/QC procedures and improvement of the archiving system.

1.2.3.2 QA/QC process

The starting point for preparing a high-quality GHG inventory consists in consideration of the expectations and requirements directed at the inventory. The inventory principles defined in the UNFCCC and IPCC guidelines, that is, transparency, consistency, comparability, completeness, accuracy and timeliness, are dimensions of quality for the inventory and form the set of criteria for assessing the output produced by the national inventory system. In addition, the principle of continuous improvement is included.

Since this submission updated QA/QC forms were used for QA/QC procedures. The forms follows the IPCC 2006 Gl. (IPCC, 2006) and reflects specific issues for the Czech Republic. The main coordinator of QA/QC procedures is Denitsa Grozeva (CHMI) as well as NIS coordinator Eva Krtkova (CHMI). Updated QA/QC forms are presented in Annex 5.4 of this report.

The inventory planning stage includes the setting of quality objectives and elaboration of the QA/QC plan for the coming inventory preparation, compilation and reporting work. The setting of quality objectives is based on the inventory principles. Quality objectives are specific expressions about the standard that is aimed at in the inventory preparation with regard to the inventory principles. The aim of the objectives is to be appropriate and realistic while taking account of the available resources and other conditions in the operating environment. Where possible, quality objectives should be measurable.

The quality objectives regarding all calculation sectors for inventory submissions are the following:

1) Continuous improvement
   - Treatment of review feedback is systematic
   - Improvements promised in the National Inventory Report (NIR) are introduced
   - Improvement of the inventory should be systematic. An improvement plan for a longer time horizon focused on gradual implementation of higher tiers for almost all key categories is being developed.
2) Transparency
   - Archiving of the inventory is systematic and complete
   - Internal documentation of calculations supports emission and removal estimates
   - CRF Tables and the National Inventory Report (NIR) include transparent and appropriate descriptions of emission and removal estimates and of their preparation.
3) Consistency
   - The time series are consistent
   - Data have been used in a consistent manner in the inventory.
4) Comparability
   - The methodologies and formats used in the inventory meet comparability requirements.
5) Completeness
   - The inventory covers all the emission sources, sinks and gases

6) Accuracy
   - The estimates are systematically neither greater nor less than the actual emissions or removals
   - The calculation is correct
   - Inventory uncertainties are estimated.
7) Timeliness
   - High-quality inventory reports reach their recipient (EU/UNFCCC) within the set time.

The quality objectives and the planned general QC and QA procedures regarding all the calculation sectors are recorded as the QA/QC plan. The QA/QC plan specifies the actions, the schedules for the actions and the responsibilities to attain the quality objectives and to provide confidence in the Czech national system's capability and implementation to perform and deliver high-quality inventories. The QA/QC plan is updated annually.

1.2.3.3 Quality control procedures

The QC procedures, which aim at attainment of the quality objectives, are performed by the experts during inventory calculation and compilation according to the QA/QC plan.

The QC procedures used in the Czech GHG inventory comply with the IPCC 2006 Guidelines (IPCC, 2006). General inventory QC checks (Annex A5.4), include routine checks of the integrity, correctness and completeness of data, identification of errors and deficiencies and documentation and archiving of inventory data and quality control checks. In addition to general QC checks, category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are employed on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.

Once the experts have implemented the QC procedures, they complete the QA/QC form for each source/sink category, which provides a record of the procedures performed. The results of the completed QC checks are recorded in the internal documents for the calculation and archived in the expert organisations and at CHMI. Key findings are summarised in the sector-specific chapters of NIR.

Specifically, QC procedures in the sectors are organised as described below:

Each sector-solving institution – KONEKO, CDV, CHMI (Industrial processes), IFER and CUEC – will suggest, to the NIS coordinator (CHMI, Mrs. Eva Krtková), their QA/QC guarantors, responsible for the compliance of all the QA/QC procedures in the given sector with the IPCC 2006 Guidelines (IPCC, 2006) and also with the QA/QC plan.

At the basic level of control, individual steps should be controlled according to the Table presented in Annex A5. 4. The first step is carried out by the person responsible for the respective sub-sector (auto-control). This is followed by the 2nd step carried out by an expert familiar with the topic. The reporting on the implemented controls is documented in a special form prepared by CHMI. The completed form with all the records of the performed checks is, for QC, Tier 1, submitted to the NIS coordinating institution – CHMI, together with data outputs: (i) XML file generated by the CRF Reporter, (ii) detailed calculation spreadsheet in MS Excel format, containing, in addition to all the calculation steps, also all the activity data, emission factors and other parameters, as well as further supplementary data necessary for emission determination in the given category. All these files are then submitted to the central archive at CHMI. The records of the performed QC checks, Tier 2, are submitted later.

The sectoral QA/QC guarantor, in cooperation with the NIS coordinator, will assess the conditions for Tier 2 in the given sector (e.g. comparison with EU ETS data or with other independent sources). If everything is in order, the sectoral QA/QC guarantor organizes the QC check according to Tier 2.

CHMI, as the NIS coordinating institution, carries out mainly formal control of data outputs in the CRF Reporter, similar to the ”Synthesis and Assessment“ control performed by the UNFCCC Secretariat. Thus, CHMI controls the consistency of time series, and possible IEF exceedance of the expected intervals (outliers), as well as the completeness and suitability of the use of notation keys and commentaries in the CRF Reporter (mainly for NE and IE), etc.

1.2.3.4 Quality assurance procedures

Quality assurance comprises a planned system of review procedures. The QA reviews are performed after application of the QC procedures to the finalised inventory. The inventory QA system comprises reviews and audits to assess the quality of the inventory and the inventory preparation and reporting process, to determine the conformity of the procedures employed and to identify areas where improvements could be made. While QC procedures are carried out annually and for all the sectors, it is anticipated that QA activities will be performed by the individual sectors at longer intervals. Each sector should be reviewed by a QA audit approx. once in three years, as far as possible. In addition, QA activities should be focused mainly on key categories.

Peer reviews (QA procedures) are sector- or category-specific projects that are performed by external experts or groups of experts. The reviewers should preferably be external experts who are independent of the inventory preparation. The objective of the peer review is to ensure that the inventory results, assumptions and methods are reasonable, as judged by those knowledgeable in the specific field.

An example of QA activities performed in the past was the QA audit focused on General and cross-cutting issues and on Transport, which was performed by Slovak GHG inventory experts in November 2009. The objectives of this QA review were

- Judgement of the suitability of the general and crosscutting issues (including uncertainty) and to check whether the national approach used for road transport is in line with the IPCC methodology
- Recommendation of improvements in both cases.

Another QA procedure is held for Energy sector – stationary combustion and for Industrial Processes sector. External specialist for these sectors is participating on this issues.

Similar bilateral QA reviews concentrated more on individual sectors are planned for the future. Example of functional peer review can be deemed annual QA/QC assessment performed by EEA for each EU member state. Findings of the assessment and remedies/explanations are discussed and stored in a web based application specifically designed for this purpose. Most recent selective QA activity is the participation in "Project on assistance to MS with KP reporting" launched by European Commission.

The annual UNFCCC inventory reviews have similar and even more important impact on improving the quality of the national inventory. Therefore, the Czech team very carefully analyses the comments and recommendations of the international Expert Review Team and strives to implement them as far as possible.

1.2.3.5 Implementation of QA/QC procedures in cases of recalculations

The QA/QC procedures described up to date are related particularly to standard situations, where the emission data from previous years remain unchanged and only emissions for the currently processed year are determined. The IPCC methodology requires that, in some cases, the emissions for previous years also be recalculated. These recalculations should be performed when an attempt is made to increase the accuracy by introducing a new methodology for the given category of sources or sinks, when more exact input data has been obtained or when consistent application of control procedures has revealed inadequacies in earlier emission determinations. In addition, recalculation should be performed in response to recommendations of the international inspection teams organized by the bodies of either the UN Framework Convention or the European Commission.

While new data are available roughly ten or eleven months after the end of the monitored year for standard emission determinations for the previous year, reasons for recalculation mostly arise well beforehand. If the methodology is changed during recalculation, the task becomes far more difficult than in standard determination of the previous year, as the new method must be thoroughly studied and tested. In addition, in order to maintain consistency of the time series, the recalculation is generally introduced for the entire time period, i.e. beginning with the reference year 1990. It is thus obvious that the danger of potential errors or omissions is greater in recalculation than in standard determination of the previous year using a well-tried methodology.

For these reasons, in recalculation, greater attention must be paid to QA/QC control mechanisms where, in addition to technical QC control (first step), it is necessary to employ more demanding control procedures (second step) and, where possible, also independent QA control by an expert not participating in the emission inventory in the given sector. While, for standardly performed QA/QC procedures, longer time validity is assumed, planning control procedures for recalculation must be tailored for the specific recalculation by the sector manager in cooperation with the NIS coordinator and QA/QC NIS guarantor.

Specific examples of recalculation are given in the sector-oriented chapters and in Chapter 10.

1.2.4 Changes in the national inventory arrangements since previous annual GHG inventory submission

No significant changes were made in the Czech national inventory team and the main pillars of the national inventory system declared in the Czech Republic’s Initial Report under the Kyoto Protocol are operational and running.

1.3 Inventory preparation, and data collection, processing and storage

1.3.1 Activity data collection

Collection of activity data is based mainly on the official documents of the *Czech Statistical Office* (CzSO), which are published annually, where the *Czech Statistical Yearbook* is the most representative example. However for industrial processes, because of the *Czech Act on Statistics*, production data are not generally available when there are fewer than 4 enterprises in the whole country. In such cases, inventory compilers have to rely either on specific statistical materials edited by sectoral associations or, in some cases, inventory experts have to carry out the relevant inquiries. In a few cases, the Czech register of individual sources and emissions, called REZZO, is utilized as source of activity data.

Emission estimates from Sector 1.A Fuel Combustion Activities are based on the official Czech Energy Balance, compiled by the *Czech Statistical Office*. Data from the Czech Energy balance are processed both in the Reference Approach (TPES - primary sources data are used) and in the Sectoral Approach (data for fuel transformations and final consumptions). However, in the latter case, some additional data are required (e.g. data on transportation statistics).

Recently data from EU ETS system are used as well. For the purposes of Energy sector are these data used more for control purposes, more detailed information is given in relevant chapter for Energy sector. Furthermore, for the emission estimates in IPPU sectors are EU ETS data used in much higher extend. For some subcategories, e.g. Cement Production or Lime Production is these data used for the complete inventory; in the subcategories is EU ETS data used for improving emission factors and data. These improvements are listed in the Improvement Plan.

Furthermore across different sectors are used specific sectoral associations. In each chapter for subsectors are listed data providers for the specific subsectors.

1.3.2 Data processing and storage

Data Sector 1.A Fuel Combustion Activities are processed by the system of interconnected spreadsheets, compiled in MS Excel following "Worksheets" presented in IPCC 2006 Guidelines, Vol. 2. Workbook. The system is extended by incorporating sheets with modified energy balance: these sheets represent an input data system. This system was recently a bit modified to be more transparent.

Also, in the majority of other sectors, data are processed in a similar way - by using a system of joined spreadsheets taken from the *Workbook* and slightly modified in order to respect national circumstances. The following examples of such cases of processing can be mentioned: agriculture, waste, fugitive emissions. For LULUCF, a specific spreadsheet system is used, respecting the national methodology.

Originally, the calculation spreadsheets related to the individual sectors were stored only in the relevant sector-solving institutions. On the basis of recommendations from the "in-country review" in 2007, a simple system was developed for central archiving, based on storage of documents from institutions participating in the national system in electronic form in a central folder-structured FTP data box located at CHMI. During the subsequent "in-country review" in 2009, this system was evaluated as only partly satisfactory and consequently it was decided to further improve the archiving system using more sophisticated arrangements.

Archiving process scheme

The NIS coordinator is responsible for the administration and functioning of the archive. The archiving system is administered in accordance with the provisions of the Kyoto Protocol and the IPPC methodological recommendations.

Material archived by the sector-solving organizations

- Input data in unmodified form
- Files for transformation of original data to calculation sheets (if used)
- Calculation sheets
- Outputs from CRF
- Outputs from QA/QC
- Other relevant documents

Material archived by the coordinator

- All administrative agenda with text outputs (contracts, orders, invoices)
- Important correspondence related to the operation and functioning of NIS
- Outputs from QA/QC
- Other relevant documents

Structural arrangements of the NIS Archive

The archiving system contains and connects 4 individual units.

1) The archive of the sector-solving organization
   - Functionality and administration are based on contracts with the sector-solving organizations
   - Administration is provided by the sectoral organizations
2) Central storage site for sharing material in the context of NIS
   - Storage site accessible at private ftp
   - Administered by the NIS coordinator
   - Contains working materials for current submissions intended for archiving
3) Central closed archive of the NIS Coordinator
   - Internal central archive, administered by the NIS coordinator
   - Contains all the officially archived materials
   - The content of the archive is stored in duplicate on special media designed for data archiving
   - The archive is located in the seat of the coordinator (CHMI – Prague Komořany)
   - Entries in the archive are always performed as of 30 June of the relevant year of submission and a detailed records of them is also archived.
   - Entries in the archive are also performed after the end of re-submissions or during any other unplanned intervention into the database or text part of already archived submissions.
   - Prior to archiving, data for archiving must be checked and authorized by the QA/QC guarantor of the relevant sectoral organization.
4) Central accessible archive
   - Mirror image of the central closed archive, available on the internet
   - Does not contain sensitive documents, but does contain a complete list of archived files
   - Available at http://portal.chmi.cz
   - Administered by the NIS coordinator
   - Updating corresponds to the entries in the Central closed archive, available a maximum of 3 working days after completion of archiving.

1.4 Brief general description of methodologies (including tiers used) and data sources used

The methods used in the Czech greenhouse gas inventory are consistent with the IPCC methodology, which has been prepared for the purpose of compilation of national inventories of anthropogenic GHG emissions and removals. The updated 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) are used for the inventory since this submission. For LULUCF sector IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003) was used as well.

Depending on the complexity of the calculation and types of emission factors used (generally recommended - *default*, country-specific, site-specific and technology-specific), the approaches described in the IPCC methodology consist of three tiers. Tier 1 is typically characterized by simpler calculations, based on the basic statistical data and on the use of generally recommended emission factors (*default*) of global or continental applicability, tabulated directly in above mentioned methodical manuals.

Tier 2 is based on sophisticated calculation and usually requires more detailed and less accessible statistical data. The emission factors (country-specific or technology-specific) are usually derived using calculations based on more complex studies and better knowledge of the source. Even in these cases, it is sometimes possible to find the necessary parameters for the calculation in IPCC manuals. Procedures in Tier 3 are usually considered to consist in procedures based on the results of direct measurements carried out under local conditions.

Methods of higher tiers should be applied mainly for key categories. Key categories (key source categories) are defined as categories that cumulatively contribute 90% or more to the overall uncertainty either in level or in trend. Apparently, procedures in higher tiers should be more accurate and should better reflect reality. However, they are more demanding in all respects, and especially they are more expensive. An overview of the methods and emission factors used by the Czech Republic for estimation of emissions of greenhouse gases is given in the CRF Table “Summary 3”.

Because of the above-described problems encountered in the application of the methods of higher tiers, these procedures have so far been introduced only for some key categories. For example, for combustion of fuels, country-specific factors are employed only for Brown/Hard Coal, Brown Coal + Lignite, Bituminous Coal, Coking Coal, Gas Works Gas, Refinery Gas, LPG and Natural Gas, while the default emission factors are employed for the rest of the other fuels. For Bituminous Coal, Brown Coal + Lignite and Brown Coal Briquettes are used country specific oxidation factors as well. Similarly, for Industrial Processes, only the Tier 1 method is used for the production of iron and steel. In contrast, the methods of higher tiers and/or country-specific factors are employed far more frequently for other key categories. Chapter 10 describes the “Improvement Plan”, which will also encompass gradual introduction of more sophisticated methods of higher tiers.

All direct GHG emissions can also be expressed in terms of total (or aggregated) values, which are calculated as a sum of the emissions of the individual gases multiplied by the Global Warming Potential values (GWP). GWP correspond to the factor by which the given gas is more effective in absorption of terrestrial radiation than CO_2 (1 for CO_2, 25 for CH_4 and 298 for N_2O). The total amount of F-gases is relatively small compared to CO_2, CH_4 and N_2O; nevertheless their GWP values are larger by 2-4 orders of magnitude. Consequently, total aggregated emissions to be reduced according to the *Kyoto Protocol* are expressed as the equivalent amount of CO_2 with the same radiation absorption effect as the sum of the individual gases.

On the other hand, in preparing this inventory, somewhat less attention was paid to emissions of the precursors NO_X, CO, NMVOC, NH_3 and SO_2, which are covered primarily by the *Convention on Long-Range Transboundary Air Pollution* (CLRTAP) and are not directly related to the Kyoto Protocol. Their inventories are compiled for the purposes of CLRTAP by NFR (*New Format of Reporting*) by another team at CHMI. Thus emissions of precursors in the GHG inventory (CRF) have been fully taken over and transferred from NFR to CRF. A detailed description of the methodology used to estimate emissions of *precursors* is provided in the *Czech Informative Inventory Report (IIR), Submission under the UNECE/CLRTAP Convention* (submitted annually by 15th February) and shortly in chapter 9 of the NIR.

In September of 2014, the Czech national greenhouse gas inventory was subject to “*centralised review*”. The Czech national inventory team received annual inventory report in April 2015. Since the delay caused by not-fully functioning reporting software occurred in this submission, the recommendations were implemented in the submission to as high extend as possible. Other recommendations are part of the Improvement plan for the future improvement of specific categories.

Methodical aspects are described in a greater detail in sector-oriented Chapters 3 to 8 and in Chapter 10 “Recalculations and Improvements”. Chapter 10 also deals with the reactions of the Czech team to the comments and recommendations of the recent international review organised by UNFCCC.

1.5 Brief description of key categories

The IPCC 2006 Guidelines (IPCC, 2006) provides two approaches of determining the key categories (key sources). Key categories by definition contribute to 90% percent of the overall uncertainty in a level (in emissions per year) or in a trend. Approach 2 follows from this definition, and requires thorough analysis of the uncertainty and use of sophisticated statistical procedures and evaluation of sources in terms of the appropriate characteristics. However, it is more difficult to obtain the necessary data for this approach and this information is not yet used on the national level.

Tab. 1-1 Identification of key categories by level assessment (LA) and trend assessment (TA) for 2014 evaluated with and without LULUCF (Approach 1)

IPCC Source Categories	GHG	LA,%	TA,%	Cumulative Total (LA,%)	Cumulative Total (TA,%)	KC type
1.A Stationary Combustion - Solid Fuels	CO_2	37.24	27.74	37.24	27.74	LA, TA
1.A Stationary Combustion - Liquid Fuels	CO_2	12.81	5.74	50.05	66.26	LA, TA
1.A.3.b Transport - Road Transportation	CO_2	10.79	16.91	60.84	44.65	LA, TA
1.A Stationary Combustion - Gaseous Fuels	CO_2	9.19	15.87	70.03	60.52	LA, TA
4.A.1 Forest Land remaining Forest Land	CO_2	4.63	1.09	74.66	87.21	LA, TA
2.C.1 Iron and Steel Production	CO_2	4.35	0.06	79.01	99.44	LA
5.A Solid Waste Disposal on Land	CH_4	2.23	2.82	81.24	82.07	LA, TA
1.B.1.a Coal Mining and Handling	CH_4	2.10	4.33	83.34	75.29	LA, TA
3.A Enteric Fermentation	CH_4	1.89	1.54	85.23	86.12	LA, TA
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	1.87	3.97	87.10	79.25	LA, TA
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	1.61	0.46	88.70	94.10	LA, TA
2.A.1 Cement Production	CO_2	0.99	0.29	89.70	97.08	LA
3.B Manure Management	N_2O	0.88	4.69	90.58	70.95	LA, TA
2.B.8 Petrochemical and carbon black production	CO_2	0.72	0.77	91.30	90.84	LA, TA
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	0.53	0.33	91.83	96.79	LA
3.B Manure Management	CH_4	0.51	2.51	92.34	84.58	LA, TA
5.D Wastewater treatment and discharge	CH_4	0.49	1.04	92.83	88.25	LA, TA
2.B.1 Ammonia Production	CO_2	0.46	0.02	93.29	99.79	LA
1.A Stationary Combustion - Liquid Fuels	N_2O	0.45	0.70	93.74	92.99	LA, TA
2.A.2 Lime Production	CO_2	0.42	0.39	94.16	95.36	LA
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	0.42	0.15	94.58	98.09	LA
3.G Liming	CO_2	0.10	0.92	98.84	89.33	TA
1.A Stationary Combustion - Solid Fuels	CH_4	0.12	0.90	98.74	90.23	TA
1.A.3.b Transport - Road Transportation	N_2O	0.41	0.74	95.40	91.74	TA
2.C.2 Ferroalloys Production	CH_4	0.34	0.71	95.74	92.46	TA
2.B.2 Nitric Acid Production	N_2O	0.17	0.65	97.90	93.81	TA
1.A Stationary Combustion - Other fuels - 1A2	CO_2	0.20	0.43	96.99	94.68	TA
1.A Stationary Combustion - Other fuels - MSW	CO_2	0.23	0.46	96.58	94.10	TA

The procedure of the Approach 1 is based on the fact that ninety percent of the overall uncertainty in a level or in a trend is usually caused only by those sources whose contribution to total emissions does not exceed 95%. This procedure is illustrated in Tab. 1-1 (determined on the basis of the level of emissions, i.e. level assessment and on the basis of trends, i.e. trend assessment). The sources or their categories are for level assessment ordered on the basis of decreasing contribution to total emissions. The key categories were considered to be those whose cumulative contribution is less than 95%. For trend assessment, a similar procedure is used; with the difference that here the decisive quantity is defined as the product of the relative contribution to the total emissions (determined in the previous case) and the absolute value of the relative deviation of the individual trends from the total trend.

For the right identification of key categories, also assessment without consideration of the LULUCF categories was employed. It is obvious from Tab. 1-2 that no additional *key category* was identified when the LULUCF categories were not considered.

On the whole, 28 key categories were identified either by level assessment or by trend assessment. A summary of the assessed numbers concerning key categories is given in Tab. 1-2.

Tab. 1-2 Figures for key categories assessed

Key categories (KC) with LULUCF	28
KC identified by LA	21
KC identified by TA	22
KC identified by LA + TA concurrently	15
KC identified by only LA	6
KC identified by only TA	7
Key Categories (KC) without LULUCF:	25
KC identified by LA	19
KC identified by TA	20
KC identified by LA + TA concurrently	14
KC identified by only LA	5
KC identified by only TA	6

Of the overall number of 28 key categories, some of them are right on the 95% borderline and thus appear only occasionally. Complete tables for key category analysis are presented in Annex 1 of this report.

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

Uncertainty analysis characterizes the extent (i.e. possible interval) of results for the entire national inventory and for its individual components. Knowledge of the individual and overall uncertainties enables compilers of emission inventories better understanding of the inventory process, which encompasses collection of suitable input data and their evaluation. Uncertainty analysis also help in identifying those categories of emission sources and sinks that contribute most to the overall uncertainty and thus establish priorities for further improvement of the quality of the data.

A method of uncertainty determination based on the error propagation method (Tier 1), using calculation sheets obtained according to the prescribed methodology (IPCC, 2006), has been used in the Czech national inventory for a number of years. The accuracy of the calculation algorithm has been sufficiently verified but problems have been caused to date by the only roughly estimated input parameters (i.e. uncertainty in the activity data and emission factors for the individual categories).

Consequently, the existing procedure was recently reviewed and these input parameters were refined both on the basis of data published in the literature (IPCC methodical manuals, national inventory report, scientific literature) and also on the basis of qualified expert estimates. Experts from CHMI and all the contributing sectoral organizations participated in this work. The individual experts investigated the uncertainty parameters coming under their field of work and proposed new ones or defended the original ones in discussions. Details are described in the study (CHMI, 2012b).

However, refinement of the input parameters did not substantially affect the resultant uncertainty values. For example, the resultant uncertainty in greenhouse gas emissions (including LULUCF) in the data for 2010 (reported in 2012) corresponded to a reduction of the value 3.79% to 3.43% and the resultant uncertainty in the trend decreased from 2.40% to 2.34%.

Uncertainty analysis of Tier 1, which is presented in this volume of NIR, employs the same source categorization as used in key categories assessment. Actual results of the uncertainty analysis for 2012 after above mentioned revision of the input parameters are given in Annex 2.

Results of uncertainty assessment were obtained (i) for all sectors including LULUCF and (ii) for comparison also for all sectors without LULUCF. The estimated overall uncertainty in level assessment (case with LULUCF) reached 3.36%. The corresponding uncertainty in trend is 2.34%.

The same source categories used in key sources assessment have also been used even in uncertainty analysis. In this way, the uncertainty analysis result will be used later for Tier 2 key source analysis, which might be more suitable. The uncertainty analysis is provided in Annex 2 tables.

1.7 General assessment of completeness

CRF Table 9 (Completeness) has been used to give information on the aspect of completeness. This part of the text includes additional information. All the categories of sources and sinks included in the IPCC Guidelines are covered. No additional sources and sinks specific to the Czech Republic have been identified. Both direct GHGs as well as precursor gases are covered by the Czech inventory. The geographic coverage is complete.

Additionally this year was used the ‘completeness’ function of new CRF Reporter. However, it was discovered, that this functionality doesn’t always give proper results, so additional form created by CHMI was used for the completeness checks. Example of this form is given in Annex 5.5 (for Waste sector).

Specifically, there are some empty tables reported in this submission, since the CRF Reporter wasn't able to import specific tables or display information filled in subcategories. This issue is occurring only for categories, which are not occurring in the Czech Republic.

1.7.1 Notation keys

The sources and sinks not considered in the inventory but included in the IPCC Guidelines are clearly indicated and the reasons for this exclusion are explained in Documentation box in CRF Reporter and in relevant chapter of NIR. In addition, the notation keys presented below are used to fill in the blanks in all the CRF Tables. Notation keys are used according to the UNFCCC guidelines on reporting and review (FCCC/CP/2002/8).

Allocations to categories may differ from Party to Party. The main reasons for different category allocations are different allocations in the national statistics, insufficient information on the national statistics, national methods, and the impossibility of disaggregating the reported emission values.

IE (included elsewhere):

"IE" is used for emissions by sources and removals by sinks of greenhouse gases that have been estimated but included elsewhere in the inventory instead of in the expected source/sink category. Where "IE" is used in the inventory, the CRF completeness table (Table 9) indicates where (in the inventory) these emissions or removals have been included. This deviation from the expected category is explained.

NE (not estimated):

"NE" is used for existing emissions by sources and removals by sinks of greenhouse gases that have not been estimated. Where "NE" is used in an inventory for emissions or removals, both the NIR and the CRF completeness table indicate why the emissions or removals have not been estimated. For emissions by sources and removals by sinks of greenhouse gases marked by "NE", check-ups are in progress to establish if they actually are "NO" (not occurring). As part of the improvement programme of the inventory, it is planned that these source or sink categories will be either estimated or allocated to "NO".

Overview of not estimated (NE) categories of sources and sinks and categories included elsewhere (IE) and the relevant explanations are given in CRF Table 9.

2 Trends in greenhouse gas emissions

According to the Kyoto Protocol, Czech national GHG emissions have to decrease by 8% of base year emissions during the five-year commitment period from 2008 to 2012. The Czech Republic has already met its goal, however it is very difficult to separate influences of general decrease in industrial and agricultural production and increase in overall energy-emission efficiency.

For 2013 – 2020 is existing joint commitment of the EU, its MS and Iceland to reduce average annual emissions by 20% compared to base year.

2.1 Description and interpretation of emission trends for aggregated GHG emissions

Tab. 2-1 presents a summary of GHG emissions excl. bunkers for the period from 1990 to 2014. For CO_2, CH_4 and N_2O the base year is 1990; for F-gases the base year is 1995.

Tab. 2-1 GHG emissions from 1990-2014 excl. bunkers [kt CO_2 eq.]

	CO_2[1]	CH_4[3]	N_2O[3]	HFCs	PFCs	NF_3	SF_6	Total emissions excl. LULUCF	incl. LULUCF
1990	161 668.42	22 563.03	11 165.96				85.22	195 344.80	188 876.77
1991	146 053.74	20 838.66	9 698.46				85.05	176 570.67	166 976.07
1992	141 572.12	19 560.38	8 880.26		NE		86.35	169 989.91	159 902.35
1993	135 594.97	18 615.39	7 946.59				87.55	162 120.51	152 442.90
1994	129 195.13	17 617.14	7 687.23				88.64	154 461.38	146 906.52
1995	129 773.57	17 299.96	7 847.55	0.23	0.01	NO	89.65	154 892.15	146 861.74
1996	132 240.47	17 113.37	7 711.63	34.68	0.47	NO	99.24	157 047.89	148 668.11
1997	128 739.04	16 696.24	7 675.06	99.02	1.56	NO	97.02	153 145.95	145 679.88
1998	123 702.92	16 119.85	7 544.18	134.15	1.53	NO	95.75	147 454.13	139 847.13
1999	115 481.66	15 517.45	7 402.06	147.60	0.84	NO	96.69	138 512.73	130 624.79
2000	125 848.37	14 537.75	7 412.71	203.99	3.95	NO	109.13	147 992.74	139 204.62
2001	125 547.94	14 220.34	7 457.84	308.59	8.54	NO	99.54	147 515.14	138 400.70
2002	122 599.80	13 826.79	7 221.56	400.58	15.43	NO	121.95	144 049.44	135 304.39
2003	126 158.05	13 841.92	6 941.09	508.64	7.27	NO	145.35	147 433.08	140 186.27
2004	126 883.32	13 440.31	7 263.75	602.47	10.98	NO	121.16	148 166.34	140 399.08
2005	124 596.54	13 799.64	6 893.86	700.77	12.74	NO	112.32	145 967.01	137 853.55
2006	125 929.80	14 075.40	6 914.89	937.23	29.01	NO	109.41	147 812.79	141 868.19
2007	126 939.56	13 650.58	6 895.80	1 282.34	27.03	NO	94.53	148 653.72	144 929.36
2008	121 805.18	14 058.72	6 685.29	1 511.87	37.29	NO	94.40	144 004.88	137 124.31
2009	113 985.70	13 569.31	6 393.76	1 639.13	44.14	NO	97.15	135 569.59	127 659.58
2010	115 770.77	13 804.95	6 201.12	1 947.71	49.32	NO	81.29	137 686.93	130 509.88
2011	114 125.61	13 705.98	6 286.78	2 219.11	10.72	NO	86.43	136 356.76	127 978.72
2012	109 863.70	13 820.99	6 217.53	2 395.39	8.74	1.80	90.68	132 315.62	123 772.48
2013	106 491.27	13 194.86	6 056.27	2 621.18	6.61	3.82	93.38	128 389.78	120 473.44
2014	101 154.38	13 311.83	6 335.87	2 830.38	5.34	2.35	96.01	123 650.70	115 858.02
%[2)]	**-37.43**	**-41.00**	**-43.26**				**12.67**	**-36.70**	**-38.66**

Note: Global warming potentials (GWPs) used (100 years time horizon): CO_2 = 1; CH_4 = 25; N_2O = 298; SF_6 = 22 800; NF_3 = 17 200; HFCs and PFCs consist of different substances, therefore GWPs have to be calculated individually depending on substances

[1]GHG emissions excluding emissions/removals from LULUCF

[2] relative to base year

[3]incl. LULUCF

GHG emissions and removals have significantly decreased in the period 1990 – 1994, mainly driven by the economy transition and pursuing major dropdown in heavy industry activities in the country. The fast decrease has stopped around 145 000 kt CO_2 eq. and continues fluctuating ever since (see Fig. 2-1). From 2010 to 2014 the total GHG emissions (incl. LULUCF) decreased by 11.23% or 14 651.86 kt CO_2 eq. resulting in total emissions of 115 858.02 kt CO_2 eq. The decrease was caused by CO_2, CH_4 and PFCs emissions (decreased by 12.63%; 3.57% and 89.17%) despite increase in HFC and SF_6 emissions (raised by 45% and 18%) compared to previous year. The total GHG emissions and removals in 2014 were -38.66% below the base year level including LULUCF and -36.70%, when excluding LULUCF.

The decrease in CO_2 was 5%, while CH_4 emissions don't show substantial trend and N_2O emission increased by 4.6% between 2013 and 2014. Although F-gases show an increase of 7.7% the total emissions decreased between 2013 and 2014 by 3.8% (including LULUCF) and 3.7% (excluding LULUCF).

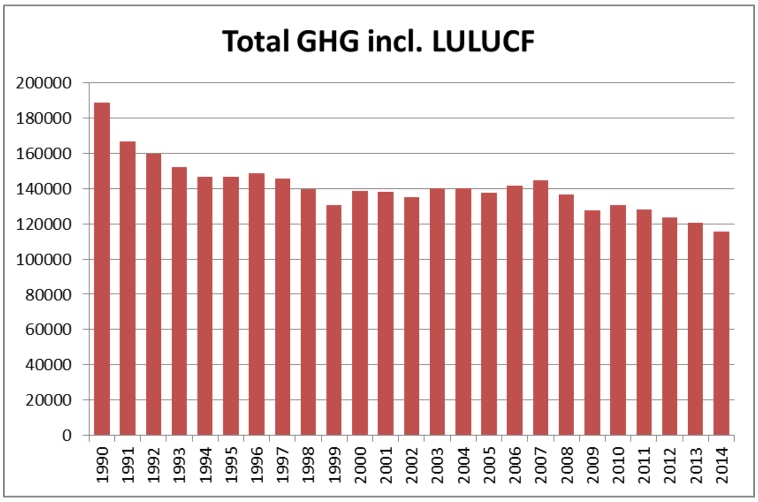


Fig. 2-1 Total trend of GHG emissions, [kt CO_2 eq.]

In 1989 then Czechoslovak economy was one of the centrally planned economies with high level of monopolization. All economic processes were controlled through central planning. For all practical purposes, there was no real market and this situation resulted in an ever deepening economic and technological lag which resulted in high energy and material inefficiency. Since 1989 to the present the economy transformed successfully to a developed market-driven economy. The transformation led to a decline in production, investment in environmental protection, energy efficiency, fuel switch and increasing use of renewable energy.

Greenhouse gases emission trend between 2007 and 2009 and supposedly up to present days passed through significant change driven mainly by economic recession. It is noteworthy that in 2014 some of the industrial and energy subsectors reached its lowest amounts of emitted GHGs according to the whole reported time-series.

2.2 Description and interpretation of emission trends by sector

2.2.1 Description and interpretation of emission trends by gas

The major greenhouse gas in the Czech Republic is CO_2, which represents 81.81% of total GHG emissions (excl. LULUCF) in 2014, compared to 82.76% in the base year. It is followed by CH_4 (10.77% in 2014, 11.55% in the base year), N_2O (5.12% in 2014, 5.72% in the base year) and F-gases (2.54% in 2014, 0.05%

in the base year). The trend of individual GHG emissions relative to emissions in the respective base years is presented in Fig. 2-2.

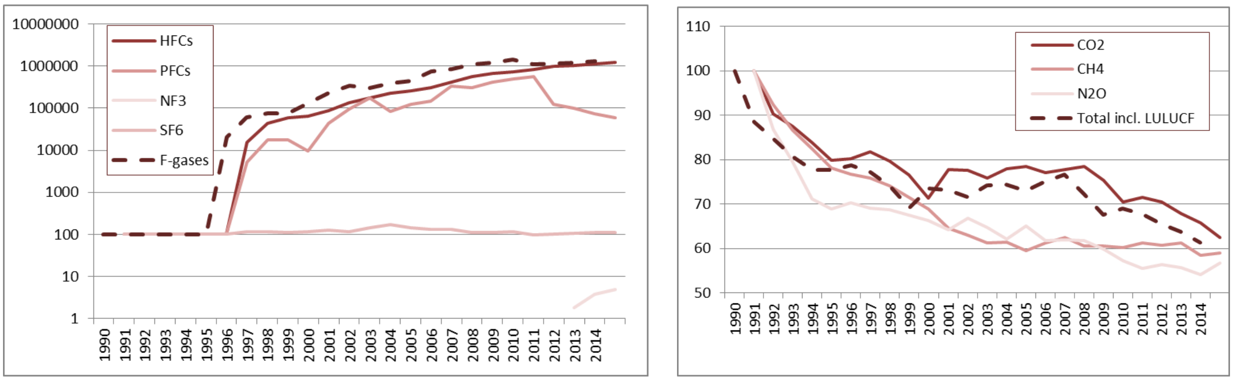


Fig. 2-2 Trend in CO_2, CH_4 and N_2O emissions 1990 - 2014 in index form (base year = 100%) and Trend in HFCs, PFCs (1995 – 2014) and SF_6 (1990 – 2014) actual emissions in index form (base year = 100%)

CO_2

CO_2 emissions have been rapidly decreasing in early 90's, after 1994 the emissions have kept at average of 68% of the amount produced in 1990. Inter-annual decrease in CO_2 emissions (excl. LULUCF) from 2010 to 2014 by 12.63% results the total decrease of 37.43% from 1990 to 2014. Quoting in absolute figures, CO_2 emissions and removals decreased from 161 668.42 to 101 154.38 kt CO_2 in the period from 1990 to 2014, mainly due to lower emissions from the 1 Energy category (mainly 1.A.2 Manufacturing Industries & Construction, 1.A.4.a Commercial/Institutional and 1.A.4.b Residential).

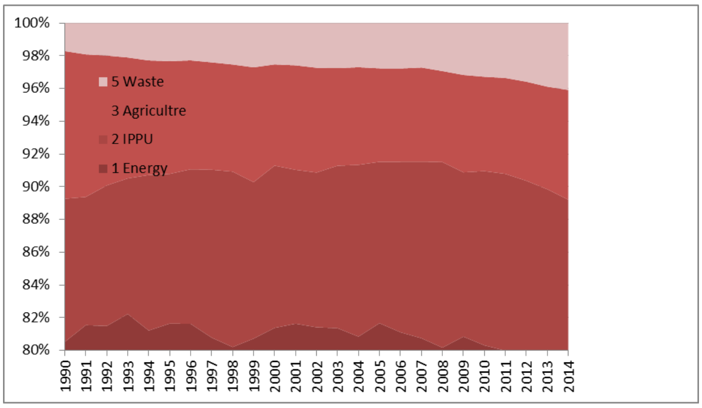


Fig. 2-3 Percentual share of GHGs (Y-axis begins at 80% - part of CO_2 share is hidden)

The main source of CO_2 emissions is fossil fuel combustion; within the 1.A Fuel Combustion category, 1.A.1 Energy Industry and 1.A.2 Manufacturing Industries & Construction sub-categories are the most important. CO_2 emissions increased remarkably between 1990 and 2014 from the 1.A.3 Transport category from 7 284 to 17 157 kt CO_2 eq.

CH_4

CH_4 emissions share decreased almost steadily during the period from 1990 to 2004, from 2004 methane fluctuated around 60% of its base year emissions. In 2014 CH_4 emissions were 41% below the base year level, mainly due to lower contribution of 1.B Fugitive Emissions from Fuels and emissions from 3 Agriculture and despite increase from the 5 Waste category. The main sources of CH_4 emissions are 1.B Fugitive Emissions from Fuels (solid fuel), 3 Agriculture (3.A Enteric Fermentation and 3.B Manure Management) and 5 Waste (5.A Solid Waste Disposal on Land and 5.D Wastewater Treatment and Discharge).

N_2O

N_2O emissions strongly decreased from 1990 to 1994 by 31.69% over this period and then shows slow decreasing trend with inter-annual fluctuation. N_2O emissions decreased between 1990 and 2014 from 11 165.96 to 6 335.87 kt CO_2 eq. (incl. LULUCF). In 2014 N_2O emissions were 43.26% below the base year level, mainly due to lower emissions from 3 Agriculture and 2.B Chemical Industry and despite increase from the 1.A.3 Transport category.

The main source of N_2O emission is category 3.D Agricultural Soils (others less important sources are 1.A Fossil Fuel Combustion and 2 Industrial Processes - 2.B Chemical Industry).

HFCs

HFCs actual emissions increased remarkably between 1995 and 2014 from 0.23 to 2 830.38 kt CO_2 eq. Emissions of HFCs have been rapidly increasing since the base year 1995. In 2014, HFCs emissions were more than 2000-times higher than in the base year 1995.

The main sources of HFCs emissions are 2.F Product Uses as ODS substitutes (Refrigeration and Air Conditioning).

PFCs

PFCs actual emissions show very similar trend as HFCs emissions but on much lower scale. They increased between 1995 and 2014 from 0.01 to 5.34 kt CO_2 eq. In 2014, PFCs emissions are over 200 times higher than in the base year 1995. HFCs and PFCs have not been imported and used before 1995.

The main sources of PFCs emissions are Semiconductor Manufacture, Refrigeration and Air Conditioning equipment.

SF_6

SF_6 actual emissions in 1995 accounted for 89.65 kt CO_2 eq. Between 1995 and 2014 they inter-annually fluctuated with maximum of 145.35 kt CO_2 eq. in 2003 and minimum of 81.29 kt CO_2 eq. in 2010. In 2014 SF_6 reached amount of 96.01 kt, the level was 7.1% higher the base year (1995).

The main sources of SF_6 emissions is 2.G Other product manufacture and use.

NF_3

With the technological progress a new gas was included in this year submission. NF_3 is a gas, used mainly for manufacturing of LCD displays, solar panels and etching semiconductors. Base year for this gas is 1995. In 2014 the emissions of NF_3 equalled to 2.35 kt CO_2 eq., which is 38.46% decrease, compared to year 2014.

2.2.2 Description and interpretation of emission trends by category

Fig. 2-4 presents a summary of GHG emissions by categories for the period from 1990 to 2014:

- Category 1 Energy
- Category 2 Industrial Processes and Product Use
- Category 3 Agriculture
- Category 4 LULUCF
- Category 5 Waste

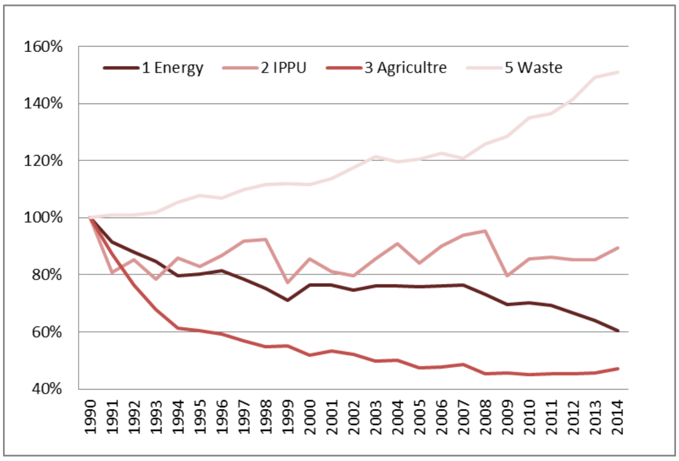


Fig. 2-4 Emission trends in 1990-2014 by categories in index form (base year = 100)

The dominant category is the 1 Energy sector, which caused for 76.85% of total GHG emissions in 2014 (80.51% in 1990) excluding LULUCF, followed by the categories 2 Industrial Processes and Product Use and 3 Agriculture, which caused for 12.36% and 6.70% of total GHG emissions in 2014 (8.75% and 9.02% in 1990, resp.), 5 Waste category covered 4.09% and 4 LULUCF category removed -7 792.68 kt CO_2 eq. which represents share of 6.73% of all GHG emissions.

The trend of GHG emissions by categories is presented in Fig. 2-4 (indexed relative to the base year), see also the percentual share of individual sectors (Fig. 2-4).

Tab. 2-2 Summary of GHG emissions by category 1990-2014 [kt CO_2 eq.]

	1 Energy	2 IPPU	3 Agriculture	4 LULUCF	5 Waste
1990	157 265.99	17 087.65	17 615.91	-6 468.02	3375.25
1991	143 953.90	13 830.83	15 379.80	-9 594.61	3406.14
1992	138 503.99	14 595.88	13 486.84	-1 087.57	3403.20
1993	133 278.12	13 435.94	11 970.91	-9 677.61	3435.54
1994	125 427.70	14 674.21	10 808.22	-7 554.86	3551.25
1995	126 440.33	14 162.86	10 672.59	-8 030.42	3616.37
1996	128 173.36	14 836.73	10 443.56	-8 379.77	3594.23
1997	123 698.71	15 713.53	10 045.38	-7 466.06	3688.32
1998	118 262.82	15 799.54	9 648.27	-7 607.00	3743.50
1999	111 809.35	13 238.20	9 711.34	-7 887.94	3753.84
2000	120 235.09	14 642.16	9 377.76	-8 788.12	3737.72
2001	120 427.58	13 860.33	9 414.43	-9 114.45	3812.80
2002	117 278.24	13 612.35	9 215.35	-8 745.05	3943.50
2003	119 951.30	14 626.68	8 786.02	-7 246.81	4069.08
2004	119 782.12	15 545.44	8 829.76	-7 767.25	4009.02
2005	119 197.15	14 388.64	8 334.90	-8 113.47	4046.32
2006	119 890.71	15 391.33	8 418.95	-5 944.60	4111.80
2007	120 027.32	16 036.44	8 545.17	-3 724.36	4044.78
2008	115 132.91	16 282.34	8 368. 75	-6 880.57	4220.89
2009	109 594.01	13 603.11	8 064.89	-7 910.02	4307.58
2010	110 580.44	14 650.50	7 933.15	-7 177.05	4522.83
2011	109 084.92	14 710.61	7 985.70	-8 378.03	4575.53
2012	104 980.68	14 590.17	8 001.87	-8 543.14	4742.90
2013	100 760.48	14 598.63	8 040.63	-7 916.34	4990.04
2014	95 026.02	15 283.26	8 287.16	-7 792.68	5054.26
[1]%	-5.69%	4.69%	3.07%	-1.56%	1.29%
[2]%	-39.58%	-10.56%	-52.96%	20.48%	49.74%

[1] *Difference relative to previous year*
[2] *Difference relative to base year*

Tab. 2-3 Overview of trends in categories and subcategories (kt CO_2 eq.)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2010	2013	2014
Total (net emissions)	**188 876.77**	**146 861.74**	**139 204.62**	**137 853.55**	**130 509.88**	**120 473.44**	**115 858.02**
1. Energy	**157 265.99**	**126 440.33**	**120 235.09**	**119 197.15**	**110 580.44**	**100 760.48**	**95 026.02**
A. Fuel combustion (sectoral approach)	**146 607.77**	**118 002.70**	**113 811.68**	**113 435.04**	**105 421.74**	**96 771.43**	**91 063.04**
1. Energy industries	56 912.49	61 862.75	62 110.53	63 213.92	61 980.30	56 004.99	53 151.11
2. Manufacturing industries and construction	51 223.91	26 173.59	23 421.48	18 836.11	12 255.83	11 110.37	10 037.80
3. Transport	7 284.03	9 354.55	12 141.77	17 459.48	17 323.07	16 649.55	17 157.13
4. Other sectors	31 187.34	20 611.81	15 957.95	13 652.06	13 533.39	12 697.10	10 374.80
5. Other	NO	NO	179.95	273.47	329.14	309.43	342.20
B. Fugitive emissions from fuels	**10 658.22**	**8 437.62**	**6 423.40**	**5 762.11**	**5 158.70**	**3 989.04**	**3 962.98**
1. Solid fuels	9 576.11	7 600.67	5 547.00	4 866.40	4 261.55	3 354.61	3 331.17
2. Oil and natural gas and other emissions from energy production	1 082.12	836.95	876.40	895.71	897.15	634.43	631.81
2. Industrial Processes	**17 087.65**	**14 162.86**	**14 642.16**	**14 388.64**	**14 650.50**	**14 598.63**	**15 283.26**
A. Mineral industry	4 058.64	3 002.08	3 594.47	3 277.53	3 023.30	2 394.38	2 543.48
B. Chemical industry	2 944.23	2 808.20	2 937.08	2 837.88	2 378.46	2 093.56	2 372.84
C. Metal industry	9 667.79	7 952.73	7 438.74	7 104.96	6 829.21	7 045.16	7 092.70
D. Non-energy products from fuels and solvent use	125.56	103.75	148.60	136.23	117.72	117.04	116.64
E. Electronic industry	NO,NE	NO,NE	11.17	6.64	40.20	17.13	20.01
F. Product uses as ODS substitutes	IE,NO	0.24	205.34	707.98	1 956.83	2 627.05	2 835.27
G. Other product manufacture and use	291.43	295.86	306.77	317.41	304.79	304.32	302.32
3. Agriculture	**17 615.91**	**10 672.59**	**9 377.76**	**8 334.90**	**7 933.15**	**8 040.63**	**8 287.16**
A. Enteric fermentation	5 754.89	3 588.22	3 048.33	2 848.41	2 720.02	2 758.52	2 817.27
B. Manure management	5 082.03	3 399.58	3 058.32	2 521.50	2 199.67	2 009.52	2 080.21
D. Agricultural soils	5 492.63	3 465.18	3 111.22	2 826.83	2 840.73	3 011.40	3 182.35
G. Liming	1 177.82	110.34	112.28	63.98	61.46	135.50	150.29
H. Urea application	108.53	109.27	47.61	74.17	111.27	125.69	57.03
4. Land use, land-use change and forestry	**-6 468.02**	**-8 030.42**	**-8 788.12**	**-8 113.47**	**-7 177.05**	**-7 916.34**	**-7 792.68**
A. Forest land	-4 838.96	-7 100.55	-7 262.61	-6 386.33	-5 102.54	-7 372.83	-7 310.63
B. Cropland	120.62	127.91	89.27	49.02	30.67	19.81	17.14
C. Grassland	- 145.34	-325.56	-496.90	-526.97	-628.68	-592.02	-569.10
D. Wetlands	21.51	9.11	26.46	21.24	34.26	31.41	26.76
E. Settlements	85.09	90.72	132.24	164.42	128.58	88.56	127.60
F. Other land	0	0	0	10.27	7.21	41.53	8.55
G. Harvested wood products	-1 712.95	-833.50	-1 277.79	-1 446.21	-1 647.68	-133.96	-94.13
5. Waste	**3 375.25**	**3 616.37**	**3 737.72**	**4 046.32**	**4 522.83**	**4 990.04**	**5 054.26**
A. Solid waste disposal	1 979.27	2 404.98	2 681.79	2 867.18	3 224.08	3 363.89	3 330.79
B. Biological treatment of solid waste	NE,IE	NE,IE	NE,IE	60.51	198.17	577.12	654.29
C. Incineration and open burning of waste	23.57	71.99	64.18	137.64	141.15	132.44	134.13
D. Waste water treatment and discharge	1 372.41	1 139.41	991.75	981.00	959.42	916.59	935.05
Memo items:							
International bunkers	528.22	562.83	593.83	978.94	965.41	860.43	882.76
Aviation	528.22	562.83	593.83	978.94	965.41	860.43	882.76
CO_2 emissions from biomass	5 415.90	4 705.72	5 319.41	7 060.47	9 941.80	12 795.33	13 247.69
Long-term storage of C in waste disposal sites	4 243.13	5 350.91	6 613.29	8 037.83	9 621.38	10 440.98	10 689.37
Indirect N_2O	1 054.01	597.95	1 563.81	1 662.19	1 563.89	1 427.92	1 395.60
Indirect CO_2	3 917.38	3 220.33	2 905.26	2 714.03	2 489.08	2 346.95	2 234.28
Total CO_2 equivalent emissions without land use, land-use change and forestry	**195 344.80**	**154 892.15**	**147 992.74**	**145 967.01**	**137 686.93**	**128 389.78**	**123 650.70**
Total CO_2 equivalent emissions with land use, land-use change and forestry	**188 876.77**	**146 861.74**	**139 204.62**	**137 853.55**	**130 509.88**	**120 473.44**	**115 858.02**
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry	**199 262.18**	**158 112.48**	**150 898.00**	**148 681.04**	**140 176.01**	**130 736.73**	**125 884.98**
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	**192 794.16**	**150 082.07**	**142 109.88**	**140 567.57**	**132 998.96**	**122 820.39**	**118 092.30**

Energy (IPCC Category 1)

The trend for GHG emissions from 1 Energy category shows decreasing trend of emissions. They strongly decreased from 1990 to 1994 and then fluctuated by 2002. After 2002 they stayed relatively stable by 2007. In the period 2000 – 2007 emissions kept around 120 000 kt CO_2 eq. Total decrease between 1990 and 2014 is 39.6%. Between 2013 to 2014 emissions from category 1 Energy slightly decreased by 5.7%.

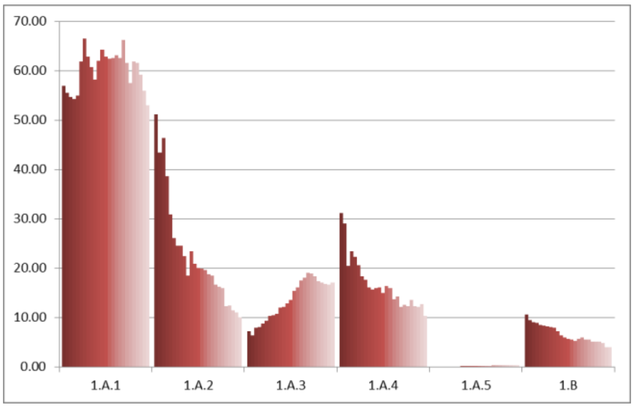


Fig. 2-5 Trends in Energy by categories 1990-2014 (Tg CO_2 eq.)

From the total 95 026.02 kt CO_2 eq. in 2014 95.8% comes from 1.A Fuel Combustion, the rest are 1.B Fugitive Emissions from Fuels (mainly Solid Fuels). 1.B Fugitive Emissions from Fuels is the largest source for CH_4, which represented 28.4% of all CH_4 emissions in 2014. 33.3% of all CH_4 emissions in 2014 originated from Energy category.

CO_2 emissions from fossil fuels combustion (category 1.A Energy) are the main source in Czech Republic's inventory with a share of 88.6% in national CO_2 emissions (excl. LULUCF). N_2O from category 1 Energy contributes for 16.3% in 2014 in national N_2O emissions.

Industrial Processes and Product Use (IPCC Category 2)

GHG emissions from the 2 Industrial Processes and Product Use category fluctuated with decreasing trend during the whole period 1990 to 2014. In early 90's emissions decreased rather rapidly, then reached decade minimum in 1999 and subsequently decreased with total minimum in 2009 (global economic recession). Between 1990 and 2014 emissions (CO_2 eq.) from this category decreased by 10.56%. In 2014 emissions amounted for 15 283.26 kt CO_2 eq.

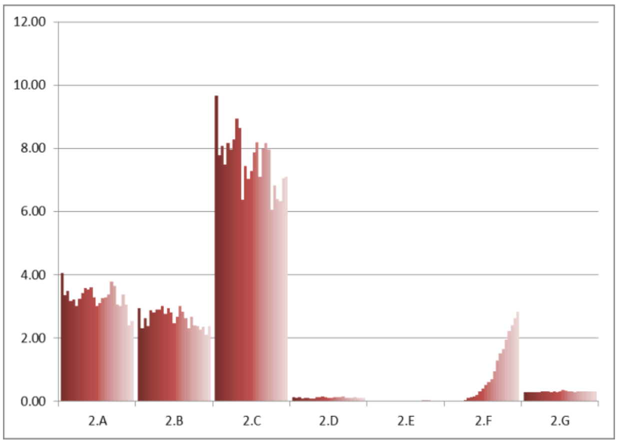


Fig. 2-6 Trends in IPPU by categories 1990-2014

The main categories in the 2 Industrial Processes and Product Use category are 2.C Metal Industry (46.4%), 2.A Mineral Industry (16.6%), 2.B Chemical Industry (15.5%) and 2.F Product Uses as ODS substitutes (18.6%) of the sectoral emissions in 2014 (Fig. 2-6).

The most important GHG of the 2 Industrial Processes and Product Use category was CO_2 with 73.47% of sectoral emissions, followed by F-gases (18.55%).

Agriculture (IPCC Category 3)

GHG emissions from the category 3 Agriculture decreased relatively steadily over the period from 1990 to 2003 and then fluctuated. In 2010 emissions reached minimum level which is 45.03% below the base year level.

Agriculture amounted 8 287.16 kt CO_2 eq. in 2014 which corresponds to 6.7% of national total emissions (excluding LULUCF). The most important sub-category 3.D Agricultural Soils (N_2O emissions) contributed by 38.4% to sectoral total in 2014, followed by the 3.A Enteric Fermentation (34%).

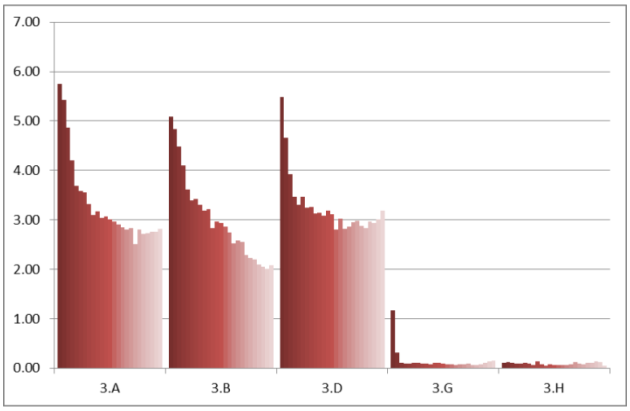


Fig. 2-7 Trends in Agriculture by categories 1990-2014 (Tg CO_2 eq.)

3 Agriculture is the largest source for N_2O and second largest source for CH_4 emissions (71.07% of total emissions of N_2O and 27.09% of total emissions of CH_4, excluding LULUCF). However it's emission trend steadily decreases over the whole observed period.

Land Use, Land-Use Change and Forestry (IPCC Category 4)

GHG removals from the 4 Land Use, Land-Use Change and Forestry category vary through the whole time series with minimum of – 10 087.57 kt CO_2 eq. in 1992 and maximum -3 724.36 kt CO_2 eq. in 2007. In 2014 removals were by 20.48% above the base year level.

Emissions and removals amounted to -7 792.68 kt CO_2 eq. in 2014, which corresponds to 6.7% of total national emissions. Emissions and removals are calculated from all categories and in line with GPG for LULUCF; IPCC 2003, IPCC 2006 Gl. and IPCC 2013.

LULUCF category is the largest sink for CO_2. Net CO_2 removals from this category amounted to -7 792.68 kt CO_2 eq. in 2014. CH_4 emissions amounted to 73.31 kt CO_2 eq., N_2O to 12 kt CO_2 eq. Trends of the sub-categories in LULUCF sector are presented in Fig. 2-8.

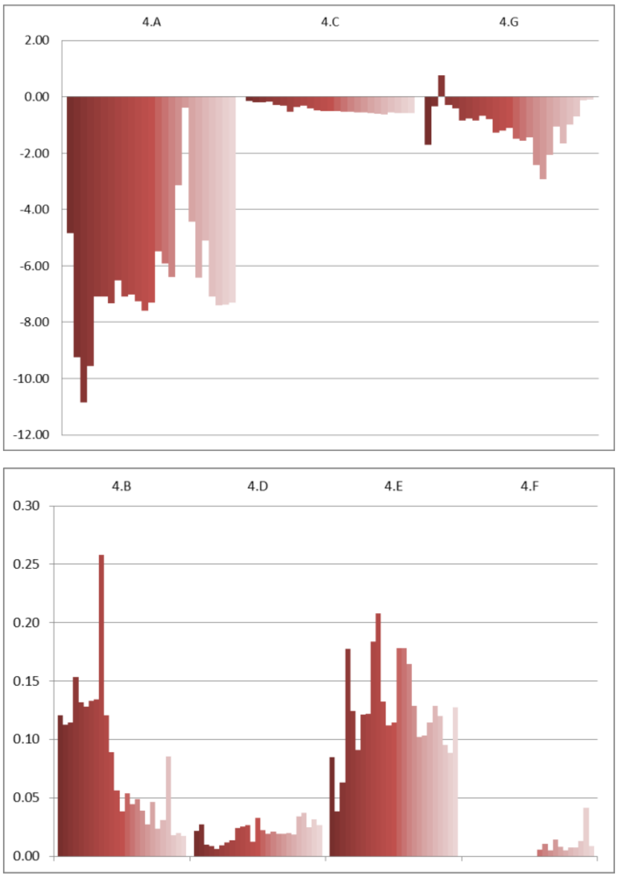


Fig. 2-8 Trends in LULUCF by separate source and sink categories 1990 – 2014 (Tg CO_2 eq.)

Waste (IPCC Category 5)

GHG emissions from category 5 Waste substantially increased during the whole period. In 2014 emissions amounted for 5 054.26 kt CO_2 eq., which is 49.74% above the base year level. The increase of emissions is mainly due to higher emissions of CH_4 from 5.A Solid Waste Disposal and due higher emissions in 5.C Incineration and open burning of waste. As a result of CH_4 recovery systems installed in 5.B Wastewater Treatment and Discharge total emissions from this category decreased by approx. 32% compared to the base year. The share of category 5 Waste in total emissions was 4.09% in 2014.

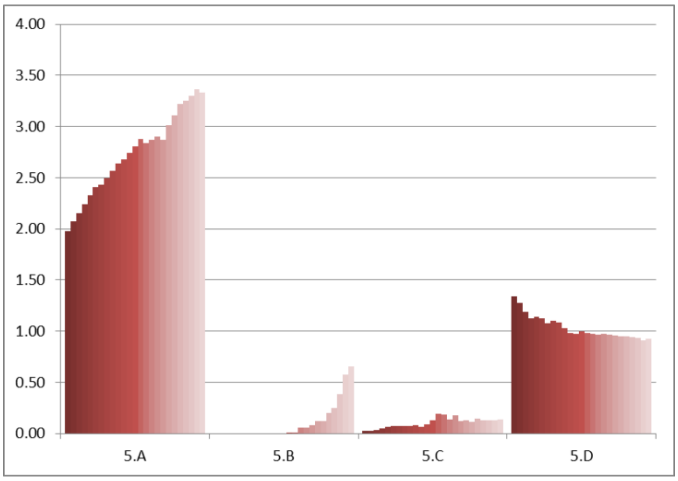


Fig. 2-9 Trends in Waste by categories 1990-2014 (Tg CO_2 eq.)

The main source is solid 5.A Solid Waste Disposal, which accounted for 71% of sectoral CH_4 emissions in 2014, followed by 5.D Wastewater Treatment and Discharge (15.6%) and 5.B Biological treatment of solid waste (13.2%). Trends of the separate sub-categories in Waste sector can be observed on Fig. 2-9.

92.58% of all emissions from Waste category are CH_4 emissions; CO_2 contributes by 2.61% and N_2O by 5.81%.

2.2.3 Description and interpretation of emission trends of indirect greenhouse gases and SO_2

Description of trends of emissions of indirect greenhouse gases is provided in Chapter 9.

2.2.4 Description and interpretation of emission trends for KP-LULUCF inventory

Of the qualifying KP LULUCF activities, emission removals from Forest Management dominate for both 2013 and 2014. There removals are enhanced by estimates for Afforestation/Reforestation activities and by the contribution from changes in carbon pools associated with Harvested Wood Products (HWP). On the contrary, Deforestation represents emissions for both years (Tab. 2-4).

Tab. 2-4 Summary of GHG emissions and removals for KP LULUCF activities [kt CO_2 eq.]

Year	Article 3.3 activities		Article 3.4 activities		HWP
	Afforestration and Reforestration	Deforestation	Forest Management	Other Art. 3.4 activities	HWP contribution
2013	-491.6	234.3	-6 271.6	NA	-134.0
2014	-549.8	231.2	-6 188.1	NA	-94.1
Total*	-1 042.4	465.5	-12 459.6	NA	-228.1

**) Cumulative net emissions and removals for all years of the commitment period reported in the current submission*

3 Energy (CRF Sector 1)

3.1 Overview of sector

The energy sector in the Czech Republic is driven by the combustion of fossil fuels in stationary and mobile sources; however fugitive emissions are also important source of emissions. The two main categories are 1.A Fuel Combustion and 1.B Fugitive Emissions from Fuels.

Activity data are based on the energy balance of the Czech Republic prepared by the Czech Statistical Office (CzSO). Data from the energy balance form the basic framework for processing greenhouse gas emissions from combustion in stationary and mobile sources. Greenhouse gas emissions from stationary sources are calculated from the activity data and the emission factors.

Processing of the activity data is based on the total energy balance of the Czech Republic. The energy balance is prepared by CzSO, and is divided into issues for Solid Fuels, Liquid Fuels, Natural Gas, renewable energy sources and production of heat and electrical energy. Information on the energy balance forms the basis for preparing a database of activity data in the Reference and Sectoral Approaches. The Reference Approach is based on data from the source part of the energy balance; the Sectoral Approach involves processing of data on fuel consumption in a structure corresponding to the requirements of the IPCC categorization.

Default emission factors from the IPCC methodology have been for key categories gradually substituted by country specific emission factors. Moreover, in case of CO_2 emission factors from lignite (brown coal) and bituminous coal the previous country-specific emission factors were in this submission refined by using recent national data.

In connection with implementation of new methodology (IPCC, 2006), there were in this submission newly applied relevant default emission factors from this methodology. As a consequence of these innovations, considerably increasing amount of recalculations appeared in this submission compared to previous years.

Inventories of CO_2, CH_4 and N_2O emissions from subsector 1.A.3 Transport are performed using the CDV model for mobile sources. This model is fully harmonised with activity data from the official CzSO Energy balance mentioned above.

Fugitive emissions in sector 1.B are determined by calculation from activity data and country-specific or default emission factors. The activity data are obtained first of all from the official CzSO energy balance. The sector statistics and annual targeted surveys are used in special cases, when data missing or are insufficient.

3.1.1 Key categories in sector 1 Energy

Combustion processes included in category 1.A make a decisive contribution to total emissions of greenhouse gases. All CO_2, CH_4 and N_2O emissions are derived from the combustion of fossil respectively biofuels and other fuels in stationary and mobile sources.

On the whole, 11 key sources have been identified in sector 1, the most important of which are the first 4 given Tab 3-1. This group of sources contributes 84.57% to total greenhouse gas emissions (without LULUCF).

It is apparent from the table that the first four categories are of fundamental importance for the level of greenhouse gas emissions in the Czech Republic and, of these, the combustion of Solid Fuels constitutes a decisive source. This consists primarily in the combustion of Solid Fuels for the production of electricity and supply of heat. Another important category consists in the combustion of Liquid Fuels in the transport sector and the combustion of Natural Gas has approximately the same importance. This corresponds mostly to the direct production of heat for buildings in the private and public sector and for households. Consequently, increased attention is paid to it.

The results of the inventory, including the activity data, are submitted in the standard CRF format. For direct greenhouse gases, the consumption of fuels and "implied" emission factors are also given. However, for stationary sources, the fuel consumption is given in the CRF format in aggregated structure, i.e. as Solid, Liquid and Gaseous Fuels according to IPCC definition. All the CRF Tables in sector 1.A were appropriately completed for the entire required time interval of 1990 to 2014.

In 1.B Fugitive Emissions from Fuels category, especially 1.B.1.a Coal Mining and Handling was evaluated as a key category (Tab. 3-1.) Category 1.B.2 also was identified as a key category by the latest assessment, but only in one from the four tests (LA). Moreover, identifiers placed this category just over the borderline between key and non-key categories.

Tab. 3-1 Overview of key categories in 1 Energy (2014)

Category	Gas	Character of category	% of total GHG*
1.A Stationary Combustion - Solid Fuels	CO_2	LA, TA	44.97
1.A Stationary Combustion - Liquid Fuels	CO_2	LA, TA	15.46
1.A.3.b Transport - Road Transportation	CO_2	LA, TA	13.03
1.A Stationary Combustion - Gaseous Fuels	CO_2	LA, TA	11.10
1.B.1.a Coal Mining and Handling	CH_4	LA, TA	2.53
1.A Stationary Combustion - Liquid Fuels	N_2O	LA, TA	0.54
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	LA	0.51
1.A Stationary Combustion - Solid Fuels	CH_4	TA	0.15
1.A.3.b Transport - Road Transportation	N_2O	TA	0.49
1.A Stationary Combustion - Other fuels - 1A2	CO_2	TA	1.94
1.A Stationary Combustion - Other fuels - MSW	CO_2	TA	0.28

** assessed without considering LULUCF*
KC: key category, LA, LA: identified by level assessment with and without considering LULUCF, respectively*
TA, TA: identified by trend assessment with and without considering LULUCF, respectively.*

3.1.2 Emissions Trends

CO_2 emissions from the 1.A sector decreased by 38.1% from 144 Mt CO_2 in 1990 to 89 Tg CO_2 in 2014. Furthermore CO_2 emissions from the 1.B sector decreased by 55.7% from 458 kt in 1990 to 203 kt in 2014; in addition, CH_4 emissions from the 1.B sector decreased by 63.1% from 408 kt in 1990 to 150 kt in 2014. Fig. 3-1 indicates overall trend in CO_2 and CH_4 emissions in the whole time series for both sectors. Tab. 3-2 provides data for trends in 1 Energy for each gas reported in the sector.

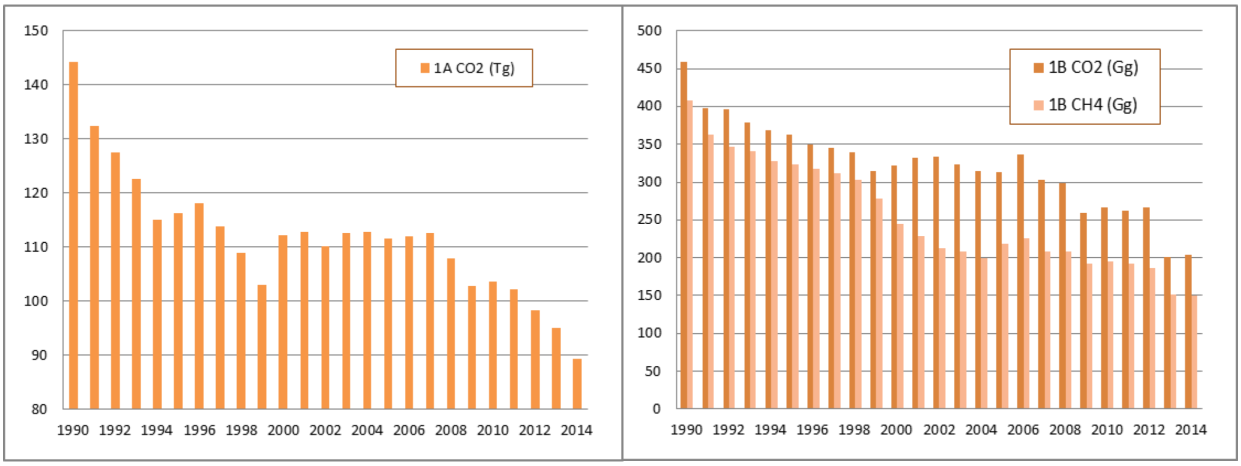


Fig. 3-1 Trend total CO_2 (Sectoral Approach) in 1.A and trend of CO_2 and CH_4 from 1.B sector in period 1990 – 2014

Tab. 3-2 Emissions of greenhouse gases and their trend from 1990 – 2014 from IPCC Category 1 Energy

	CO_2 [kt]	CH_4 [kt]	N_2O [kt]
1990	144 739	470	2.609
1991	132 831	417	2.373
1992	127 986	392	2.374
1993	122 969	385	2.333
1994	115 518	368	2.363
1995	116 710	360	2.428
1996	118 515	355	2.591
1997	114 281	346	2.585
1998	109 196	331	2.631
1999	103 417	303	2.716
2000	112 601	271	2.907
2001	113 128	255	3.062
2002	110 395	237	3.184
2003	113 014	236	3.490
2004	113 031	227	3.628
2005	111 991	243	3.759
2006	112 415	254	3.800
2007	112 968	235	3.975
2008	108 145	234	3.846
2009	103 010	218	3.763
2010	103 925	223	3.651
2011	102 531	219	3.631
2012	98 613	212	3.543
2013	95 216	180	3.486
2014	89 586	176	3.466
Trend 1990/2014	**-38%**	**-62%**	**33%**

3.1.2.1 Emission trends by subcategories

The individual subsectors have different contributions to trends in emissions. Fig. 3-2 illustrates the trends in emissions on the example of CO_2 emissions and the share of CO_2 emissions in different subsectors in 2014.

The greatest increase in emissions was recorded in subsector 1.A.3 Transport between 1990 and 2007, when emissions increased by 160%. In absolute values, this corresponded to an increase from 7 Tg CO_2 in 1990 to 18.3 Tg in 2007. A slight decrease has been apparent since 2008, corresponding to 0.1 Tg in

2014. Emissions from subsector 1.A.1 Energy Industries are almost constant with slight fluctuations over the entire period; the greatest reduction occurred in subsectors 1.A.2 and 1.A.4 from 50.9 and 29.7 Tg CO_2 in 1990 to 10 and 9.7 Tg CO_2 in 2014, respectively.

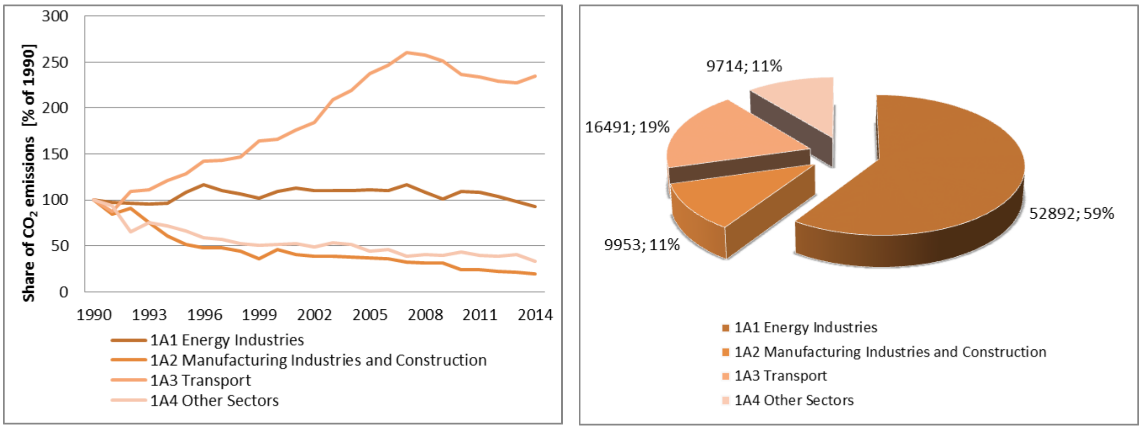


Fig. 3-3 Share and development of CO_2 emissions from 1990 - 2014 in individual sub-sectors; share of CO_2 emissions in individual subsectors in 2014 [kt]

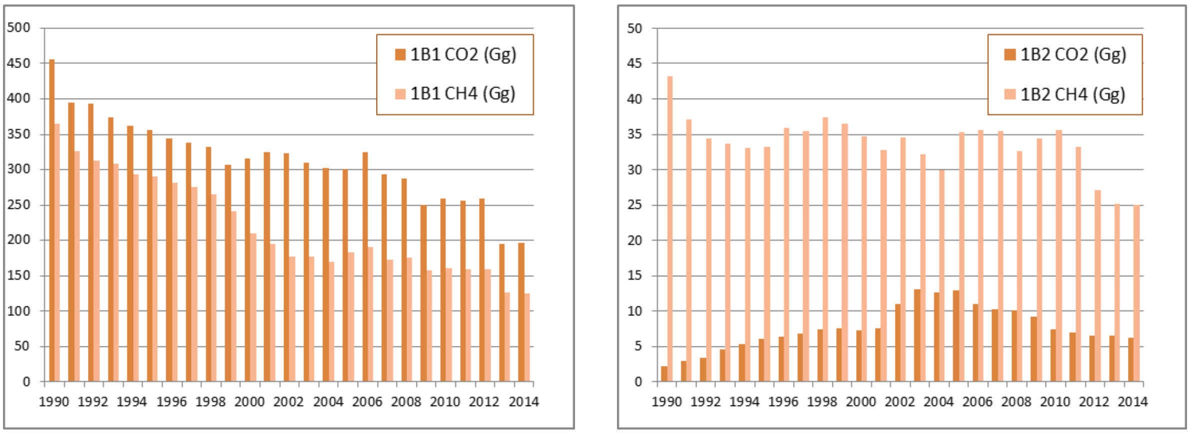


Fig. 3-3 CO_2 and CH_4 trend from the sector Fugitive Emissions from Solid Fuels and from from the sector Fugitive Emissions from Oil and Natural Gas

The fugitive emissions from Solid fuels also indicate substantial decrease in the whole time-series, i.e. 56.9% for CO_2 emission and 65.6% for CH_4 emissions. Fugitive CH_4 emissions from Oil and Natural Gas also indicate decrease for 42.1% in the time series. Fugitive CO_2 emissions from Oil and Natural Gas indicates increase, however these emissions are of minor importance in the whole submission.

The trends for different subcategories are also presented in Tab. 3-3.

Tab. 3-3 Total GHG emissions in [kt CO_2 equivalent] from 1990 – 2014 by sub categories of Energy

	1	1.A	1.A.1	1.A.2	1.A.3	1.A.4	1.A.5	1.B	1.B.1	1.B.2
1990	157 266	146 608	56 912	51 224	7 284	31 187	NO	10 658	9 576	1 082
1991	143 954	134 488	55 535	43 474	6 390	29 088	NO	9 466	8 535	931
1992	138 504	129 430	54 705	46 345	7 973	20 406	NO	9 074	8 211	863
1993	133 278	124 361	54 325	38 577	8 076	23 383	NO	8 917	8 072	845
1994	125 428	116 884	54 983	30 854	8 812	22 234	NO	8 544	7 712	832
1995	126 440	118 003	61 863	26 174	9 355	20 612	NO	8 438	7 601	837
1996	128 173	119 886	66 589	24 621	10 366	18 310	NO	8 287	7 382	905
1997	123 699	115 570	62 878	24 604	10 460	17 629	NO	8 128	7 236	892
1998	118 263	110 365	60 757	22 506	10 747	16 181	173	7 898	6 958	940
1999	111 809	104 557	58 266	18 504	11 986	15 634	167	7 253	6 331	922
2000	120 235	113 812	62 111	23 421	12 142	15 958	180	6 423	5 547	876
2001	120 428	114 394	64 301	20 876	12 904	16 152	161	6 034	5 206	828
2002	117 278	111 640	62 862	19 996	13 515	15 026	242	5 638	4 765	873
2003	119 951	114 407	62 520	19 928	15 339	16 374	245	5 544	4 728	816
2004	119 782	114 480	62 617	19 560	16 112	15 917	273	5 302	4 540	762
2005	119 197	113 435	63 214	18 836	17 459	13 652	273	5 762	4 866	896
2006	119 891	113 906	62 670	18 534	18 113	14 329	259	5 984	5 084	900
2007	120 027	114 505	66 302	16 651	19 056	12 149	347	5 522	4 626	897
2008	115 133	109 624	61 564	16 187	18 902	12 594	377	5 508	4 684	825
2009	109 594	104 521	57 493	15 940	18 379	12 345	364	5 073	4 205	868
2010	110 580	105 422	61 980	12 256	17 323	13 533	329	5 159	4 262	897
2011	109 085	104 002	61 686	12 456	17 123	12 351	387	5 083	4 244	839
2012	104 981	100 070	59 351	11 410	16 801	12 193	316	4 911	4 227	684
2013	100 760	96 771	56 005	11 110	16 650	12 697	309	3 989	3 355	634
2014	95 026	91 063	53 151	10 038	17 157	10 375	342	3 963	3 331	632
Total Trend 1990 - 2014	**-40%**	**-38%**	**-6.6%**	**-80%**	**136%**	**-67%**	**98%**	**-63%**	**-65%**	**-42%**

1)Trend 1998-2014

3.2 Fuel combustion activities (CRF 1.A)

3.2.1 Comparison of the sectoral approach with the reference approach

In addition to the Sectoral approach (SA), used commonly for determination of greenhouse gas emissions from sector 1.A, the IPCC methodology requires that a Reference Approach (RA)is also performed, whose main objective is to control the estimation of the CO_2 emissions in the Sectoral approach. The calculation does not require a great deal of input activity data, since the reference approach requires only the basic values included in the source section of the national energy balance (primary sources) and some additional information. It provides information only on total CO_2 emissions without any further division into consumer sectors.

From the 2015 submission onward, it is required to use the Reference Approach in line with IPCC 2006 Guidelines (IPCC, 2006). The main difference between the new reference approach and the old one, used to date (IPCC, 1997), is that, instead of the concept of “long-term stored carbon” (stored carbon), used for some non-energy fuels, now a new, broader concept is used - “excluded carbon”, which includes not only the stored carbon, but also carbon used and emitted as CO_2 in other sectors, not only in 1.A (most often in sector 2 IPPU). This means that the “excluded carbon” is deducted from the total carbon, calculated on the basis of the apparent domestic consumption (Apparent consumption, AC). This is mainly necessary for carbon contained in fossil fuels used as: (i) raw materials for further treatment in the industry (feedstocks), (ii) reductants and (iii) non-energy products.

An overview of materials containing “excluded carbon” is given in Tab. 3-4.

Tab. 3-4 Products used as feedstocks, reductants, and for non-energy products (IPCC, 2006)

Feedstocks	Naphtha
	LPG (propane - butane)
	Oils used as feedstocks
	Refinery gas
	Natural gas
	Ethane
Reductants	Metallurgical coke and petroleum coke
	Coal and coal tar/pitch
	Natural gas
Non-energy products	Bitumen
	Lubricants
	Paraffin waxes
	White spirit

For fuels which are used in sectors other than the Energy sector – 1.A (i.e. non-energy fuels: for example coke or naphtha), it is necessary to know the quantity of the particular material that is used outside 1.A (e.g. like feedstock or reductant).

In the Czech national inventory, the above-mentioned “excluded carbon” is considered for accounting for the following substances:

- Naphtha
- Bitumen
- Paraffin waxes
- Oils, used for production of hydrogen by partial oxidation (further for ammonia)
- White spirit

Tab. 3-5 and 3-6 report values set by the reference approach for 1990, 1995, 2000, 2005, 2010, 2011, 2012, 2013 and 2014 along with a comparison between the reference and sectoral approach for the same years. Tab. 3-7 summarizes comparison for the whole time period. The relative differences are less than 2% in the majority of cases.

Tab. 3-5 Activity data in energy units (PJ), used in reference and sectoral approach for basic groups of fossil fuels

Year	Type of fossil fuels	Apparent Consumption (PJ)	Carbon excluded (PJ)	Reference approach (PJ)	Sectoral approach (PJ)	(RA-SA)/SA (%)
1990	Liquid Fuels	358.6	71.8	286.8	300.0	-4.4
	Solid Fuels	1315.1	86.7	1 228.4	1 150.0	6.8
	Gaseous Fuels	219.9	0.0	219.9	205.4	7.0
	Other Fuels				0.26	
	Total	1893.6	158.5	1 735.1	1 655.7	4.8
1995	Liquid Fuels	321.3	97.0	224.3	240.0	-6.5
	Solid Fuels	937.6	71.0	866.6	878.7	-1.4
	Gaseous Fuels	274.7	0.0	274.7	260.8	5.3
	Other Fuels				0.65	
	Total	1533.7	168.0	1 365.7	1 380.2	-1.1
2000	Liquid Fuels	311.4	87.6	223.8	238.6	-6.2
	Solid Fuels	901.8	66.3	835.5	810.1	3.1
	Gaseous Fuels	314.5	0.0	314.5	305.1	3.1
	Other Fuels				1.28	
	Total	1527.7	153.9	1 373.0	1 355.0	1.4
2005	Liquid Fuels	387.5	111.4	276.2	292.1	-5.4
	Solid Fuels	847.1	75.5	771.6	754.7	2.2
	Gaseous Fuels	323.0	0.0	323.0	318.9	1.3
	Other Fuels				5.69	
	Total	1557.6	186.8	1 370.8	1 371.3	0.0
2010	Liquid Fuels	369.8	100.0	269.8	276.2	-2.3
	Solid Fuels	769.4	68.3	701.1	685.7	2.3
	Gaseous Fuels	338.5	3.8	334.7	309.8	8.1
	Other Fuels				5.89	
	Total	1477.8	172.1	1 305.7	1 277.6	2.2
2011	Liquid Fuels	357.4	93.8	263.6	270.7	-2.6
	Solid Fuels	754.4	64.5	689.8	686.1	0.6
	Gaseous Fuels	285.7	4.0	281.7	282.5	-0.3
	Other Fuels				6.78	
	Total	1397.4	162.3	1 235.1	1 246.0	-0.9
2012	Liquid Fuels	351.1	96.6	254.5	264.5	-3.7
	Solid Fuels	696.1	63.3	632.8	654.5	-3.3
	Gaseous Fuels	287.6	4.1	283.5	278.3	1.9
	Other Fuels				5.78	
	Total	1334.9	164.0	1 170.9	1 203.0	-2.7
2013	Liquid Fuels	339.4	91.2	248.3	255.8	-2.9
	Solid Fuels	681.9	67.5	614.4	627.5	-2.1
	Gaseous Fuels	291.4	3.9	287.6	282.8	1.7
	Other Fuels				4.67	
	Total	1312.8	162.6	1 150.2	1 170.7	-1.8
2014	Liquid Fuels	358.7	101.9	256.8	266.6	-3.7
	Solid Fuels	660.5	68.8	591.7	575.4	2.8
	Gaseous Fuels	259.4	4.0	255.4	250.4	2.0
	Other Fuels				5.66	
	Total	1278.6	174.7	1 104.0	1 098.1	0.5

Tab. 3-6 Results for CO_2 emissions (kt) according to reference approach and comparison with sectoral approach

Year	Type of fossil fuels	Apparent Consumption (kt CO_2)	Carbon excluded (kt CO_2)	Reference approach (kt CO_2)	Sectoral approach (kt CO_2)	(RA-SA)/SA (%)
1990	Liquid Fuels	26 352	5 392	20 959	22 220	-5.7
	Solid Fuels	127 002	9 280	117 722	110 823	6.2
	Gaseous Fuels	11 990	0	11 990	11 201	7.0
	Other Fuels				36.5	
	Total	165 344	14 672	150 672	144 280	4.4
1995	Liquid Fuels	23 432	7 197	16 235	17 530	-7.4
	Solid Fuels	90 507	7 600	82 907	84 384	-1.8
	Gaseous Fuels	15 110	0	15 110	14 343	5.3
	Other Fuels				90.9	
	Total	129 049	14 797	114 252	116 348	-1.8
2000	Liquid Fuels	22 801	6 481	16 320	17 296	-5.6
	Solid Fuels	87 112	7 093	80 019	78 020	2.6
	Gaseous Fuels	17 297	0	17 297	16 777	3.1
	Other Fuels				185.9	
	Total	127 210	13 574	113 636	112 279	1.2
2005	Liquid Fuels	28 359	8 282	20 077	21 108	-4.9
	Solid Fuels	81 573	7 750	73 823	72 462	1.9
	Gaseous Fuels	17 765	0	17 765	17 535	1.3
	Other Fuels				572.0	
	Total	127 697	16 032	111 665	111 677	0.0
2010	Liquid Fuels	27 112	7 417	19 695	19 945	-1.3
	Solid Fuels	74 284	6 977	67 307	65 994	2.0
	Gaseous Fuels	18 717	210	18 507	17 126	8.1
	Other Fuels				592.5	
	Total	120 114	14 604	105 509	103 658	1.8
2011	Liquid Fuels	26 205	6 954	19 250	19 564	-1.6
	Solid Fuels	73 311	6 602	66 710	66 383	0.5
	Gaseous Fuels	15 786	220	15 565	15 610	-0.3
	Other Fuels				710.9	
	Total	115 302	13 776	101 526	102 269	-0.7
2012	Liquid Fuels	25 800	7 157	18 643	19 110	-2.4
	Solid Fuels	67 723	6 462	61 261	63 210	-3.1
	Gaseous Fuels	15 876	225	15 651	15 363	1.9
	Other Fuels				664.2	
	Total	109 399	13 843	95 555	98 347	-2.8
2013	Liquid Fuels	24 893	6 756	18 137	18 490	-1.9
	Solid Fuels	66 054	6 872	59 182	60 368	-2.0
	Gaseous Fuels	16 117	215	15 902	15 616	1.8
	Other Fuels				539.9	
	Total	107 065	13 843	93 222	95 014	-1.9
2014	Liquid Fuels	26 346	7 535	18 811	19 262	-2.3
	Solid Fuels	64 094	6 971	57 123	55 609	2.7
	Gaseous Fuels	14 358	220	14 138	13 860	2.0
	Other Fuels				651.4	
	Total	104 798	14 726	90 072	89 383	0.8

Tab. 3-7 Apparent consumption in energy units (PJ) used in reference and sectoral approach for all fossil fuels and corresponding results for CO_2 emissions (kt)

Year	Appar. cons. (PJ)	Carbon excluded (PJ)	Reference approach (PJ)	Sectoral approach (PJ)	(RA-SA)/SA (%)	Emissions of Apparent Consumption (kt CO_2)	Carbon excluded (kt CO_2)	Reference approach (kt CO_2)	Sectoral approach (kt CO_2)	(RA-SA)/SA (%)
1990	1 893.5	158.5	1 735.1	1 655.7	4.8	165 343.9	14 671.9	150 672.0	144 280.1	4.4
1991	1 702.4	114.0	1 588.4	1 522.0	4.4	148 621.0	10 765.8	137 855.2	132 432.5	4.1
1992	1 639.7	120.2	1 519.5	1 486.4	2.2	140 768.5	11 327.0	129 441.5	127 589.2	1.5
1993	1 578.8	108.3	1 470.5	1 431.2	2.7	135 128.7	10 250.4	124 878.3	122 591.2	1.9
1994	1 510.4	130.6	1 379.8	1 353.9	1.9	128 392.2	12 125.3	116 266.8	115 150.3	1.0
1995	1 533.7	168.0	1 365.7	1 380.2	-1.1	129 048.8	14 796.9	114 252.0	116 348.2	-1.8
1996	1 575.8	174.0	1 401.8	1 418.8	-1.2	131 039.9	15 311.5	115 728.5	118 164.8	-2.1
1997	1 589.7	171.2	1 418.5	1 375.0	3.2	132 638.9	15 250.9	117 388.0	113 936.7	3.0
1998	1 538.5	167.2	1 371.3	1 326.7	3.4	127 212.2	14 934.9	112 277.3	108 856.0	3.1
1999	1 421.5	149.1	1 272.5	1 267.7	0.4	115 776.1	12 875.7	102 900.4	103 103.3	-0.2
2000	1 527.7	153.9	1 373.8	1 355.0	1.4	127 210.4	13 574.3	113 636.1	112 278.7	1.2
2001	1 552.3	151.2	1 401.0	1 373.8	2.0	128 098.5	13 261.9	114 836.6	112 796.1	1.8
2002	1 535.2	158.9	1 376.3	1 343.8	2.4	126 440.8	14 023.3	112 417.5	110 061.3	2.1
2003	1 551.6	167.5	1 384.1	1 377.0	0.5	127 945.4	14 870.9	113 074.5	112 690.9	0.3
2004	1 520.1	195.7	1 324.4	1 382.7	-4.2	124 432.1	17 064.3	107 367.8	112 717.0	-4.7
2005	1 557.6	186.8	1 370.8	1 371.3	0.0	127 696.7	16 031.9	111 664.8	111 677.3	0.0
2006	1 585.3	196.8	1 388.4	1 373.5	1.1	130 572.6	17 089.8	113 482.8	112 079.2	1.3
2007	1 585.6	187.4	1 398.3	1 374.3	1.7	131 248.4	16 424.4	114 824.0	112 665.1	1.9
2008	1 524.2	192.4	1 331.8	1 323.6	0.6	125 168.6	16 524.1	108 644.5	107 847.2	0.7
2009	1 400.9	157.2	1 243.7	1 257.0	-1.1	114 842.3	13 332.3	101 510.0	102 750.9	-1.2
2010	1 477.8	172.1	1 305.7	1 277.5	2.2	120 113.6	14 604.2	105 509.4	103 658.2	1.8
2011	1 397.4	162.3	1 235.1	1 246.0	-0.9	115 301.8	13 776.2	101 525.6	102 268.7	-0.7
2012	1 334.9	164.0	1 170.9	1 203.0	-2.7	109 398.5	13 843.4	95 555.1	98 347.5	-2.8
2013	1 312.8	162.6	1 150.2	1 170.7	-1.8	107 064.7	13 842.9	93 221.8	95 014.3	-1.9
2014	1 278.6	174.6	1 104.0	1 098.1	0.5	104 797.7	14 725.6	90 072.1	89 382.7	0.8

3.2.2 International bunker fuels

In the Czech Republic, this corresponds only to the storage of Kerosene Jet Fuel for international air transport since the Czech Republic does not have an ocean fleet.

Basic activity data are available in the CzSO energy balance (CzSO, 2015). Tab. 3-8 gives the amount of stored Kerosene Jet Fuel.

Tab. 3-8 Kerosene Jet Fuel in international bunkers

Year	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
[TJ/year]	7325	6020	6967	5792	7208	7805	5866	6759	7991	7520	8234	8750	7 556
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	
[TJ/year]	10163	13062	13573	14070	14763	15644	14287	13387	13272	12367	11931	12241	

3.2.3 Feedstocks and non-energy use of fuels

The new methodology valid starting last year (IPCC, 2006) clearly sets the borderlines between the Energy and Industrial Processes and Product Use (IPPU) sectors. Compared to the previous methodology version (IPCC, 1997), emissions from non-energy use of fuels is reported mainly in sector 2 – IPPU. To prevent double counting or omission of resources, it is necessary to carefully carry out a completeness check of CO_2 emissions in sectors 1.A (Energy – combustion) and 2 – IPPU, for those kinds of fuels that are used for both energy and non-energy purposes.

Non-energy fuels are divided into three categories:

1) **Raw materials for the chemical industry (Feedstocks)**. These fossil fuels are used in particular in the production of organic compounds and to a lesser extent in the production of inorganic chemicals (e.g. ammonia) and their derivatives. For organic substances, normally part of the carbon contained in the feedstock remains largely stored in these products. Typical examples of raw materials are feedstocks for the petrochemical industry (naphtha), natural gas, or different types of oils (e.g. the production of hydrogen for the subsequent production of ammonia by partial oxidation).
2) **Reductants**. Carbon is used as a reductant in metallurgy and inorganic technologies. Unlike the previous case, here when using fossil fuel as reductant only a very small amount of carbon remains fixed in the products for a longer time and the larger part of the carbon is oxidized during the reduction process. Metallurgical coke is a typical reductant.
3) **Non-energy products**. Non-energy products are materials derived from fuels in refineries or coke plants which, unlike the previous two cases, are used directly for their conventional physical properties, specifically as lubricants (lubricating oils and petrolatum), diluents and solvents, bitumen (for covering roads and roofs) and paraffin. Emissions of CO_2 and other GHG occur only to a limited extent in the IPPU category (e.g. during the oxidation of lubricants and paraffin). Substantial emissions occur during their recovery and during disposal by incineration (in the sector Energy and in Waste).

Emissions from feedstocks in the chemical industry are reported in subsector 2.B, from reductants primarily in subsector 2.C and from non-energy products, used mainly for purposes other than combustion (e.g. lubricating oils) in subsector 2.D.

In accordance with the Regulation No 1099/2008 of the European Parliament and of the Council on energy statistics, the energy balance of the Czech Republic distinguishes amongst various types of fuels in their use for energy and non-energy purposes. Below are listed the different kinds of fuels with a high proportion of non-energy use in the Czech Republic.

Some types of liquid fuels are designed mainly for non-energy use. This is primarily naphtha, for which CzSO indicates, since 2001, that virtually the entire amount is consumed for non-energy purposes by the chemical industry, mainly as petrochemicals (2.B). For example, in 2014 the consumption was 45.7 PJ. The non-energy use of LPG is less significant .

Another important type of liquid fuels consumed for non-energy purposes of fuels is a group designated as Other Oils. Their most significant share is Other Petroleum Products, which finds application in the production of hydrogen by partial oxidation with steam for subsequent production of ammonia and a further part of it is also included under Solvent Use. In 2014, the consumption of Other Petroleum Products for non-energy purposes (particularly in sub-sectors 2.B, 2.D) was 21.4 PJ, compared to 11.7 PJ utilized for combustion in sector 1.A. White Spirit and Paraffin Wax are less important categories and are indeed only used for non-energy purposes in 2.D; naturally their consumption is small compared to Other Petroleum Products (total of 1.3 PJ in 2014).

Liquid fuels used especially for non-energy purposes also include bitumen, whose consumption in 2014 was 18.2 TJ and lubricants with consumption of 6.3 PJ in 2014. While there are practically no emissions of CO_2 in the use of bitumen (Stored carbon), in the use of lubricants part is oxidized to CO_2 (Reported in 2.D).

Solid fuels for non-energy purposes are mainly used as reductants. These include coke (Coke Oven Coke), of which 53.9 PJ were used in 2014 in the production of iron and steel (2.C) compared to 10.9 PJ utilized in sector 1.A. In the case of tar (Coal Tar) 14.9 PJ were used in 2014 in industry, while 0.9 PJ were used in sector 1.A.

In many countries natural gas (NG) is also used as a feedstock. It was not used until recently in the Czech Republic and since 2008 CzSO has indicated that approximately 1% of annual consumption of natural gas in the Czech Republic is used for non-energy purposes in the chemical industry. This non-energy use is reported under 2.B.10.

Fuels for non-energy use are not accounted for in the Sectoral approach in category 1.A. In the Reference approach, NEU are deducted from the apparent consumption as excluded carbon (see Sub-chapter "CO_2 reference approach and comparison with the sectoral approach").

Tab. 3-9 lists the calorific values of the energy balance calculation of CzSO and default emission factors, which were used in the reference approach.

Tab. 3-9 Net calorific values and emission factors of feedstocks

Non-energy Fuels	NCV	EF
	[GJ/kt]	[t CO_2/TJ]
LPG	45 945	65.86[1)]
Naphtha	43 600	73.30
White Spirit	40 193	73.30
Lubricants	40 193	73.30
Bitumen	40 193	80.70
Paraffin Wax	40 193	73.30
Petroleum Coke	38 500	97.50
Other Petroleum Products	39 910	73.30
Refinery Gas	46 023	55.08[1)]
Coke Oven Coke	28 594[)]	107.0

1) *country-specific value*
2) *used in blast furnaces*

3.2.4 Methodological issues

The chapter describes procedures, which are applied for emission estimates from combustion sources in general. Each chapter for specific subcategories then contains (if applicable) any specific procedures used for these specific sources.

The data for the whole time series was constructed on the basis of data from the CzSO Questionnaire (CzSO, 2015), where the data on fuel consumption are provided in various ways. Data are available for Solid and Liquid Fuels in mass units (kt p.a.), where the net caloric values of these fuels are also tabulated. The consumption of gaseous fuels derived from fossil fuels is given in TJ p.a. Natural Gas is given in thousand m^3 and the consumption in TJ is also tabulated; however, in this case it is calculated using the gross caloric value. The Energy balance in mass units (kt p.a.) for last reported year (2014) is given in Annex 4, Tables A4-1 – A4-7.

Since 2012 submission net calorific values for Liquid Fuels for the whole time series are available. These are now assumed to be correct (agreed by CzSO) and therefore used for conversion of activity data from natural units to energy units. Except of the official NCV provided by CzSO country specific NCVs are used, for Refinery Gas and LPG.

The principles of preparation of the emission inventory are further specified in detail for the individual phases of data preparation and processing and subsequent utilization of the results of calculations with subsequent data storage.

3.2.4.1 Collection of activity data

In collection of activity data, all the background data are stored at the workplace of the sector compiler, where possible in electronic form. These consist primarily in datasets obtained from CzSO as officially submitted data for drawing up the activity data. The dataset for the last reported year is given in Annex 4, Tables A4-1 – A4-7; similar datasets for the whole time series are stored in the archive of the sectoral expert.

If the data are taken from the Internet, the relevant passages (texts, tables) are stored in separate files with designation of the web site where they were obtained and the date of acquisition.

Data taken from printed documents are suitably cited, the written documents are stored in printed form at the workplace of the sector compiler and, where possible, the relevant passages (texts, tables) are scanned and stored in electronic form.

When the stage is completed, all the stored data are transferred to electronic media (CD, external HD, flash disks, etc.) and stored with the sector compiler; the most important working files that contain data sources, calculation procedures and the final results are submitted in electronic form for storage at the coordination workplace.

In case EU ETS data are used, the original forms are stored in archive of national inventory system coordinator, as well as officially at Ministry of Environment.

3.2.4.2 Conversion of activity data to the CRF format

The activity data are converted from the energy balance to the CRF structure in the EXCEL format. Each working file has a “Title page” as the first sheet. Using interconnected system of excel files was created computational model for emission estimates from the stationary sources in Energy sector.

The Title page shall contain particularly the following information:

- the name and description of the file
- the author of the file
- the date of creation of the file
- the dates of the latest up-dating, in order
- the source of the data employed
- description of transfer of specific data from the source files
- the means of aggregation of the data base employed in conversion
- explanations and comments.

Separate computational files for each kind of fuels are used, which are then interconnected with the final computational files, where are data transferred in the specific subcategories and the computation of emission estimates is carried out. The operational part of the files contains whole computational approach for estimation of CO_2, CH_4 and N_2O emissions, which includes following steps:

- complete division of data about consumption of each kind of fuels from Energy balance provided by CzSO into the structure compatible with CRF Reporter (for purposes of Sectoral and Reference Approaches)
- complete set of NCV for specific kinds of fuels and emission and oxidation factors (if applicable)
- computation of emission estimates

- summation of activity data and emissions for each group of fuels (solid, liquid, gaseous etc.) into specific subcategories

Outputs form the computational model are datasets, which are possible to import into CRF Reporter. All computational sheets are managed in whole time-series and units of input and output values are recorded as well.

For current submission is added additional part of computational model, which enables comparison of data from previous submission with the data from current submission. This step is important especially because this year's submission was compiled using new updated methodology IPCC 2006 Guidelines (IPCC, 2006).

3.2.4.3 Calculations of emissions

Original activity data are provided in kilotons. It means that it is necessary to convert these values to energy units – terajoules. For this conversion are used calorific values listed in Annex 5.

Coke Oven Gas, Gas Works Gas and biofuels are given directly in terajoules in the CzSO Questionnaires (CzSO, 2015), however the data were calculated using the gross calorific values, so it is necessary to recalculate these values to net calorific values.

Natural Gas is provided in the statistic reporting in the CzSO Questionnaire (CzSO, 2015) in thousand m^3 and in TJ; however, the data in TJ is determined using the gross caloric value. Volume reported by CzSO in thousand m^3 is related to the „trade conditions“, i.e. temperature 15°C and pressure 101.3 kPa.

CzSO uses for the conversion between gross and net calorific value coefficient NCV/GCV = 0.9. Research was carried out in 2014 to develop a methodology for determining the precise values of this coefficient. Details concerning the research and methodology of determining the NCV/GCV coefficient are provided in Annex 5.

It was found (see Annex 5) that the NCV/GCV ratio for natural gas can be very closely described by the linear dependence.

$$\frac{NCV}{GCV} = (0.001011 \cdot GCV) + 0.863274$$

where NCV and GCV are expressed in MJ/m^3 in the reference temperatures of 15 ˚C (i.e. trade conditions). However, the improved values of the NCV/GCV ratio are not far from the IPCC default value of 0.9. For example, the value NCV = 34.489 MJ/m^3 given in Tab. 3-10 corresponds to the ratio NVC/GCV=0.9019 calculated from the above equation. This equation was used for calculation of NCV from GCV for the whole time period.

For calculation of CO_2 emissions are used emission factors, which are either provided in the IPCC 2006 Guidelines (IPCC, 2006), or which were determined as country-specific emission factors. Since CO_2 emission factors depend on quality of specific of fuel, the values of emission factors are listed in the specific chapters bellow. Default emission factors from the IPCC methodology have been for key categories gradually substituted by country specific emission factors. Moreover, in case of CO_2 emission factors from lignite (brown coal) and bituminous coal, the previous country-specific emission factors were in this submission refined by using up-to-date national data. Description of used country-specific emission factors including ways of their evaluations is provided in Annex 3.

CH_4 and N_2O emissions from fuel combustion from stationary sources are not among the key categories. Thus contrary to CO_2 emission factors, for CH_4 and N_2O emission factors are used always default values from IPCC 2006 Guidelines (IPCC, 2006). CH_4 and N_2O emission factors are listed in the specific subchapters for specific subcategories.

General CO_2 emission factors and NCV are provided in Tab. 3- 10.

Tab. 3-10 Net calorific values (NCV), CO_2 emission factors and oxidation factors used in the Czech GHG inventory – 2014

Fuel (IPCC 2006 Guidelines definitions)	NCV [TJ/kt]	CO_2 EF [a] [t CO_2/TJ]	Oxidation factor	CO_2 EF [b] [t CO_2/TJ]
Crude Oil	42.400	73.30	1	73.30
Gas/Diesel Oil	42.600	74.10	1	74.10
Residual Fuel Oil	39.500	77.40	1	77.40
LPG [d]	45.945	65.86	1	65.86
Naphtha	43.600	73.30	1	73.30
Bitumen	40.193	80.70	1	80.70
Lubricants	40.193	73.30	1	73.30
Petroleum Coke	38.500	97.50	1	97.50
Other Oil	39.921	73.30	1	73.30
Coking Coal [d]	29.468	93.55	1	93.55
Other Bituminous Coal [d]	22.249	95.16	0.9707	92.37
Lignite (Brown Coal) [d]	12.082	100.69	0.9846	99.14
Brown Coal Briquettes	21.149	97.50	0.9846[d]	96.00
Coke Oven Coke	28.572	107.00	1	107.00
Coke Oven Gas (TJ/mill. m^3)	16.064 [c]	44.40	1	44.40
Natural Gas (TJ/Gg) [d]	48.836	55.35	1	55.35
Natural Gas (TJ/mill. m^3) [d]	34.489	55.35	1	55.35

a) Emission factor without oxidation factor
b) Resulting emission factor with oxidation factor
c) TJ/mill. m^3, t= 15 °C, p = 101.3 kPa
d) Country specific values of CO_2 EFs and oxidation factors

3.2.5 Uncertainties and time-series consistency

The emission inventory is based on 2 types of data accompanied by different levels of uncertainty:

- Activity data (consumption of individual kinds of fuels)
- Emission factors

Extensive research was carried out in 2012 to obtain new, more accurate values for the uncertainties (CHMI, 2012b). The results are given in chapter 1.6 and Annex 2 furthermore lists source of expert judgement provided for uncertainty analysis for each category. Further research for uncertainties is planned for 2016 and 2017.

Activity data

Information on fuel consumption is taken from CzSO (CzSO, 2015).

Uncertainties:

1) on the part of CzSO in collecting and processing the primary data

CzSO does not explicitly state the uncertainties in the published data. However, the uncertainty differs for the individual groups of data – statistical reports from the individual enterprises (economic units with more than 20 employees); consumption by the population is calculated on the basis of models and reports by suppliers of network energy (gas, electricity), production of the individual kinds of fuels (especially automotive fuels) and customs reports (imports, exports); the remainder is calculated so that the fuel consumption is balanced. Each step is accompanied by a different level of uncertainty. Overall the uncertainty in Natural Gas activity data should be lower than uncertainty of Solid Fuels activity data since the Natural Gas is measured more accurately in comparison to for instance coal.

Uncertainties also arise during data processing. CzSO obtains data in mass units – tons per year (1st level of uncertainty). The resultant balance is expressed in energy units – TJ p.a. Recalculation from mass units to energy units must be performed using the fuel calorific value. The determination of these values is accompanied by uncertainties following from the method employed (mostly laboratory expertise) (2nd level of uncertainty). The average fuel calorific value valid for all of the Czech Republic must be determined for each kind of fuel. Because the calorific value differs substantially in dependence on the mine location, it is necessary to determine the average calorific value on the basis of a weighted average – 3rd level of uncertainty.

2) on the part of the sector compiler in interpretation of CzSO data

The sector compiler introduced uncertainty into the processing that can be based on an elementary error in interpreting the data. However, because routine control procedures are employed and no fuel may be missing or calculated twice in the final balance, this uncertainty can be considered to be less than 1% (approx. 0.5%).

Emission factors

For calcualtions were applied

1) Default emission factors

The research carried out in 2012 focused also on the determining of uncertainties of emission factors (CHMI, 2012b). Results are provided in the Tab. 3-11. The uncertainty values for the default emission factors are based on the 2006 Guidelines (IPCC, 2006).

2) Country specific emission factors

The country-specific emission factors were determined on the basis of experimental data and this uncertainty can be estimated at approx. 2.5%.

Tab. 3-11 Uncertainty data from Energy sector (stationary combustion) for uncertainty analysis

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
CO_2	1.A Stationary combustion – Solid Fuels	4	3	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A Stationary combustion – Gaseous Fuels	3	2.5	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A Stationary combustion– Liquid Fuels	5	3	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A Stationary combustion – Other Fuels – 1.A.2	10	15	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.3.e Other Transportation	4	3	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.5.b Mobile sources in agriculture and forestry	7	3	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A Stationary combustion – Solid Fuels	5	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A Stationary combustion – Gaseous Fuels	4	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A Stationary combustion – Liquid Fuels	5	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A Stationary combustion – Biomass	8	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.5.b Mobile sources in agriculture and forestry	7	50	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.3.e Other Transportation	4	50	E. Krtkova, V. Neuzil, AD and EF unc. in line

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
				with 2006 Guidelines
N_2O	1.A Stationary combustion – Solid Fuels	5	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A Stationary combustion – Gaseous Fuels	4	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A Stationary combustion – Liquid Fuels	5	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A Stationary combustion – Biomass	8	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A Stationary combustion – Other Fuels – 1.A.2	10	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.e Other Transportation	4	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.5.b Mobile sources in agriculture and forestry	7	60	E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines

Time - series consistency

The time series consistency is regularly monitored by the sector compiler and evaluated as an instrument for revealing potential errors. As the sector compilers create the data time series from external CzSO data, they cannot affect the variation in the time series of activity data during processing.

However, feedback to the primary data processor does exist. If an anomaly is identified in the time series, CzSO is informed about this fact and is requested to provide an explanation.

So far, no means have been found for consistent and systematic verification of the consistency of time series at CzSO and for analysis of the causes of fluctuations. Rather than elementary errors, preliminary analysis indicates that the anomalies are caused solely by the methodology for ordering the statistical data in the energy balance structure. Assignment of the statistical data on fuel consumption to the individual energy balance chapters is performed by the valid methodology according to CZ-NACE (the former Czech equivalent was OKEC – Branch Classification of Economic Activities). The CZ-NACE code is assigned to economic entities on the basis of their Id.No. (Identification Numbers). This can result in substantial inter-annual changes in the individual subcategories.

Example:

The decisive CZ-NACE code for entity A is that for chemical production. He operates a large boiler with a substantial fraction of fuel in the entire 1.A.2.c subsector. The energy production is split off to independent entity B, whose main activity is production and supply of heat. In the final analysis, the reported fuel consumption is shifted from 1.A.2.c to 1.A.1.a.

In the Czech Republic, the 1990's and beginning of the 20th century were a period when a route to rational utilization of means of production was sought and changes in the ownership structure of energy-production facilities were quite frequent. Consequently, consistency of the time series is interrupted in some subcategories. Justification for the exact causes of each such change lies outside the current capabilities of the sector compiler.

Changes in the consistency of time series of emission data must follow changes in activity data. If different anomalies occur, these anomalies are verified and any errors in the determination of the emission data are immediately eliminated.

Other Fuels (CRF 1.A.1.a) - Uncertainties and time-series consistency

The time series comes from two data sources – time-series was reproduced by MIT and data about current incineration comes from ISOH (Information system of waste management). There are no country-specific uncertainties yet, as all the factors but activity data used in the equations are default IPCC factors.

3.2.6 QA/QC and verification

The general QA/QC plan was formulated since the last submission and is presented in the Chapter 1.2.3. The QA/QC procedures applied in the company KONEKO Ltd. are based on the QA/QC plan for GHG inventory in the Czech Republic and are harmonized with the QA/QC system of the Transport Research Centre (CDV). As the basic data sources for the processing of activity data are based on the energy balance of the Czech Republic the main emphasis is given to close cooperation with the Czech statistical office (CzSO). This cooperation is based on the contract between CHMI, as the NIS coordination workplace, and CzSO. CzSO is a state institution established for statistical data processing in the Czech Republic, which has its own control and verification mechanisms and procedures to ensure data quality.

Sectoral guarantor and administrator of QA/QC procedures, Vladimir Neuzil (KONEKO manager):

- processes and updates the sectoral QA/QC plan
- organizes QC procedure
- ensures verification procedures and is responsible for its realization
- is responsible for the submission of all documents and data files for the storing in the coordinating institution suggests external experts for QA procedure
- ensures data input in the CRF Reporter
- carries out auto-control – control of input data and primary computations
- ensures and is responsible for the storing of documents

The QC procedures are related to the processing, manipulation, documentation, storing and transmission of information. The first step of the control is carried out by the expert responsible for the Sectoral Approach (Vladimir Neuzil), followed up by the control carried out by the QA/QC expert familiar with the topic (Pavel Fott, former NIS coordinator). At this control level individual steps are controlled according official QA/QC methodology (IPCC, 2006).

Data transmission to the CRF Reporter is accomplished by the data administrator. After data transmission to the CRF Reporter the control of correct data transmission based on the summary values of activity data and emission data is carried out. If there are any discrepancies, the erroneous data are detected and corrected.

Verification procedures are included upon the suggestion of the QA/QC sectoral guarantor after the consultation with the NIS coordinator. They are aimed mainly at the comparison with independent data sources that are not based on data processing from the CzSO energy balance. The relevant independent sources in the Czech Republic are represented by data published and verified within the EU Emission Trading Scheme (ETS), from the national system REZZO, used for the registration of ambient air pollutants, and based mainly on data collection from individual plants. In addition to emission data the REZZO database includes also activity data, independent of CzSO data. The way how to optimally use the above data sources has to be determined on the basis of systematic research and will be covered in the national inventory improvement plan.

External co-worker of KONEKO (Pavel Fott) familiar with the relevant topic participates in the QC procedures. The cooperation is based on ad hoc contracts ensured by the QA/QC sectoral guarantor. As already mentioned above, also experts from CzSO, closely cooperating with CHMI and KONEKO, take part in the control procedures.

The QA procedures are planned in a way described in the general part of the QA/QC plan, i.e. approximately once in three years. This year the QA was held by external expert of NIS team. Since this submission was processed using new updated methodology, the QA/QC procedures were applied on very detail this year.

Other QC procedures were performed using data indicators which should have the same course as the reported value. Where these data are available, details of this QC are given in the following figures.

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

This category is divided into 3 sub categories:

- Electricity Generation (CRF 1.A.1.a.i)
- Combined Heat and Power Generation (1.A.1.a.ii)
- Heat Plants (1.A.1.a.iii)

Even though this division is used in the new methodology (IPCC, 2006), since so far no reliable data are available for this detailed classification, in this submission, the reported data are summarized in category CRF 1.A.1.a.i.

3.2.7.1 Category description (CRF 1.A.1.a.i)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.1.a.i, 2014								
Structure of Fuels	**Activity**	**CO_2**			**CH_4**		**N_2O**	
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**	**[-]**	**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
Heating and Other Gasoil	42.6	74.1	1	3.2	3	0.00013	0.6	0.00003
Fuel Oil - Low Sulphur	671.5	77.4	1	52.0	3	0.00201	0.6	0.00040
Fuel Oil - High Sulphur	39.5	77.4	1	3.1	3	0.00012	0.6	0.00002
Other Bituminous Coal	67 295.8	95.42 *)	0.971 *)	6 232.9	1	0.06730	1.4	0.09421
Brown Coal + Lignite	380 110.5	100.70 *)	0.985 *)	37 688.6	1	0.38011	1.4	0.53215
Coal Tars	73.5	80.7	1	5.9	1	0.00007	1.4	0.00010
Coke Oven Gas	5 683.3	44.4	1	252.3	1	0.00568	0.1	0.00057
Natural Gas	34 089.5	55.35 *)	1	1 887.0	1	0.03409	0.1	0.00341
Waste - fossil fraction	2 410.1	145.1	1	349.8	0.0208	0.00005	5.208	0.01255
Waste - biomass fraction	3 615.1	145.1	1	524.7	0.0208	0.00008	5.208	0.01883
Wood/Wood Waste	14 949.0	112.0	1	1 674.3	30	0.44847	4	0.05980
Gaseous Biomass	916.0	54.6	1	50.0	1	0.00092	0.1	0.00009
Total year 2014	**509 896.3**			**48 723.7**		**0.93902**		**0.72217**
Total year 2013	535 653.3			50 020.1		0.94317		0.75505
Index 2014/2013	0.95			0.95		1.00		0.96
Total year 1990	569 994.5			54 713.8		0.60160		0.75963
Index 2014/1990	0.89			0.89		1.56		0.95

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are presented in detail in the following outline.

2014							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coal Tars	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke Oven Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Waste - fossil fraction	ISOH, MIT	D	D	D	Tier 1	Tier 1	Tier 1
Waste - biomass fraction	ISOH, MIT	D	D	D	Tier 1	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

The fraction of CO_2 emissions from sector 1.A.1 equalled 59.2% in 2014 in the whole Energy sector (1.A) – combustion of fuels.

In source category 1.A.1.a, the energy balance includes district heating stations and electricity and heat production at public power stations.

This category encompasses all the facilities that produce electric energy and heat supplies, where this production is their main activity and they supply their products to the public mains. Examples include the power plants of ČEZ Inc., DALKIA Inc. power plants and heating plants, Energy United Inc. and a number of others in the individual regions and larger cities in the Czech Republic.

In 2014, the fraction of CO_2 emissions in subsector 1.A.1.a equalled 91.8% of total CO_2 emissions in sector 1.A.1 .

Of the total installed capacity of electricity generation of 19.2 GWe in 2014, 10.5 GWe corresponded to for thermal power plants:

Nuclear	4 290	MWe
Hydro	2 062	MWe
Solar photovoltaic	2 068	MWe
Wind	278	MWe
Combustible fuels	11 392	MWe
Total capacity	**20 090**	**MWe**

In the final energy balance of CzSO (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in the Transformation Sector under the items:

- Main Activity Producer Electricity Plants
- Main Activity Producer CHP Plants
- Main Activity Producer Heat Plants

The category includes consumption of all kinds of fuels in enterprises covered by NACE Rev. 2:

35.11 Production of electricity

35.30 Steam and air conditioning supply (production, collection and distribution of steam and hot water for heating, power and other purposes)

The volume of production of electricity and heat and the structure of the sources are shown in the following overview.

Electricity production (GWh)	**45 853**
Main activity producer electricity plants	24 521
Main activity producer CHP plants	14 018
Autoproducer electricity plants	57
Autoproducer CHP plants	7 257
Heat production (TJ)	**119 947**
Main activity producer CHP plants	86 386
Main activity producer heat plants	17 223
Autoproducer CHP plants	9 764
Autoproducer heat plants	6 574

Fig. 3-4 presents an overview of development of CO_2 emissions in source category 1.A.1.a.

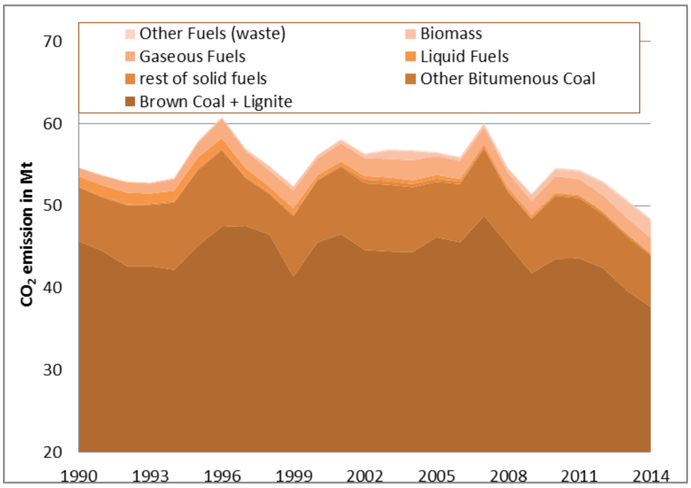


Fig. 3-4 Development of CO_2 emissions in 1.A.1.a category

CO_2 emissions exhibit a stable trend with only a few oscillations over the whole time series.

The trend in emissions is mainly shaped by the development and structures of the electricity generation installations involved, since these installations account for the majority of the pertinent emissions. As is clear from the figure, Solid Fuels are the main driving force for emissions in this source category. Brown Coal and Lignite are the most important, with average consumption of 452 PJ, corresponding to 44 239 kt CO_2/year on an average for the whole 1990 – 2014 period. The second largest consumption corresponds to Other Bituminous Coal, with an average consumption of 78 PJ, corresponding to 7 282 kt CO_2/year on an average for the whole 1990 – 2014 period. The remaining Solid Fuels do not correspond to any significant consumption in this category.

Since 2007, the country-specific emission factor for Brown Coal + Lignite has been equal to 27.27 t C/TJ; a country-specific emission factor equal to 25.43 t C/TJ for Other Bituminous Coal and Coking Coal has been used to calculate CO_2 emissions. In 2014 was conducted research in order to update these emission factors. The detailed description of the research is provided in Annex 3. As mentioned above, this means that approximately 95% of the emissions from fuels in this category were determined using country-specific emission factors, i.e. at the level of Tier 2.

Since last submission country specific oxidation factors for Other Bituminous Coal, Brown Coal and Lignite and Brown Coal Briquettes were applied. The detailed description of the research is given in Annex 3.

Liquid Fuels play a minor role in the electricity supply of the Czech Republic. They are used for auxiliary and supplementary firing in power stations – for instance stabilization of burners. Use of Liquid Fuels has decreased by more than half since 1990.

Natural Gas also plays a role in this source category. Use of NG does not exhibit a substantially oscillating trend. At the beginning of the period, it shows increasing trend, but later only minor changes were observed, which can be considered insignificant.

The item Other Fuels in Fig. 3-4 represents waste consumption for waste incineration.

3.2.7.2 Methodological issues (CRF 1.A.1.a.i)

The basic methodological approaches were presented in section 3.2.4. In the following text, only specific problems, which are characteristic for the described subsector, will be addressed. This is essentially a waste combustion in the municipal waste incinerators, which simultaneously produce electricity and supply heat - see chapter 3.2.7.2.1.

3.2.7.2.1 Other Fuels (CRF 1.A.1.a.i): Waste Incineration for energy purposes

This category consists of emissions caused by incineration of municipal solid waste for energy purposes. Originally this chapter was part of 5.C Waste Incineration but, based on the suggestion of ICR (in-country review), this chapter was shifted under the energy sector. This chapter is still prepared by CUEC (Charles University Environment Center) – the organization responsible for the Waste sector.

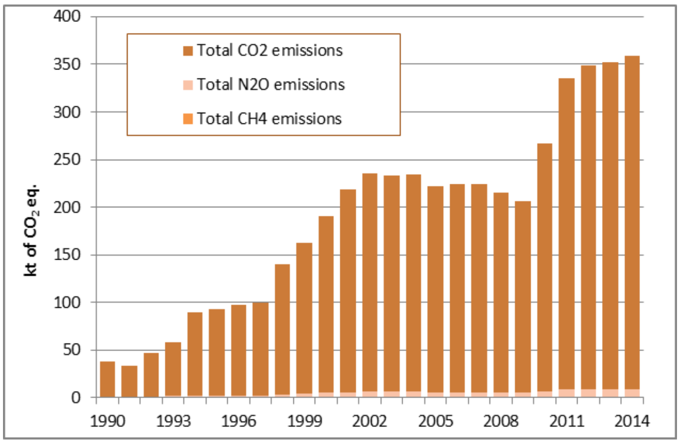


Fig. 3-5 trend of GHG emissions from waste incineration for energy purposes

This category consists of emissions of CO_2 from incinerated fossil carbon in MSW and emissions of methane and N_2O from incineration of MSW.

There are three municipal solid waste (MSW) incineration plants in the Czech Republic. One is located in Prague (ZEVO Malesice), one in Brno (SAKO) and the newest one in Liberec (Termizo). The amount of incinerated waste increased in previous year and this inventory year. This is due to the fact that the incinerator in Brno was recently reconstructed and its former annual capacity of 240 kt of MSW was decreased to 224 kt of MSW. In reality the new technology actually allowed the facility to be used to its full potential (the old stokers were regularly out of order and the real former capacity of the plant was about one third of the nominal maximum value) and since then there has been a constant increase in incinerated waste in this category.

Tab. 3-12 Capacity of municipal waste incineration plants in the Czech Republic, 2014

Incinerator (city)	Capacity (kt) 2014
TERMIZO (Liberec)	96
Pražské služby a.s. (Praha)	310
SAKO a.s. (Brno)	224

There are also 76 other facilities incinerating or co-incinerating industrial and hazardous waste, with a total capacity 600 kt of waste. This waste is reported under 5C.

All the parameters and calculations are shown in the following Tab. 3-13.

Tab. 3-13 Parameters and emissions from waste incineration 1990-2014

	Used factors								
Amount of carbon fraction	0.4								
Fosil carbon fraction	0.4								
Combust efficiency fraction	0.95								
C-CO_2 ratio	3.7								
Avrg. Emission factor kt (CH_4/kt)	2E-07								
Avrg. Emission factor kt (N_2O/kt)	5E-05								
	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**
MSW incinerated (kt MSW)	66	163	334	388	467	586	610	615	628
MSW incinerated (TJ NCV)	656	1631	3190	3957	4900	5574	5840	5887	6025
Biogenic (TJ)	393	979	1914	2374	2940	3345	3504	3532	3615
Fossil (TJ)	262	652	1276	1583	1960	2230	2336	2355	2410
Total CO_2 emissions (kt CO_2) Fossil	**36.5**	**90.9**	**185.9**	**216.4**	**260.3**	**326.5**	**339.9**	**342.5**	**349.8**
Total CO_2 emissions (kt CO_2) Biogenic	**54.8**	**136.4**	**278.9**	**324.6**	**390.4**	**489.7**	**509.9**	**513.7**	**524.7**
Total CH_4 emissions (kt CO_2 eq.)	**3.3E-04**	**8.2E-04**	**1.7E-03**	**1.9E-03**	**2.3E-03**	**2.9E-03**	**3.0E-03**	**3.1E-03**	**3.1E-03**
Total N_2O emissions (kt CO_2 eq.)	**1.0**	**2.4**	**5.0**	**5.8**	**7.0**	**8.7**	**9.1**	**9.2**	**9.4**

3.2.7.3 Uncertainties and time-series consistency (CRF 1.A.1.a.i)

See chapter 3.2.5.

3.2.7.4 Category-specific QA/QC and verification (CRF 1.A.1.a.i)

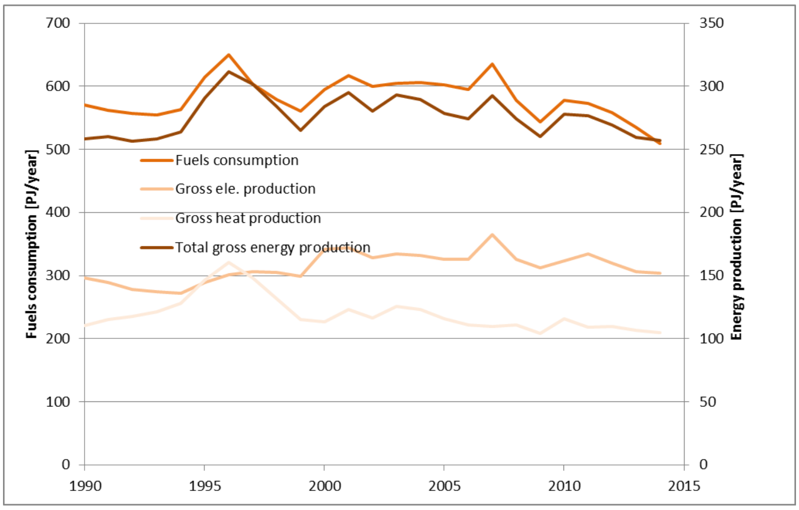


Fig. 3-6 The ratio between the total consumption of fuels from the heat sources in the category 1.A1.a and overall energy production

Fig. 3-5 shows the correlation of fuel consumption in category 1.A.1.a and total gross electricity and heat production. Total energy production should have a similar trend to total fuels consumption in category 1.A.1.a.

Throughout the whole time period it is possible to see a good correlation between the total fuel consumption and gross energy production. There are minor fluctuations, caused by variation of the ratio between the electricity and the amount of heat produced.

For additional information please see chapter 3.2.6.

3.2.7.4.1 Other Fuels (CRF 1.A.1.a.i): Waste Incineration for energy purposes

Waste incineration is reported in the energy but in NIS it is still managed under waste sector and for this particular chapter all relevant QA/QC procedures are described in waste chapter.

3.2.7.5 Category-specific recalculations (CRF 1.A.1.a.i)

Due to minor changes in official activity data recalculation in 2013 was performed. In case of fossil fraction of waste and biomass fraction of waste the consumption for 2013 increased by 0.8%.

3.2.7.5.1 Other Fuels (CRF 1.A.1.a.i): Waste Incineration for energy purposes

No recalculations were performed this year.

3.2.7.6 Category-specific planned improvements (CRF 1.A.1.a.i)

The new methodology includes further subdivision of category 1.A.1.a into:

- 1.A.1.a.i - Electricity Generation
- 1.A.1.a.ii - Combined Heat and Power Generation
- 1.A.1.a.iii - Heat Plants

In the current submission, this detailed division was not employed and all the activity data and GHG emissions are included in category 1.A.1.a.i. Although the materials from CzSO contain information for the distribution of fuel consumption in each subsector, it will be necessary to verify their credibility and reliability from the aspect of trends during the entire time series.

Therefore, for the next submission, attention will be focused on the distribution of fuels in the specified subsectors in the detailed division.

Furthermore, emphasis will be placed on determining the country-specific emission factors for other fuels, while considering the significance of the individual types of fuel.

3.2.8 Petroleum Refining (CRF 1.A.1.b)

3.2.8.1 Category description (CRF 1.A.1.b)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.1.b, 2014								
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O /TJ]	[kt]
Refinery Gas	6 029.0	55.076	1	332.1	1	0.00603	0.6	0.00362
Other Oil	3 591.9	73.3	1	263.3	3	0.01078	0.6	0.00216
Natural Gas	3 591.9	55.353	1	210.4	1	0.00380	0.1	0.00038
Total year 2014	13 421.70			805.7		0.02061		0.00615
Total year 2013	12 287.40			701.8		0.01751		0.00525
Index 2014/2013	1.09			1.15		1.21		1.17
Total year 1990	8 705.40			492.6		0.0102		0.00232
Index 2014/1990	1.54			1.64		2.02		2.65

The origin of the data, emission factors used and the method for calculating the emissions for each gas is shown in details in the following outline.

2014							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Refinery Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Other Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1

This category includes all facilities that process raw petroleum imported into this country as their primary raw material. Domestic petroleum constitutes approximately 2.3% of the total amount in 2014. All fuels used in the internal refinery processes, internal consumption (reported by companies as "own use") for production of electricity and heat and heat supplied to the public mains are included in emission calculations in this subcategory. This corresponds primarily to the Česká rafinérská Inc. company in the Czech Republic. Fugitive CH_4 emissions are included in category 1.B.2.a Fugitive Emissions from Fuels - Oil.

The fraction of CO_2 emissions in subsector 1.A.1.b in CO_2 emissions in sector 1.A.1 equalled 1.5% in 2014. It contributed 0.9% to CO_2 emissions in the whole Energy sector.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported under the item:

- Refinery Fuel
- Relevant NACE Rev. 2 code: 19.20 - Manufacture of refined petroleum products

Starting with this submission, the greenhouse gas emissions from combustion of refinery gas are estimated using country-specific emission factor. Detailed description of the research carried out in 2013 is provided in Annex 3 of this NIR. The default emission factors were used for the rest of the liquid fuels. A country-specific emission factor is used also for Natural Gas – see the outlines at the beginning of each subchapter.

Fig. 3-7 shows an overview of emissions trends in source category 1.A.1.b:

No consumption of Solid Fuels occurred in this category.

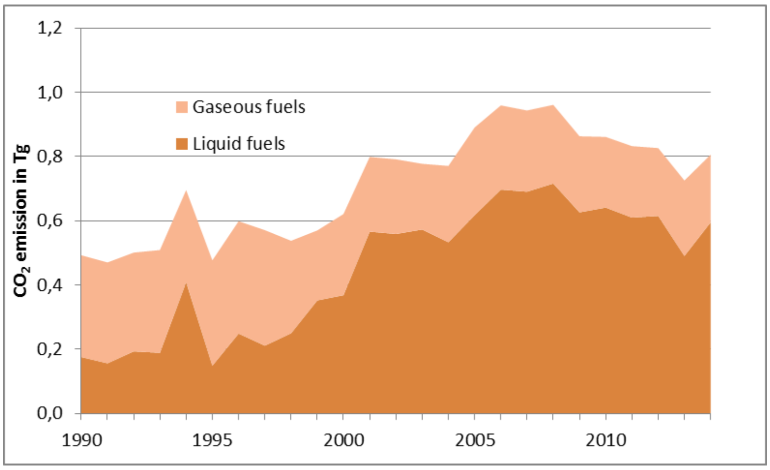


Fig. 3-7 Development of CO_2 emissions in 1.A.1.b category

Liquid Fuels are of the greatest importance and exhibit an increasing trend in the whole period. The fluctuations that have occurred over the years can be explained as resulting from differences in production quantities (see also Fig. 3-8). The maximum production equal to 716 kt CO_2 occurred in 2008, followed by a value of 697 kt CO_2 in 2006. Thereafter, production decreased to the resulting level of 595 kt CO_2 in 2014.

The second greatest role is played by Natural Gas, with emissions in the range between 205 kt CO_2 in 2003 and 360 kt CO_2 in 1997 and resulting in 210 kt CO_2 in 2014.

3.2.8.2 Methodological issues (CRF 1.A.1.b)

Basic methodological approaches were presented in the section 3.2.4. In Chapter 3.2.8. no specific approaches were used for performing QA/QC in category 1.A.1.b.

3.2.8.3 Uncertainties and time-series consistency (CRF 1.A.1.b)

See chapter 3.2.5.

3.2.8.4 Category-specific QA/QC and verification (CRF 1.A.1.b)

Fig. 3-11 contains a comparison of fuel consumption in sector 1.A.1.b with the total amount of crude oil processed in the Czech Republic in the separate years.

It is apparent from the figure that, since 2000, the amount of fuel used is proportional to the amount of crude oil processed. It is clear that the specific energy consumption for processing crude oil was lower in the period from 1990 to 2000 than at the present time and that it went through certain fluctuations. These resulted from the fact that the production capacities of both refineries (Litvinov and Kralupy nad Vltavou) were expanded in this period towards deeper crude oil processing (especially using cracking units since the end of the 1990s.

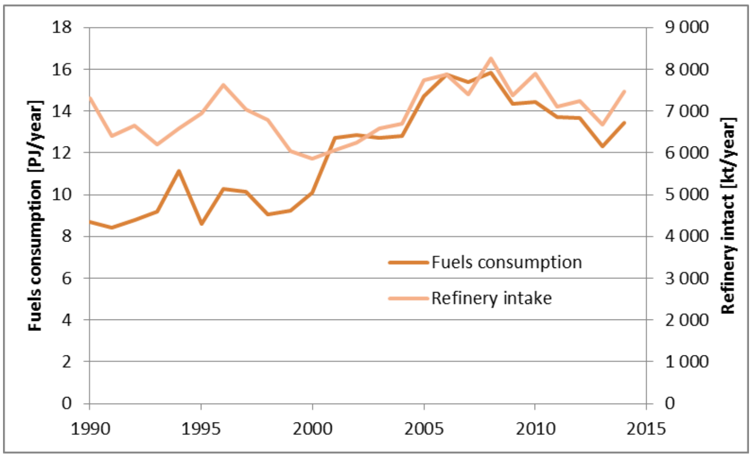


Fig. 3-8 Comparison of fuel consumption in the sector 1.A.1.b and amount of crude oil processed

The other QA/QC procedures were performed as described in chapter 3.2.6.

3.2.8.5 Category-specific recalculations (CRF 1.A.1.b)

Due to minor changes in official activity data recalculation in 2013 was performed. In 2013 the consumption of natural gas was increased by 11%.

3.2.8.6 Category-specific planned improvements (CRF 1.A.1.b)

Since the consumption of liquid fuels in 1994 shows a large difference (outlier) compared to 1993 and 1995 in further submissions, this data will be subjected to inspection. Specifically it is about the consumption of Other Oil as refinery fuel.

No further improvement in this subcategory are currently planned.

3.2.9 Manufacture of solid fuels and other energy industries (1.A.1.c)

This category is divided into two subcategories:

- Manufacture of Solid Fuels (1.A.1.c.i)
- Other Energy Industries (1.A.1.c.ii)

Given that this division is used in the new methodology (IPCC, 2006) and the fact that there are no precise data for more detailed classification, the data are reported in this submission as a summary in category CRF 1.A.1.c.ii. Production of briquettes, which would fall under 1.A.1.c.i in the Czech Republic has been terminated and, in terms of the share of this production in the emissions, it was negligible and further accurate data on fuel consumption in this category are now hard to access.

3.2.9.1 Category description (CRF 1.A.1.c.ii)

The structure of fuels, their consumption, the emission factors and emissions of various greenhouse gases are shown in the following outline.

1.A.1.c, 2014								
Structure of Fuels	**Activity**	**CO_2**			**CH_4**		**N_2O**	
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**		**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
Heating and Other Gasoil	681.6	74.1	1	50.5	3	0.00204	0.6	0.00041
Brown Coal + Lignite	36 887.2	100.31*)	0.985*)	3 657.4	1	0.03689	1.4	0.05164
Coal Tars	0.0	80.7	1	0.0	1	0.00000	1.4	0.00000
Gas Works Gas	17 666.1	100.38*)	1	1 774.3	1	0.01767	0.1	0.00177
Coke Oven Gas	2 707.8	44.40	1	120.2	1	0.00271	0.1	0.00027
Natural Gas	173.2	55.30*)	1	9.1	1	0.00017	0.1	0.00002
Total year 2014	58 115.9			5 612.1		0.05948		0.05411
Total year 2013	67 391.4			6 169.4		0.06884		0.06137
Index 2014/2013	0.86			0.91		0.86		0.88
Total year 1990	28 984.6			1 516.4		0.03348		0.00794
Index 2014/1990	2.01			3.70		1.78		6.81

*) *Country specific data*

The table shows that, while the index for fuel consumption in 2014/1990 is 2.01, the same index is significantly higher for CO_2 emissions. This is caused by the high proportion of coke oven gas, which has a relatively low emission factor, in the fuel structure in 1990. Later, part of coke oven gas was reallocated to other subsectors (1.A.1.a and 1.A.2.a). Even more important, a high proportion of coke oven gas, combined with its relatively low emission factor compared to other fuels, occurred in N_2O emissions.
The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is presented in detail in the following outline.

2014							
Structure of Fuels	**Source of Activity data**	**Emission factors**			**Method used**		
		CO_2	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coal Tars	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gas Works Gas	CzSO, CHMI	CS	D	D	Tier 2	Tier 1	Tier 1
Coke Oven Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1

This category includes all facilities that process Solid Fuels from mining through coking processes to the production of secondary fuels, such as Brown-Coal Briquettes, Coke Oven Gas or Generator Gas. It also includes fuels for the production of electrical energy and heat for internal consumption (reported by companies as "own use").

There are a number of companies in the Czech Republic that belong to this category. These are mainly companies performing underground and surface mining of coal and its subsequent processing, located in the vicinity of coal deposits. The category also includes Coke plants and the production of Generator Gas. Other energy industries, such as facilities for extraction of Natural Gas and Petroleum are of minor importance in the Czech Republic.

The fraction of CO_2 emissions in subsector 1.A.1.c in CO_2 emissions in sector 1.A.1 equalled 11% in 2014. It contributed only 6% to CO_2 emissions in the whole Energy sector 1.A.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in capture Energy Sector under the items:

- Coal Mines
- Oil and Gas Extraction
- Coke Ovens (Energy)
- Gas Works (Energy)
- Patent Fuel Plants (Energy)
- BKB Plants (Energy)
- Non-specified (Energy)

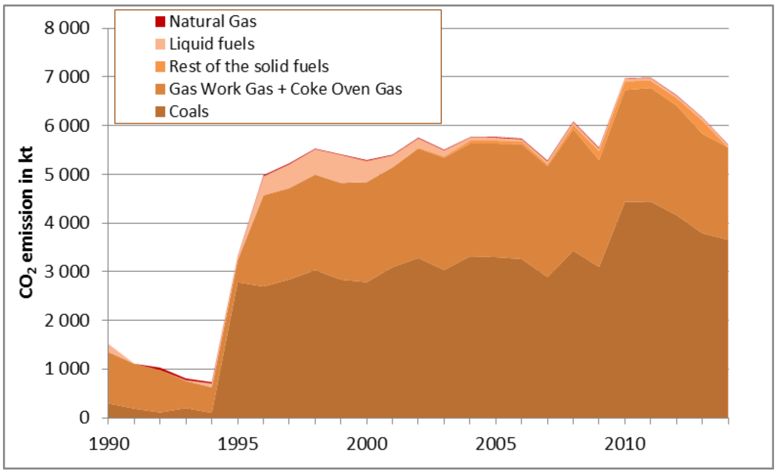


Fig. 3-9 Development of CO_2 emissions in 1.A.1.c.ii category

There are embodied the fuels of economic part according to NACE Rev. 2

- 05.10 Mining of Hard Coal
- 05.20 Mining of Lignite
- 06.10 Extraction of Crude Oil
- 06.20 Extraction of Natural Gas
- 19.10 Manufacture of Coke oven products (operation of Coke ovens, production of Coke and Semi-Coke, production of Coke Oven Gas)
- 19.20 Manufacture of refined petroleum products (this class also includes: manufacture of Peat Briquettes, manufacture of Hard-coal and Lignite fuel Briquettes)

Fig. 3-9 provides an overview of emission trends in source category 1.A.1.c. The figure clearly shows the increase in emissions in 1995 – 2012 period. The use of Coal predominated in the whole period followed by the consumption of Gas Works Gas and Coke Oven Gas. There is very low use of Liquid Fuels and Natural Gas in this category.

Sokolovská Uhelná Inc. makes the greatest contribution to the consumption of Solid fuels . The section for processing Brown Coal was established in 1950 and also produced Gas Works Gas and other chemical products. Formally, the existence of this combine ended in 1974 when this facility was moved under the Hnědouhelné doly a briketárny company. Together with this step was established Fuel combine Vřesová. The new combined-cycle power station started to operate in 1996 (http://www.suas.cz).

Between 1990 and 1995, production of Town Gas, which was distributed in the Czech Republic by Gas Work Vřesová, has been gradually phased out. On Fig. 3-16 can be seen a decline in production of Town Gas and the starting up of production of Gas Work Gas for the production of electricity and the supply heat. Pipelines used to distribute Town Gas at that time were converted for Natural Gas and took over the role for its long-distance transport and local distribution. Coke Oven Gas is produced in the Ostrava area where the Coke Plants operating.

3.2.9.2 Methodological issues (CRF 1.A.1.c.ii)

The fuel consumption in the Vřesová Fuel combine plays a dominant role in fuel consumption in this category. This fuel is used for its own gasification process, as well as for production of technological steam, which enters into the process as a raw material. The produced high-pressure synthesis gas is then purified by acidic components (CO_2 and H_2S) and is used for power generation and supplied heat. From a methodological point of view, the whole combined production is divided into two parts – consumption of produced Gas Work Gas (and associated GHG emissions) for the production of electricity and heat and fuel consumption for technological purposes (input coal to produce technological steam). Not to neglect CO_2 emissions and other greenhouse gases, which are produced from the gasification of pressure gas, it was necessary to replace the consumption of Gas Work Gas in the model with coal, which enters into the process. The emission factor for lignite was used for the calculation of CO_2 and the value of total coal consumption in the technological part of the process was used as the activity data.

The amount of coal that was used for the production of technological steam is not directly accessible from the CzSO energy balance. Data from CHMI REZZO national emission database was used to determine the amount of coal. The quantity of coal for production of technological steam is given in Tab. 3-14.

Tab. 3-14 Consumption of Lignite for production of technological steam in Fuel combine Vřesová 1995 – 2014

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Lignite [kt/year]	1 439	1 596	1 536	1 571	1 588	1 651	1 715	1 746	1 856	1 931
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Lignite [kt/year]	2 064	2 003	2 088	2 107	1 938	2 044	2 094	2 117	1994	1951

This amount of coal is in the data calculation of CzSO included in the total fuel consumption in the sector "Transformation - autoproducer heat plants". To avoid double counting of the quantity of coal, the amount was deducted from the other calculations in the model for fuels used in autoproducers.

No other specific approaches were used in this category.

3.2.9.3 Uncertainties and time-series consistency (CRF 1.A.1.c.ii)

See chapter 3.2.5.

3.2.9.4 Category-specific QA/QC and verification (CRF 1.A.1.c.ii)

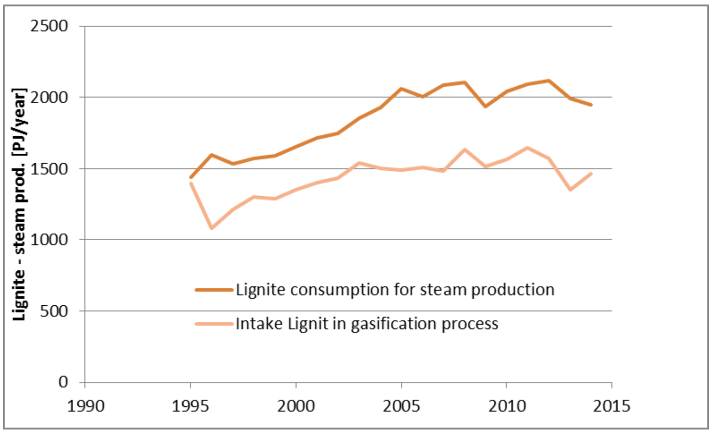


Fig. 3-10 Comparison of lignite consumption for steam production and gasification

Fig. 3-10 contains a comparison between the consumption of lignite in sector 1.A.1.c (data from the REZZO national emission database) and the total amount of lignite entering the transformation process (gasified coal) in the Czech Republic (data CzSO) in the 1995-2014 period.

Apart from the early years, when the combined cycle was starting to reach its full potential (1995 to 1998), the trends of the two curves are very similar. The minor fluctuations are caused by annual climatic influences; the technological steam is also used as a heating medium in the entire company and its consumption also depends on the average annual temperatures.

The internal expertise of experts from the Department of emissions and sources at CHMI was utilized as a QA/QC procedure for this part of the calculations. Other procedures were performed as described in chapter 3.2.6.

3.2.9.5 Category-specific recalculations (CRF 1.A.1.c.ii)

Updated data for amount of Lignite consumed in Fuel combine Vřesová were obtained. Hence for 2013 the recalculation was performed. The original value was equal 2 117 kt, the updated value is 1994. It means decrease for about 6% in activity data.

3.2.9.6 Category-specific planned improvements (CRF 1.A.1.c.ii)

Currently there are no planned improvements in this category.

3.2.10 Manufacturing industries and construction – Iron and Steel (1.A.2.a)

3.2.10.1 Category description (CRF 1.A.2.a)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.a, 2014								
Structure of Fuels	Activity data [TJ]	CO_2 EF [t CO_2/TJ]	OxF	Emission [kt]	CH_4 EF [kg CH_4/TJ]	Emission [kt]	N_2O EF [kg N_2O /TJ]	Emission [kt]
Fuel Oil - Low Sulphur	0	77.4	1	0	3	0	0.6	0
Fuel Oil - High Sulphur	0	77.4	1	0	3	0	0.6	0
Anthracite	2070.4	98.3	1	203.5	10	0.02070	1.4	0.00290
Other Bituminous Coal	444.6	94.03*)	0.971*)	40.7	10	0.00445	1.4	0.00062
Brown Coal + Lignite	195.4	100.38*)	0.985*)	19.3	10	0.00195	1.4	0.00027
Coke	8849.8	107	1	946.9	10	0.08850	1.4	0.01239
Coal Tars	0.0	80.7	0.985	0.0	10	0	1.4	0
Coke Oven Gas	9728.5	44.4	1	431.9	1	0.00973	0.1	0.00097
Natural Gas	8829.8	55.30*)	1	488.8	1	0.00883	0.1	0.00088
Wood/Wood Waste	24.1	112	1	2.7	30	0.00072	4	0.00010
Total year 2014	**30142.6**			**2133.9**		**0.13488**		**0.01814**
Total year 2013	35294.9			2846.8		0.21994		0.03024
Index 2014/2013	0.85			0.75		0.61		0.60
Total year 1990	155319.2			14860.7		1.39496		0.19576
Index 2014/1990	0.19			0.14		0.10		0.09

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is sown in details in the following outline.

2014							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Anthracite	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coal Tars	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke Oven Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

This category includes manufacturing in the area of pig iron (blast furnaces), rolling steel, casting iron, steel and alloys and is related only to ferrous metals. In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in section Industry Sector under the item: Iron and Steel. There are embodied the fuels of economic part according to NACE Rev. 2 Iron and steel: NACE Divisions 24.1 – 24.3 and 24.51, 24.52.

The fraction of CO_2 emissions in subsector 1.A.2.a in CO_2 emissions in sector 1.A.2 equalled 21% in 2014. It contributed only 2% to CO_2 emissions in the whole Energy sector.

Important facility belongs to this category is ArcelorMittal Ostrava, a.s. and Třinecké železárny a.s. Both metallurgical plants include iron ore sinter production, blast furnaces, coke production, iron processing in oxygen converters for steel and casting of steel in electric furnaces and in tandem furnaces. Production of steel using Siemens-Martin process was stopped before 1990.

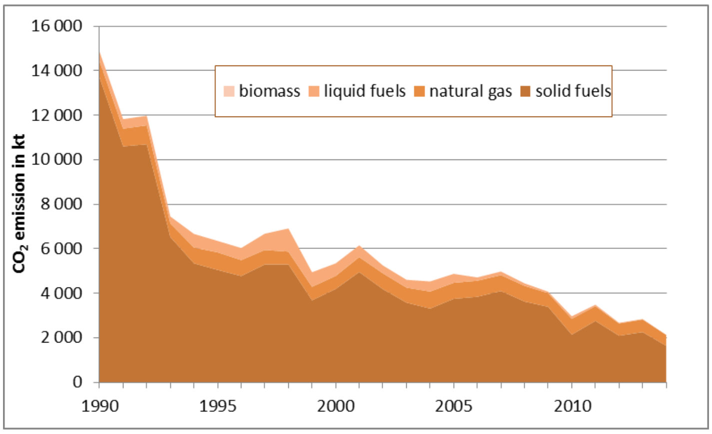


Fig. 3-11 Development of CO_2 emissions in source category 1.A.2.a

The following figure provides an overview of CO_2 emissions in the various sub-source categories in 1.A.2.a.

The graph in Fig. 3-11 shows apparent sharp decline in emissions in the early 90s, which was mainly due to the loss of markets, following the sharp political changes in the country. At the same time, an impact on the emissions was caused by the new legislation on air pollution and other environmental components. Gradual implementation and introduction of new, more stringent requirements for the protection of the environment is reflected in the decrease of emissions since about 1998. On the course of emissions after 2000 the competition of metallurgical plants in countries outside of Europe caused an impact. Minor fluctuations are caused by market demand and to a lesser extent, the necessary restructuring undertaken in individual companies.

Further, from Fig. 3-11 is clear that the main proportion of the CO_2 emissions is due to the use of fossil fuels, which are in this sector completely dominant.

3.2.10.2 Methodological issues (CRF 1.A.2.a)

All the CO_2 emissions from metallurgical coke used in blast furnaces are reported under the Industrial processes sector (2.C.1) and estimated from the amount of carbon in the coke (see Chapter 4.4). Most of the blast furnace and converter gas is combusted in the two metallurgical plants (complexes) and only party is used elsewhere. At present, we are not able to identify the exact amount of these gases combusted outside metallurgical complexes. In order to prevent double counting, we report all

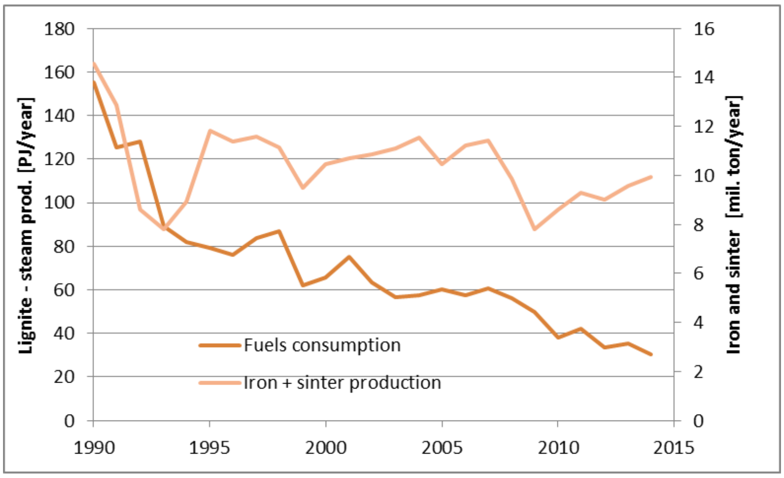


Fig. 3-12 The trend in the manufacture of agglomerates of iron ore and iron, in comparison with the development of fuel consumption in the sector 1.A.2.a

the CO_2 emissions coming from metallurgical coke under 2.C.1. As a consequence of this approach, we did not calculate any CO_2 emissions from blast furnace and converter gas.

3.2.10.3 Uncertainties and time-series consistency (CRF 1.A.2.a)

See chapter 3.2.5.

3.2.10.4 Category-specific QA/QC and verification (CRF 1.A.2.a)

The basic indicators for verification of fuel consumption in the sector of production of pig iron and steel must be considered to be the indicators of the overall production of agglomerates of iron ore and pig iron. This is because of their high energy intensity. Fig. 3-12 shows the relationship between fuel consumption and total production of sinter and iron in mil. tons.

It is clear from the graph in Fig. 3-12 that the fuel consumption decreases faster than the actual production. This is due to the gradual reduction in overall energy intensity throughout the metallurgical industry. This trend was particularly evident in the early 90s, when there was a major restructuring of production. After the decline in 1990 and 1993, this restructuring made it possible to return the volume of production to almost the level of 1990, but the decrease in total fuel consumption continued. Additional reductions in energy intensity are then evident until the end of the period.

Generally accepted methods of QA/QC are described in section 3.2.6.

3.2.10.5 Category-specific recalculations (CRF 1.A.2.a)

Recalculations dues to updated activity data were performed – in 2013 the consumption of solid fuels increased by 0.15%. In 2012 and 2013 consumption of natural gas increased by 5%.

3.2.10.6 Category-specific planned improvements (CRF 1.A.2.a)

We are planning to find data making possible to identify portions of both blast furnace and converter gases, which are combusted outside metallurgical complexes (see 3.2.10.2.).

3.2.11 Manufacturing industries and construction – Non-Ferrous Metals (1.A.2.b)

3.2.11.1 Category description (CRF 1.A.2.b)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.b, 2014								
Structure of Fuels	**Activity data [TJ]**	**CO_2 EF [t CO_2/TJ]**	**OxF**	**Emission [kt]**	**CH_4 EF [kg CH_4/TJ]**	**Emission [kt]**	**N_2O EF [kg N_2O /TJ]**	**Emission [kt]**
Fuel Oil - Low Sulphur	1.6	77.4	1	0.1	3	0.000005	0.6	0.000001
Coke	113.8	107	1	12.2	10	0.00114	1.4	0.00016
Natural Gas	1516.7	55.30*)	1	84.0	1	0.00152	0.1	0.00015
Wood/Wood Waste	2.8	112.00	1	0.3	30	0.00009	4	0.00001
Total year 2014	1635.0			96.6		0.00274		0.00032
Total year 2013	2036.5			120.3		0.00341		0.00040
Index 2014/2013	0.80			0.80		0.80		0.80
Total year 1990	1476.3			102.0		0.00572		0.00077
Index 2014/1990	1.11			0.95		0.48		0.42

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2014							
Structure of Fuels	**Source of**	**Emission factors**			**Method used**		
	Activity data	**CO_2**	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

This category encompasses combustion processes in various areas of production of non-ferrous metals. In the Czech Republic, this corresponds mainly to foundry processes; primary production of nonferrous metals is not performed on an industrial scale in this country. In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:

Non-Ferrous Metals

There are embodied the fuels of economic part according to NACE Rev. 2

Non-ferrous metals: NACE Divisions 24.4, 24.53, 24.54

Important facility belongs to this category is Kovohutě Příbram. The fraction of CO_2 emissions in subsector 1.A.2.b in CO_2 emissions in sector 1.A.2 equalled 1% in 2014. It contributed only 0.1% to CO_2 emissions in the whole Energy sector.

It can be said that this is one of the sectors that rank according to its emissions of greenhouse gases among the least important in the entire sector Fuel combustion.

The following figure (Fig. 3-13) provides an overview of CO_2 emissions in the various sub-source categories in 1.A.2.b.

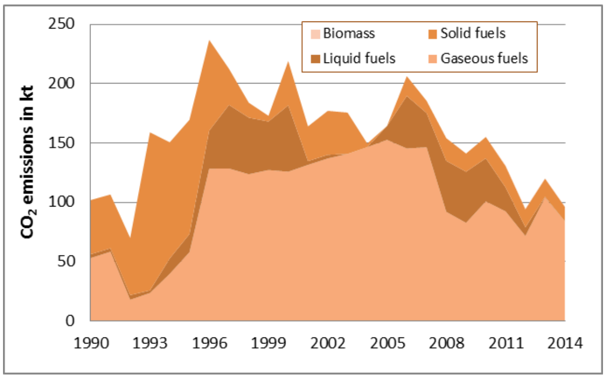


Fig. 3-13 Development of CO_2 emissions in source category 1.A.2.b

The trend in CO_2 emissions corresponds to the trends in consumption of individual types of fuels. Following a decline in the early 1990s, a sharp increase in emissions was apparent, caused by recovery in the industry. The industrial recovery in this sector was especially due to an increase in demand for ferrous metals parts in the emerging automotive industry. The decrease in emissions at the end of the period was caused by the financial crisis between 2008 and 2012, as well as by a reduction in the energy intensity of production. This is also related to a shift from fossil fuels in favour of natural gas. Furthermore, electrical energy is increasingly used for heating the metallurgical furnaces, which has a positive impact on greenhouse gas emissions.

3.2.11.2 Methodological issues (CRF 1.A.2.b)

In this subcategory, specific methodologies are not used - a description of the general procedures - see Section 3.2.4.

3.2.11.3 Uncertainties and time-series consistency (CRF 1.A.2.b)

See chapter 3.2.5.

3.2.11.4 Category-specific QA/QC and verification (CRF 1.A.2.b)

In this subcategory, specific methodologies are not used - a description of the general procedures - see Section 3.2.6.

3.2.11.5 Category-specific recalculations (CRF 1.A.2.b)

Recalculation due to updated activity data was performed – natural gas consumption increased in 2012 and 2013 by 5%.

3.2.11.6 Category-specific planned improvements (CRF 1.A.2.b)

Currently there are no planned improvements in this category.

3.2.12 Manufacturing industries and construction – Chemicals (1.A.2.c)

3.2.12.1 Category description (CRF 1.A.2.c)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.c, 2014								
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
Fuel Oil - Low Sulphur	39.5	77.4	1	3.1	3	0.00012	0.6	0.00002
Other Bituminous Coal	107.1	95.42*)	0.971*)	178.6	1	0.01949	1.4	0.00273
Brown Coal + Lignite	2380.2	100.70*)	0.985*)	662.1	1	0.06696	1.4	0.00937
Natural Gas	334.0	55.30*)	1	742.5	1	0.01341	0.1	0.00134
Wood/Wood Waste	0.0	112.00	1	4.1	30	0.00111	4	0.00015
Total year 2014	**22 136**			**1 590**		**0.10109**		**0.01362**
Total year 2013	24 216			1 792		0.12520		0.01699
Index 2014/2013	0.91			0.89		0.81		0.80
Total year 1990	33 577			2 996		0.26480		0.03723
Index 2014/1990	0.66			0.53		0.38		0.37

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2014							
Structure of Fuels	Source for	Emission factors			Method used		
	Activity data	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

This subcategory includes all the processes in the organic and inorganic chemical industry and all related processes, incl. petrochemistry. The petrochemical plants are linked to two major refinery enterprises in Litvinov (Unipetrol RPA, sro) and in Kralupy (Synthos Kralupy as). Due to the historical linkage between the two units, it is very difficult to determine the fuel combusted in the refinery and petrochemical parts of the two plants separately. Furthermore, other major plants for processing organic chemistry products are in operation in the Czech Republic (DEZA a.s. Meziříčí – processing of coal tar, SYNTHESIA a.s.

Pardubice - basic organic chemistry) and a number of factories for manufacturing of inorganic products (SPOLANA a.s. Neratovice, SPOLCHEMIE a.s. Ústí nad Labem, PRECHEZA a.s. Přerov and others). The largest plants are also equipped with energy resources, with a significant share of electricity and heat (autoproducers); this results in relatively high consumption of fossil fuels (see Fig 3-28). Heat is generated using abundant natural gas and, to a lesser extent, liquid fuels or, in some cases, electrical energy. In total, the national emission database recorded 1,000 production units that fall within sector 1.A.2.c.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:

Chemical (including Petrochemical)

There are embodied the fuels of economic part according to NACE Rev. 2:

Chemicals: NACE Division 20

The fraction of CO_2 emissions in subsector 1.A.2.c in CO_2 emissions in sector 1.A.2 equalled 15.9% in 2014. It contributed 1.8% to CO_2 emissions in the whole Energy sector.

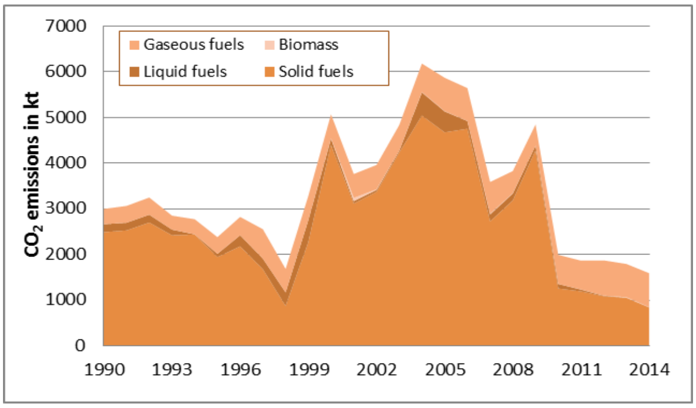


Fig. 3-14 Development of CO_2 emissions in source category 1.A.2.c

The following figure (Fig. 3-14) provides an overview of CO_2 emissions in the sub-category in 1.A.2.c.

The variations in CO_2 emissions are not directly related to the volume of chemical production, as these consist primarily in emissions from burning fossil fuels to produce electricity and heat (autoproducers). For this reason, it is not possible to comment on the development of emissions in time.

3.2.12.2 Methodological issues (CRF 1.A.2.c)

Given that in the IPCC 2006 Gl. (IPCC, 2006)is used a new approach to the allocation of feedstocks and non-energy use of fuels into IPPU. The new distribution of liquid fuels is to be considered as category specific methodological issue. This methodological approach is in the same time based on the new reallocation of fuel consumption for energy and non-energy use in the questionnaire from CzSO (2015). The reallocation of feedstocks and non-energy use of fuels in IPPU is in details described in chapter 3.2.3.

Other methodological approaches were applied as in the other subcategories, and their description is provided in chapter 3.2.4.

3.2.12.3 Uncertainties and time-series consistency (CRF 1.A.2.c)

See chapter 3.2.5.

3.2.12.4 Category-specific QA/QC and verification (CRF 1.A.2.c)

In this category, no specific QA/QC procedures were used. Given that the fuel consumption in this sector, reported directly, is not related to the production volume of chemicals, there cannot be used the relevant comparison with specific commodities.

Description of the QA/QC procedures is given in chapter 3.2.6.

3.2.12.5 Category-specific recalculations (CRF 1.A.2.c)

In the official CzSO Questionnaire submitted in 2015 the non-energy use of natural gas was reported. Amount of non-energy use of natural gas is listed in

Tab. 3-15 Amount of non-energy use of natural gas

	2008	2009	2010	2011	2012	2013	2014
Chemical and petrochemical	4 039	2 473	3 801	3 985	4 068	3 883	3 966

Research was performed in 2015 to distinguish non-energy use of natural gas. It is apparent that the most significant source of CO_2 emissions arising from this use is the production of hydrogen by steam reforming. A less significant process consists in non-selective catalytic reduction.

Based on this information, this data were reallocated in this submission. Until last submission, this data were included in 1.A.2.c; however now the non-energy use of natural gas was reallocated to sector IPPU 2.B. 10.

In addition, the activity data for solid fuels was updated, corresponding to an increase by 2.3% in the consumption of solid fuels in 2013.

3.2.12.6 Category-specific planned improvements (CRF 1.A.2.c)

Currently there are no planned improvements in this category.

3.2.13 Manufacturing industries and construction – Pulp, Paper and Print (1.A.2.d)

3.2.13.1 Category description (CRF 1.A.2.d)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.d, 2014									
Structure of Fuels	Activity	CO_2			CH_4		N_2O		
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
Fuel Oil - Low Sulphur	41.1	77.4	1	3.2	3	0.00012	0.6	0.00002
Fuel Oil - High Sulphur	0.0	77.4	1	0.0	3	0	0.6	0.00000
Other Bituminous Coal	0.0	94.03*)	0.971*)	0	10	0	1.4	0.00000
Brown Coal + Lignite	1472.0	100.38*)	0.985*)	145.6	10	0.01472	1.4	0.00206
Natural Gas	4774.3	55.30*)	1	264.3	1	0.00477	0.1	0.00048
Wood/Wood Waste	17496.6	112	1	1959.6	30	0.52490	4	0.06999
Gaseous Biomass	8185.8	54.6	1	446.9	1	0.00819	0.1	0.00082
Total year 2014	**6287.4**			**413.0**		**0.01962**		**0.00256**
Total year 2013	6916.2			463.5		0.02367		0.00316
Index 2014/2013	0.91			0.89		0.83		0.81
Total year 1990	25900.8			2285.3		0.18784		0.02724
Index 2014/1990	0.24			0.18		0.10		0.09

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2014							
Structure of Fuels	Source of	Emission factors			Method used		
	Activity data	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

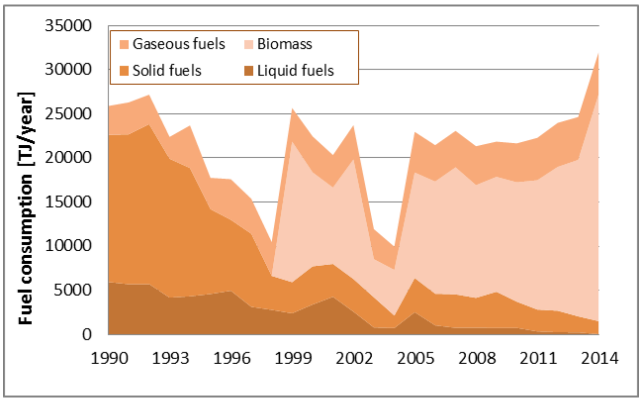


Fig. 3-15 Development of fuels consumption in source category 1.A.2.d

This subcategory includes all manufacturing processes related to the production of paper, cardboard and print in printing plants. There are two primary paper production factories in the Czech Republic (JIP - Papírny Větřní, a. s., Mondi Štětí a.s.) with a high consumption of waste wood from production processes. The other plants select the kind of fuel on the basis of the same criteria as the rest of the processing industry.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:

Paper, Pulp and Printing

There are embodied the fuels of economic part according to NACE Rev. 2

Pulp, paper and print: NACE Divisions 17 and 18

The fraction of CO_2 emissions in subsector 1.A.2.d in CO_2 emissions in sector 1.A.2 equalled 4% in 2014. It contributed 0.5% to CO_2 emissions in the whole Energy sector.

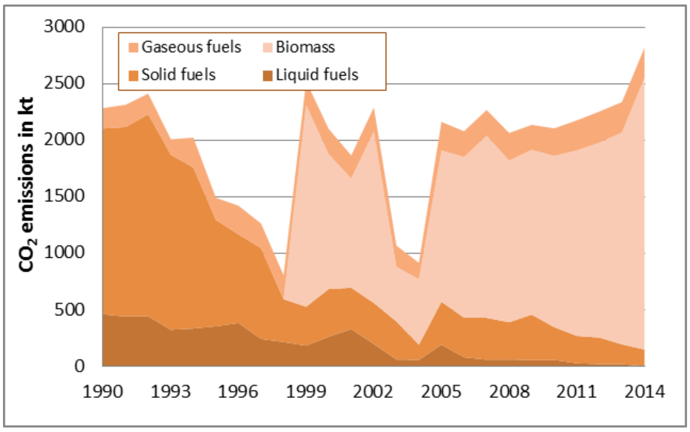


Fig. 3-16 Development of CO_2 emissions in source category 1.A.2.d

Fig. 3-15 provides an overview of fuels consumption in the sub-category in 1.A.2.d.

It is clear from the graph in Fig. 3-16 that there was significant substitution at the end of the 90s, when previously used fossil fuels (primarily lignite) were replaced by wood and later biogas. Both biofuels represent waste products from the production of paper and pulp from the two largest plants in the Czech Republic. Following the decline in 2003 and 2004, the consumption of fuels after 2005 was relatively stable, while the share of biofuels further increased.

Biofuel consumption has a beneficial effect on the production of CO_2, which is included in the balance of greenhouse gases. Fig. 3-16 shows the development of CO_2 emissions from fossil fuels only in sector 1.A.2.d.

3.2.13.2 Methodological issues (CRF 1.A.2.d)

No specific methodological approaches were applied in this subcategory, otherwise see chapter 3.2.6.

3.2.13.3 Uncertainties and time-series consistency (CRF 1.A.2.d)

See chapter 3.2.5.

3.2.13.4 Category-specific QA/QC and verification (CRF 1.A.2.d)

No specific methods for QA/QC in this category were used - otherwise see chapter 3.2.7.4.

3.2.13.5 Category-specific recalculations (CRF 1.A.2.d)

Due to updated activity data from CzSO the solid fuels consumption increased in 2013 by 2.5%. Furthermore in 2012 and 2013 consumption of natural gas was increased by 5%.

3.2.13.6 Category-specific planned improvements (CRF 1.A.2.d)

Currently there are no planned improvements in this category.

3.2.14 Manufacturing industries and construction – Food Processing, Beverages and Tobacco (1.A.2.e)

3.2.14.1 Category description (CRF 1.A.2.e)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.e, 2014								
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
LPG	91.9	65.86*)	1	6.1	1	0.00009	0.1	0.00001
Heating and Other Gasoil	0.0	74.1	1	0.0	3	0.00000	0.6	0.00000
Fuel Oil - Low Sulphur	39.5	77.4	1	3.1	3	0.00012	0.6	0.00002
Other Oil	39.9	73.3	1	2.9	3	0.00012	0.6	0.00002
Other Bituminous Coal	649.8	94.03*)	0.971*)	59.5	10	0.00650	1.4	0.00091
Brown Coal + Lignite	1094.2	100.38*)	0.985*)	108.2	10	0.01094	1.4	0.00153
Coke	227.6	107	1	24.4	10	0.00228	1.4	0.00032
Natural Gas	14277.8	55.30*)	1	790.3	1	0.01428	0.1	0.00143
Wood/Wood Waste	168.9	112.0	1	18.9	30	0.00507	4	0.00068
Gaseous Biomass	10381.9	54.6	1	566.9	1	0.01038	0.1	0.00104
Total year 2014	**16420.7**			**994.5**		**0.03432**		**0.00424**
Total year 2013	16247.8			988.4		0.03506		0.00437
Index 2014/2013	1.01			1.01		0.98		0.97
Total year 1990	37616.5			2988.2		0.21342		0.03044
Index 2014/1990	0.44			0.33		0.16		0.14

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2014							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

This subcategory includes all manufacturing processes related to the production of foodstuffs, beverages and foodstuff preparations. The subcategory also includes fuel consumption in the tobacco industry. The nature of the production processes permits the use of a relatively high fraction of biofuels, especially towards the end of the period.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:

Food, Beverages and Tobacco

There are embodied the fuels of economic part according to NACE Rev. 2

Food processing, beverages and tobacco: NACE Divisions 10, 11 and 12

The fraction of CO_2 emissions in subsector 1.A.2.e in CO_2 emissions in sector 1.A.2 equalled 10% in 2014. It contributed 1.1% to CO_2 emissions in the whole Energy sector.

The following figure provides an overview of fuels consumption in the sub-category in 1.A.2.e.

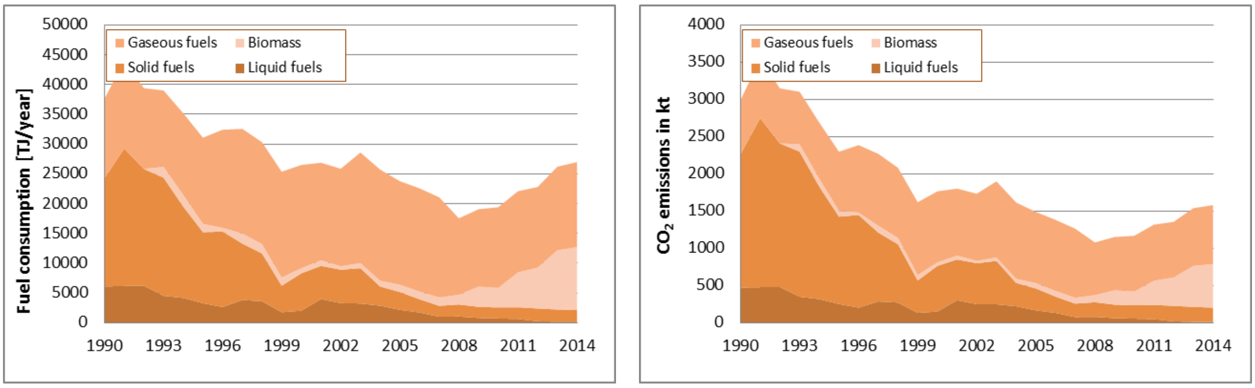


Fig. 3-17 Development of fuels consumption and CO_2 emissions from fossil fuels combustion in source category 1.A.2.e

It is obvious from the graph in Fig. 3-17 that natural gas is the dominant fuel over the entire time series with quite balanced consumption. The high share of fossil fuels at the beginning of the period reduced continuously and with replacement of fossil fuels by solid and gaseous biofuels towards the end of this period. The overall amount of fuel consumed decreased until 2008. Since 2008 there has been an increase in fuel consumption, which is covered by increasing consumption of biofuels, in response to the development of the financial crisis in the period at the end of the first decade of the 21st century.

Biofuel consumption has a beneficial effect on the production of CO_2, which is included in the balance of greenhouse gases. Fig. 3-19 shows the development of CO_2 emissions from fossil fuels only in sector 1.A.2.e.

3.2.14.2 Methodological issues (CRF 1.A.2.e)

No specific methodological approaches were applied in this subcategory, otherwise see chapter 3.2.6.

3.2.14.3 Uncertainties and time-series consistency (CRF 1.A.2.e)

See chapter 3.2.5.

3.2.14.4 Category-specific QA/QC and verification (CRF 1.A.2.e)

No specific methods for QA/QC in this category were used - otherwise see chapter 3.2.7.4.

3.2.14.5 Category-specific recalculations (CRF 1.A.2.e)

Due to updated activity data from CzSO, the solid fuels consumption increase in 2013 by 2.1%. Furthermore increase of natural gas consumption by 5% in 2012 and 2013 is apparent.

3.2.14.6 Category-specific planned improvements (CRF 1.A.2.e)

Currently there are no planned improvements in this category.

3.2.15 Manufacturing industries and construction – Non-metallic Minerals (1.A.2.f)

3.2.15.1 Category description (CRF 1.A.2.f)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline

1.A.2.f, 2014									
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
LPG	45.9	65.86*)	1	3.0	1	0.00005	0.1	0.000005
Fuel Oil - Low Sulphur	41.1	77.4	1	3.2	3	0.00012	0.6	0.00002
Fuel Oil - High Sulphur	158.0	77.4	1	12.2	3	0.00047	0.6	0.00009
Other Oil	199.6	73.3	1	14.6	3	0.00060	0.6	0.00012
Other Bituminous Coal	5 574.6	94.39*)	0.971*)	510.7	10	0.05575	1.4	0.00780
Brown Coal + Lignite	260.5	100.44*)	0.985*)	25.8	10	0.00261	1.4	0.00036
Coke	711.4	107	1	76.1	10	0.00711	1.4	0.00100
Coal Tars	771.5	80.7	1	62.3	10	0.00771	1.4	0.00108
Coke Oven Gas	62.2	44.4	1	2.8	1	0.00006	0.1	0.00001
Natural Gas	22 390.7	55.35*)	1	1 239.4	1	0.02239	0.1	0.00224
Other fuels - liquid	18.3	77.8*)	1	1.4	3	0.00005	0.6	0.00001
Other fuels - solid	3 233.7	92.8*)	1	300.2	10	0.03234	1.4	0.00453
Wood/Wood Waste	85.1	112.0	1	9.5	30	0.00255	4	0.00034
Total year 2014	33 552.8			2 261.2		0.13182		0.01761
Total year 2013	33 906.6			2 278.7		0.12855		0.01739
Index 2014/2013	0.99			0.99		1.03		1.01
Total year 1990	59 962.4			4 527.1		0.29373		0.04257
Index 2014/1990	0.56			0.50		0.45		0.41

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2014							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coal Tars	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke Oven Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Natural Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other fuels - liquid	ETS, REZZO**)	CS	D	D	Tier 2	Tier 1	Tier 1
Other fuels - solid	ETS, REZZO**)	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

**) *REZZO - national emissions database; Data were verified by the Czech Union of manufacturers of cement and lime*

Category 1.A.2.f now newly (unlike previous submissions) comprises all industrial processes for the treatment of non-minerals raw materials and products, such as cement, lime, fired building materials and refractory materials, ceramics, glass etc. Category 1.A.2.f was established by dividing the original category into 2 groups, i.e. 1.A.2.g includes the remaining sources of greenhouse gases from the "Manufacturing industries and construction" category.

The category is characterized by high energy intensity and also typically the consumption "Other fuels" that are burned at the cement works furnaces. The cement kilns in the Czech Republic are the only facilities (except for the industrial waste incinerators reported in sector 5 Waste) in which incineration of waste or alternative fuels made from waste is allowed.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:
Non-Metallic Minerals

There are embodied the fuels of economic part according to NACE Rev. 2:

NACE Divisions 23

23 Manufacture of other non-metallic mineral products
23.1 Manufacture of glass and glass products
23.2 Manufacture of refractory products
23.4 Manufacture of other porcelain and ceramic products
23.5 Manufacture of cement, lime and plaster

The fraction of CO_2 emissions in subsector 1.A.2.f in CO_2 emissions in sector 1.A.2 equalled 22.6% in 2014. It contributed 2.5% to CO_2 emissions in the whole Energy sector.

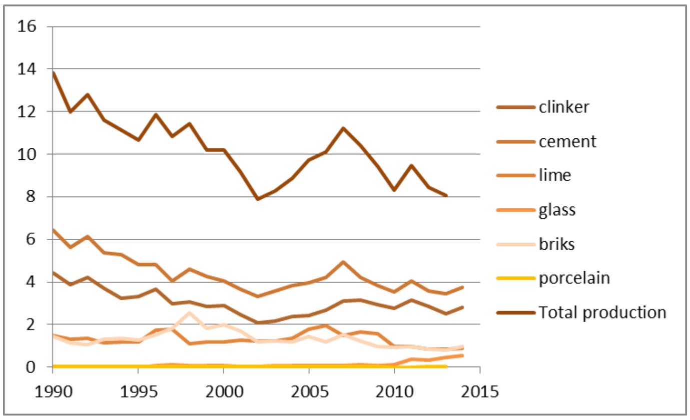
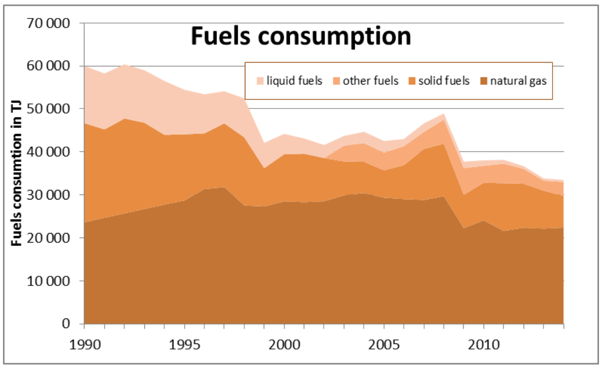


Fig. 3-18 Production of the most important mineral products

The most important businesses include mainly production of cement (a total of 5 facilities) in northern, central and eastern Bohemia and Central Moravia and lime (a total of 3 facilities) in southern and eastern Bohemia and North Moravia.

Total production of the most important mineral products is shown in the graph on Fig. 3-18.



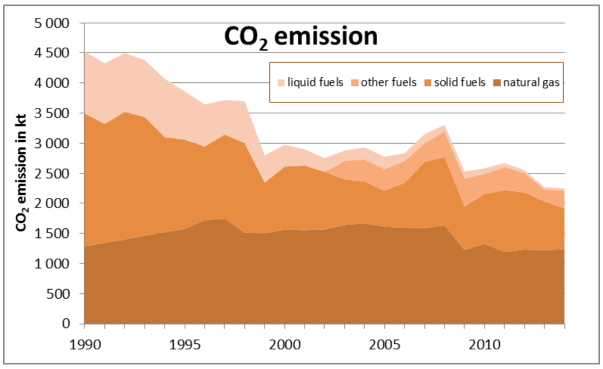


Fig. 3-19 Development of fuels consumption and CO_2 emissions in source category 1.A.2.f

Fig. 3-19 provides an overview of fuels consumption and CO_2 emissions in the sub-category in 1.A.2.f.

The graph shows the evolution of CO_2 emissions, which has the same pattern as fuel consumption. The high consumption of fossil fuel at the beginning of the period decreased gradually and it is evident that the most important fuel in this sector is natural gas. The high consumption of fossil fuels and liquid fuels declined gradually and was gradually replaced by alternative fuels from 2002 (Other fuels). The increase in fuel consumption between 2005 and 2008 was interrupted by the development of the economic crisis followed by another decline after slight recovery in 2010-2011.

3.2.15.2 Methodological issues (CRF 1.A.2.f)

The category of Non-Metallic Minerals reports consumption of alternative fuels (Other fuels). The compilation consumption balance and the determination of the emission factors are different from the procedures used for other fuels, as described in section 3.2.4. The basic source of information is the ETS database, where the emission factors for different types of alternative fuels are available. At the same time, data from the REZZO national emission database are used, where data are available on the consumption of alternative fuels in the whole time series since 2003. The resulting processed data on consumption of alternative fuels is further corrected according to the data on the server of the Union of cement and lime manufacturers (www.svcement.cz). Alternative fuel consumption is shown in Tab. 3-15.

Tab. 3-16 Consumption of alternative fuels in sector 1.A.2.f

[TJ/year]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Solid fuels	2 423.7	3 199.9	3 516.7	3 397.8	3 726.2	5 037.0	5 537.0	3 224.5	3 884.9	3 054.6	1 136.7	3 233.7
Liquid fuels	1 266.0	1 156.2	588.6	1 013.8	240.1	557.0	681.7	707.6	661.3	394.1	1 181.0	18.3
Total	3 689.7	4 356.1	4 105.3	4 411.6	3 966.3	5 594.0	6 218.7	3 932.0	4 546.2	3 448.7	2 317.7	3 252.0

Emission factors for calculating CO_2 emissions vary according to composition of the individual types of fuel (solid, liquid fuels). A variety of sorted waste is used as solid alternative fuel, including used tires, animal meal, etc. Alternative liquid fuels include mainly used oils, waste petroleum products and even rendered fats. The resulting emission factor corresponds to the relative representation of the individual types of fuels. Tab. 3-16 shows an overview of the emission factors used for solid and liquid alternative fuels in different years.

Tab. 3-17 CO_2 emission factors used in the consumption of alternative fuels in sector 1.A.2.f

[t CO_2/TJ]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Solid fuels	87.5	87.5	88.5	84.5	78.3	75.7	75.7	85.2	85.8	96.2	92.8	86.0
Liquid fuels	75.4	75.8	75.1	76.2	73.0	71.9	64.6	81.2	77.4	77.4	77.8	72.5

For the calculation of CH_4 and N_2O emissions were used default emission factors in line with the IPCC methodology 2006, for the entire time series 2003-2014 (Tab. 3-17).

Tab. 3-18 Emission factors for CH_4 and N_2O emissions used in the consumption of alternative fuels sector 1.A.2.f

EF [kg/TJ]	CH_4	N_2O
Solid fuels	10	1.4
Liquid fuels	3	0.6

3.2.15.3 Uncertainties and time-series consistency (CRF 1.A.2.f)

See chapter 3.2.5.

3.2.15.4 Category-specific QA/QC and verification (CRF 1.A.2.f)

The basic indicator for verification of fuel consumption in the sector of production of pig iron and steel was considered to correspond to the indicators of the overall production of basic products such as cement, lime, clay tiles and roof tiling or glass and fine ceramics. These are relatively large mass flows, which also exhibit high energy demands (Fig. 3-20). Comparison of total production and total fuel consumption in sub sector 1.A.2.f is shown in Fig. 3-20.

The basic trend flow of production of mineral products in total corresponds well with the total fuel consumption. Given that this is a rough comparison, it could be that the minor variations are caused by the different specific energy intensities of the individual kinds of mineral products.

Other QA/QC procedures are set out in section 3.2.6.

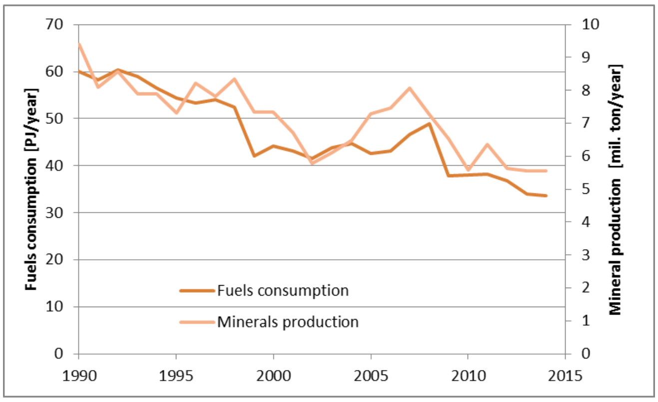


Fig. 3-20 Trends in production of mineral products compared with the development of fuel consumption in the sector 1.A.2.f

3.2.15.5 Category-specific recalculations (CRF 1.A.2.f)

Due to updated activity data the consumption of solid fuels increased in 2013 by 0.15%. Furthermore consumption of naturel gas by 5% in 2012 and 2013 occurred as well.

3.2.15.6 Category-specific planned improvements (CRF 1.A.2.f)

Currently there are no planned improvements in this category.

3.2.16 Manufacturing industries and construction – Other (1.A.2.g)

3.2.16.1 Category description (CRF 1.A.2.g)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.2.g, 2014								
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
LPG	781.1	65.86*)	1	51.4	1	0.00078	0.1	0.00008
Heating and Other Gasoil	170.4	74.1	1	12.6	3	0.00051	0.6	0.00010
Fuel Oil - Low Sulphur	824.6	77.4	1	63.8	3	0.00247	0.6	0.00049
Fuel Oil - High Sulphur	118.5	77.4	1	9.2	3	0.00036	0.6	0.00007
Other Oil	7 862.3	73.3	1	576.3	3	0.02359	0.6	0.00472
Anthracite	345.1	98.3	1	33.9	10	0.00345	1.4	0.00048
Brown Coal + Lignite	781.6	100.44*)	0.985*)	77.3	10	0.00782	1.4	0.00109
Coke	256.1	107.0	1	27.4	10	0.00256	1.4	0.00036
Coke Oven Gas	35.6	44.4	1	1.6	1	0.00004	0.1	0.000004
Natural Gas	29 384.5	55.35*)	1	1 626.5	1	0.02938	0.1	0.00294
Wood/Wood Waste	8 808.6	112	1	986.6	30	0.26426	4.0	0.03523
Gaseous Biomass	399.3	54.6	1	21.8	1	0.00040	0.1	0.00004
Total year 2014	49 767.5			3 488.4		0.33561		0.04562
Total year 2013	56 705.0			3 798.5		0.32458		0.04316
Index 2014/2013	0.88			0.92		1.03		1.06
Total year 1990	301 656.3			24 730.8		1.9732		0.2875
Index 2014/1990	0.16			0.14		0.17		0.16

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2014							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - High Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Anthracite	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Coke Oven Gas	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

The issue is that, this is a new subcategory that in this submission already does not include the sources from the subsector of Non-Metallic Minerals.

This subcategory includes the remaining enterprises in the processing industry not included in subcategories 1.A.2.a to 1.A.2.f. This is an energy-demanding branch with fuel consumption, such as the textile and leather industry, wood processing and subsequent production processes, the entire machine industry, incl. production of means of transport and the construction industry.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:

- Transport Equipment
- Machinery
- Mining (excluding fuels) and Quarrying
- Wood and Wood Products
- Construction
- Textiles and Leather
- Non-specified (Industry)

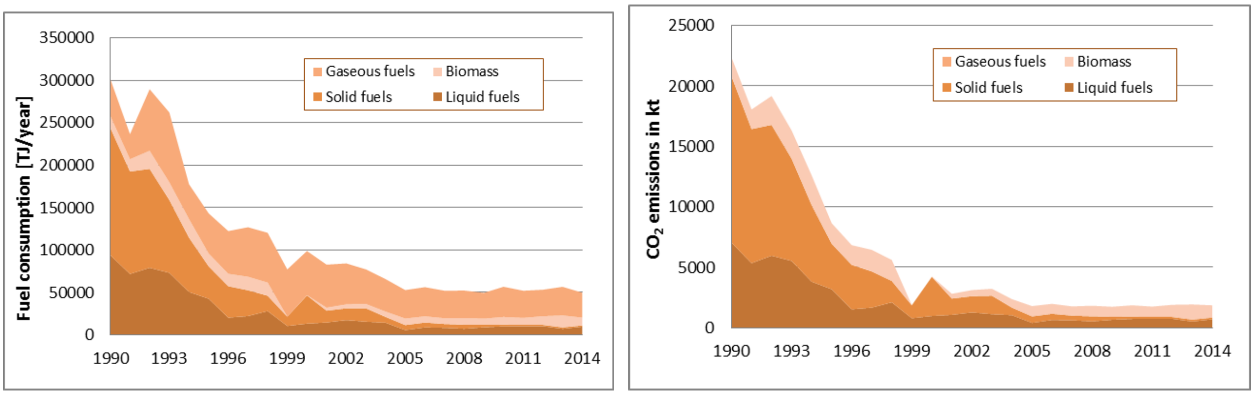


Fig. 3-21 Development of fuels consumption and CO_2 emissions in source category 1.A.2.g

There are embodied the fuels of economic part according to NACE Rev. 2 Other: NACE Divisions 05 – 09, 13 – 16, 21 – 22, 25 – 33 and 41 – 43.

The fraction of CO_2 emissions in subsector 1.A.2.f in CO_2 emissions in sector 1.A.2 equalled 24.9% in 2014. It contributed 2.8% to CO_2 emissions in the whole Energy sector. Overall emissions have exhibited a decrease since 1990. At the beginning of the period, solid Fuels were of major importance, but this has constantly decreased until 2014. Liquid fuels have also constantly decreased in importance since 1990. Natural Gas is also important fuel in this category.

The graph in Fig. 3-21 shows that the beginning of the period was characterised by highly energy-intensive types of industrial processes in this category. Social changes occurring in the Czech Republic in the early 90s resulted in energy-saving measures being introduced by newly privatized enterprises. Together, these influences led to an end to inefficient production and suppression of consumption, particularly of fossil fuels, which were the dominant fuels at the beginning of the period and virtually disappeared by 2005, when they were replaced by biomass. At the same time, the importance of liquid fuels decreased. All this was reflected very significantly by a decline in the CO_2 emissions (and other greenhouse gases). This is the category with the largest relative decrease in CO_2 emissions from 1990 to 2014 (85% decrease).

3.2.16.2 Methodological issues (CRF 1.A.2.g)

Sector specific methodological approaches were not used, the general approaches are given in chapter 3.2.4.

3.2.16.3 Uncertainties and time-series consistency (CRF 1.A.2.g)

See chapter 3.2.5.

3.2.16.4 Category-specific QA/QC and verification (CRF 1.A.2.g)

See chapter 3.2.6.

3.2.16.5 Category-specific recalculations (CRF 1.A.2.g)

Due to update activity data the consumption of solid fuels increased in 2013 by 2.4%. Furthermore consumption of natural gas increased in 2012 and 2013 by 5%.

3.2.16.6 Category-specific planned improvements (CRF 1.A.2.g)

Currently there are no planned improvements in this category.

3.2.17 Transport (1.A.3)

The categories of means of transport for the purposes of calculations of greenhouse gas emissions did not change compared to 2008. The criteria for inclusion of a certain means of transport in a particular category consist in the kind of transport, the fuel employed and the type of emission standard that the particular vehicle must meet (in road transport). The categories of vehicles are not as detailed for non-road transport.

The categories of mobile sources are following:

Domestic Aviation (CRF 1.A.3.a)

- airplanes fuelled by aviation gasoline
- airplanes fuelled by jet kerosene

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

- motorcycles,
- passenger and light duty gasoline vehicles conventional,
- passenger and light duty gasoline vehicles with EURO 1-5 limits,
- passenger and light duty diesel vehicles conventional,
- passenger and light duty diesel vehicles with EURO 1-5 limits,
- passenger cars and light duty vehicles using LPG, CNG and biofuels (separately),
- heavy duty diesel vehicles and buses, conventional,
- heavy duty diesel vehicles and buses with EURO I-VI limits,
- heavy duty vehicles and buses using CNG and biofuels (separately).

Railways(CRF 1.A.3.c)

- diesel locomotives

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

- ships with diesel engines

Other Transportation(CRF 1.A.3.e)

The consumption of Natural Gas for powering compressors for the transit gas pipeline is included in this subcategory under mobile combustion sources, but in fact it is stationary combustion. This consumption is reported in the IEA – CzSO (CzSO, 2015) Questionnaire in the section Transport Sector under the item:

- Pipeline Transport

There are embodied the fuels of economic part according to NACE Rev. 2 Pipeline Transport: NACE Divisions 35.22, 49.50.

3.2.17.1 Methodological issues

The methodology in Czech Republic operates with emission factors in unit g/kg fuel (not g/TJ energy), because the country-specific measured data of every greenhouse gas or pollutant in the internal database are in this unit. The main reason that emission factors are in g/kg fuel is fact that consumption of every fuel is in unit of weight. The emission data calculated for the CRF Reporter are not affected by the calorific value (variable in years) of individual fuel but the fuel consumption for the CRF Reporter must be converted from weight to energy (using the calorific value). So the trend of IEF depends partially on the trend of calorific value and in this case mostly on emission factor of different vehicle technology (due EURO emission standard). Emission factors of individual transport categories are always given for current submission year. All calorific values used for calculation in transport sector are presented within Energy chapter.

Activity data

Activity data for mobile sources are based on official energy balance of the Czech Republic prepared by the Czech Statistical Office (CzSO). The most important feature is annually amount of fuel sold in units of weight since emission factor values are expressed in $g.kg^{-1}$ in CDV database. The parameters necessary for distribution of sold fuels are transport mode, fuel type, weight of vehicle and equipment with more or less effective catalytic system. The appropriate distribution is necessary for assigning of the relevant emission factor. Sector 1.A.3.b Road Transportation is based on the IPCC 2006 Gl. split into five subsectors:

- 1.A.3.b.i Cars
- 1.A.3.b.ii Light Duty Trucks
- 1.A.3.b.iii Heavy Duty Trucks and Buses
- 1.A.3.b.iv Motorcycles
- 1.A.3.b.v Other

Activity data and greenhouse gas emission estimates of subsector 1.A.3.b.ii Light Duty Trucks were in this submission included in the subsector 1.A.3.b.i Cars, because the differentiation between these two subsectors was not available, when the emission model was created. In some years a lot of passenger cars are registered in Central Vehicle Register as light duty vehicles, because of fixed separation between passenger cabin and trunk space according to Czech legislation. The distribution of the data into these two subsectors is included in the current Improvement plan.

The data required for fuel distribution are provided by the Ministry of Transport (transport yearbooks), Czech Hydrometeorological Institute (research), Air Navigation Services of the Czech Republic (yearbooks), and last but not least, traffic surveys (Traffic census) and CDV research activities. Some sources for categories of road transport are monitored separately. Primarily data about CNG vehicles, which have been experiencing a boom in recent years, are collected from two public website sources. The first source of information is a Czech source administrated by the Czech Gas Association and the second one is the Natural & bio Gas Vehicle Association Europe. The most important source of information on the distribution of the dynamic structure (emission standards) of the vehicle fleet on roads in Czech Republic is particularly CDV research, a large number of traffic surveys, the traffic census every five years and also the aggregate outcomes of studies prepared in 2001 (Pisa et al., 2001), 2005 (Pisa et al., 2006) and 2010 (Pisa et al., 2010) for the Road and Motorway Directorate of the Czech Republic.

The total consumption of Kerosene in the Czech Republic is divided into five categories (Domestic Aviation, International Bunkers, Army, Industry and Commercial and Public Services). The Kerosene consumption as well as relevant emissions from the categories of Army, Industry, Commercial and Public Services are not reported in the CRF Reporter in Transport sector 1.A.3 (or International Bunkers 1.D.1), but in sectors 1.A.5.b.i, 1.A.2.f and 1.A.4.a, respectively. The other two categories (Domestic Aviation 1.A.3.a and Aviation Bunkers 1.D.1.a) were divided on the basis of expert judgment over the whole time period if the main criteria were passenger transport (now only one regular domestic line between the airports in Prague and Ostrava) and transport of goods (MoT, 2000; MoT, 2006; MoT, 2011; MoT, 2014). The regular domestic flights (12 TJ) in the Czech Republic using Kerosene are represented by a very small percentage compared to international flights (12 241 TJ). The IEA data (693 TJ) also include in the Domestic Aviation category Kerosene consumption in the categories of Army (14 tons of Jet Kerosene frontloading is included in 2014), Industry, Commercial and Public Services which is not used for aviation or transport. The following table (on the ERT recommendation) shows the distribution of Kerosene consumption in the CRF Reporter in comparison with IEA data. It is obvious from the table that the total sum of Kerosene is same in both cases.

Tab. 3-19 Distribution of Jet Kerosene consumption in CRF Reporter and IEA data in 1990-2014 [TJ]

Year	CRF Reporter						IEA data		
	Domestic Aviation (1.A.3.a)	Internat. Aviation (1.D.1.a)	Army (1.A.5.b.i)	Industry (1.A.2.f)	Commercial and Public Services (1.A.4.a)	Total CRF	Internat. Aviation	Domestic Aviation	Total IEA
1990	19	7 325	0	0	0	7 344	7 344	0	7 344
1991	20	6 020	0	0	0	6 040	6 040	0	6 040
1992	29	6 967	0	0	0	6 996	6 996	0	6 996
1993	31	5 792	0	0	0	5 823	5 823	0	5 823
1994	49	7 208	0	0	0	7 257	7 257	0	7 257
1995	15	7 805	0	0	0	7 820	7 820	0	7 820
1996	41	5 866	0	0	0	5 907	5 603	304	5 907
1997	54	6 759	0	0	0	6 812	5 217	1 595	6 812
1998	50	7 991	0	0	0	8 041	4 902	3 139	8 041
1999	48	7 520	0	0	0	7 568	5 633	1 935	7 568
2000	22	8 234	0	0	0	8 256	6 665	1 591	8 256
2001	24	8 750	0	0	0	8 774	6 762	2 012	8 774
2002	19	7 556	770	0	0	8 346	6 976	1 370	8 346
2003	24	10 163	556	0	0	10 743	8 432	2 311	10 743
2004	35	13 062	685	0	0	13 782	12 070	1 712	13 782
2005	37	13 573	728	0	0	14 338	13 182	1 156	14 338
2006	46	14 070	563	0	0	14 679	14 073	606	14 679
2007	46	14 763	823	87	217	15 936	14 462	1 472	15 934
2008	31	15 644	823	87	173	16 758	14 895	1 862	16 757
2009	45	14 287	909	87	173	15 501	14 246	1 256	15 501
2010	36	13 387	650	87	130	14 290	13 120	1 169	14 289
2011	22	13 272	1 256	87	173	14 810	12 990	1 819	14 809
2012	17	12 367	520	87	130	13 121	12 297	823	13 120
2013	19	11 931	563	43	43	12 599	11 864	736	12 600
2014	12	12 241	606	0	0	12 859	12 254	693	12 974

Emission factors

Based on the ERT recommendation, tables of emission factors for all the greenhouse gases were added. The first table is for road transportation and is divided in detail by vehicle category, fuel type and EURO standard. The second table contains information about the emission factors of non-road transportation, particularly railways, navigation and aviation. Aviation is divided into two modes (LTO and CRUISE). The emission factors were derived from the internal database of the Transport Research Centre, which contains the default emission factors taken from the IPCC and EIG databases (CO_2 and N_2O), and also those that have country-specific character (CH_4). The calculated emission factor for biomass was taken as the weighted average for gasoline and diesel oil, taking into account the real vehicle fleet on roads (recommended by ERT). Calculation of the emission factors for biomass for other greenhouse gases also takes into account the amount of renewable components in the fuel. The CDV methodology employs emission factors in unit g/kg fuel but not g/TJ energy, because the country-specific measured data in this unit are in the internal database.

Tab. 3-20 Emission factors of CO_2, N_2O and CH_4 from road transport in 2014 [g/kg fuel]

Vehicle type	Fuel type	European emission standard	EF CO_2	EF N_2O	EF CH_4
			g/kg fuel	g/kg fuel	g/kg fuel
Motorcycles	Gasoline	PRE-EURO and higher	3 071	0.06	4.10
Motorcycles	Bioethanol	PRE-EURO and higher	1 912	0.02	0.08
PC+LDT	Gasoline	PRE-EURO	3 071	0.31	0.90
PC+LDT	Gasoline	EURO I and EURO II	3 071	0.70	0.40
PC+LDT	Gasoline	EURO III and higher	3 071	0.90	0.10
PC+LDT	Diesel Oil	PRE-EURO	3 183	0.10	0.08
PC+LDT	Diesel Oil	EURO I and EURO II	3 183	0.20	0.08
PC+LDT	Diesel Oil	EURO III and higher	3 183	0.25	0.08
PC+LDT	LPG	PRE-EURO and higher	3 028	0.01	1.02
PC+LDT	CNG	PRE-EURO and higher	2 697	0.15	4.52
PC+LDT	Bioethanol	PRE-EURO and higher	1 912	0.02	0.08
PC+LDT	FAME	PRE-EURO and higher	2 620	0.02	0.06
HDT	Diesel Oil	PRE-EURO	3 183	0.10	0.60
HDT	Diesel Oil	EURO I and EURO II	3 183	0.20	0.20
HDT	Diesel Oil	EURO III and higher	3 183	0.25	0.15
HDT	CNG	PRE-EURO and higher	2 697	0.15	4.52
HDT	FAME	PRE-EURO and higher	2 620	0.02	0.06
Bus	Diesel Oil	EURO II and older	3 183	0.18	0.60
Bus	Diesel Oil	EURO III and higher	3 183	0.10	0.15
Bus	CNG	PRE-EURO and higher	2 697	0.15	4.52
Bus	FAME	PRE-EURO and higher	2 620	0.02	0.06

Tab. 3-21 Emission factors of CO_2, N_2O and CH_4 from non-road transport in 2014 [g/kg fuel]

Transport type	Fuel type	EF CO_2	EF N_2O	EF CH_4
		g/kg fuel	g/kg fuel	g/kg fuel
Railways	Diesel Oil	3 183	1.23	0.18
Water-borne navigation	Diesel Oil	3 183	0.09	0.30
Civil Aviation - LTO	Aviation Gasoline	3 065	0.09	0.02
Civil Aviation - Cruise	Aviation Gasoline	3 065	0.09	0.02
Civil Aviation - LTO	Kerosene	3 096	0.09	0.02
Civil Aviation - Cruise	Kerosene	3 096	0.09	0.02

CO_2 emissions

Carbon dioxide emissions were calculated on the basis of the total consumption of the individual automotive fuels used in transport (i.e. gasoline, diesel oil, LPG, CNG, biofuels and aviation fuels) and the emission factors for the weight of CO_2 corresponding to 1 kg of fuel burned. Consumption of the individual kinds of fuel by road, railway and water transport was determined on the basis of cooperation with the CzSO. Consumption in road transport was further divided up into the following categories of means of transport on the basis of statistics on transport output:

- gasoline-fuelled passenger vehicles;
- diesel vehicles for passenger and light freight transport;
- diesel vehicles for heavy freight transport and buses;
- passenger and light vehicles fuelled by LPG, CNG and biofuels (separately);
- heavy trucks and buses fuelled by CNG and biofuels (separately).

The share of transport in total CO_2 emissions has exhibited an increasing trend in the Czech Republic during the 90's and this growth is continuing until 2007. Individual road and freight transport make the greatest contribution to energy consumption in transport. The amount of fuel sold is monitored annually and constitutes the main input data for calculation of energy consumption.

In 2008, for the first time, in emissions of carbon dioxide from transport is recorded a decrease, which has started a downward trend continuing until 2014 (Jedlicka et al, 2014). The reduction in carbon dioxide emissions is a result primary of a reduction in the consumption of gasoline and diesel oil, which is interpreted as being a consequence of the global economic crisis. The downward trend of fuel consumption is evaluated very favourably from viewpoint of greenhouse gases.

A continuous downward trend in gasoline consumption has appeared since 2007. However, the persistent downward trend may no longer be a consequence of the economic crisis. A slight increase was recorded in diesel oil consumption in 2014. This phenomenon indicates a return to the theoretical expectations of developments in the consumption of conventional fuels. The increase of fuel consumption in 2014 may have been affected by progress of the national economy and increased goods and material transportation. The greenhouse gas emission balance reflects not only the scenario of consumption of alternative fuels, but also the scenario of trends in the transport infrastructure, further construction of the throughway network in different variants, urban bypasses, further construction of railway corridors, etc.

The consumption of gasoline fluctuated around 2 mil. tons from 2002 to 2009, but it has started to decline significantly since 2010. It even reached a value 1455 tons in 2014. This decline is caused especially by a downward trend in average fuel consumption of modern passenger cars. Since 2008 the consumption of gasoline has also included the consumption of bioethanol, which has been added to all gasoline in an amount of 2% since January 1, 2008. The fraction of bioethanol as a renewable resource in gasoline reached a value 4.1% in 2010 and the fraction of fatty acid methyl esters (FAME) as a renewable resource in diesel oil reached a value 6% in 2010 and both values will remain unchanged in the coming years. These facts (reduction in consumption and increasing the share of bio-components) have a favourable impact on CO_2 emissions.

Mobile sources used for purposes other than transport – gasoline-powered lawn mowers, chain saws, construction machinery, etc. – make a smaller contribution to the increasing consumption of gasoline and diesel oil.

In relation to CO_2 emissions from air transport, it can be stated that domestic transport makes a very small contribution to these emissions – about 1%, as it is limited mainly to flights between the three largest cities in the Czech Republic, Prague, Brno and Ostrava. Similar to road transport and consumption of aircraft fuel, this is not monitored centrally by the Czech Statistical Office. Aircraft are fuelled mainly by jet kerosene, while the consumption of and CO_2 emissions from aviation gasoline are limited to small aircraft used in agriculture and in sports and recreational activities.

- The total consumption by the army and the consumption by domestic transport (estimated on the basis of the number of flights, distances between destinations and the specific consumption of fuels per the unit distance in the LTO regime and the cruise itself) were subtracted from the total kerosene consumption. The remaining kerosene consumption is related to international air transport.

Tab. 3-22 CO_2 emissions calculation from mobile sources in 1990 – 2014 [kt CO_2]

	Aviation (without Bunkers)	Road Transportation	Railways	Water-borne navigation	Other Transport Pipeline transport	Other Mobile Agric. and others	Total
	1.A.3.a	1.A.3.b	1.A.3.c	1.A.3.d	1.A.3.e	1.A.4.c.ii + 1.A.5.b	1.A.3 + 1.A.4.c.ii + 1.A.5
1990	139.4	6 177	654	56.6	5.4	1 655	8 687
1991	38.2	5 478	582	56.2	9.2	1 439	7 602
1992	38.9	7 108	494	54.8	13.1	1 335	9 044
1993	23.7	7 299	415	54.3	17.0	1 290	9 099
1994	21.9	8 079	335	53.5	20.8	1 299	9 809
1995	13.4	8 584	334	55.2	36.0	1 191	10 210
1996	15.2	9 504	329	45.9	87.6	1 139	11 121
1997	10.0	9 654	283	38.5	75.2	1 188	11 249
1998	9.7	9 862	356	37.8	58.2	1 401	11 725
1999	12.6	11 083	332	22.1	62.2	1 377	12 889
2000	10.8	11 237	329	15.8	58.0	1 380	13 031
2001	7.8	11 975	301	24.9	59.3	1 319	13 687
2002	10.6	12 561	292	12.4	61.5	1 290	14 228
2003	10.9	14 309	286	12.4	58.1	1 237	15 914
2004	11.7	15 047	282	18.6	56.0	1 301	16 716
2005	8.8	16 344	285	15.5	68.5	1 284	18 006
2006	9.4	16 964	304	19.0	73.4	1 259	18 628
2007	9.4	17 831	301	15.8	119.0	1 336	19 612
2008	8.3	17 641	334	12.7	146.1	1 406	19 548
2009	9.3	17 155	303	15.9	151.6	1 381	19 016
2010	8.7	16 156	293	12.8	151.6	1 336	17 958
2011	4.6	15 985	287	9.6	145.5	1 400	17 832
2012	7.4	15 742	277	15.9	89.3	1 340	17 472
2013	7.5	15 619	271	6.4	92.3	1 334	17 330
2014	7.0	16 117	274	9.6	83.7	1 373	17 864

According the Fig. 3-22 the emissons of CO_2 from road transportation are following trend of energy consumption. There are no disproportions. CO_2 emission are not dependent on ratio between energy consumption in particular modes of road transportation or consumption of particular type of fuel.

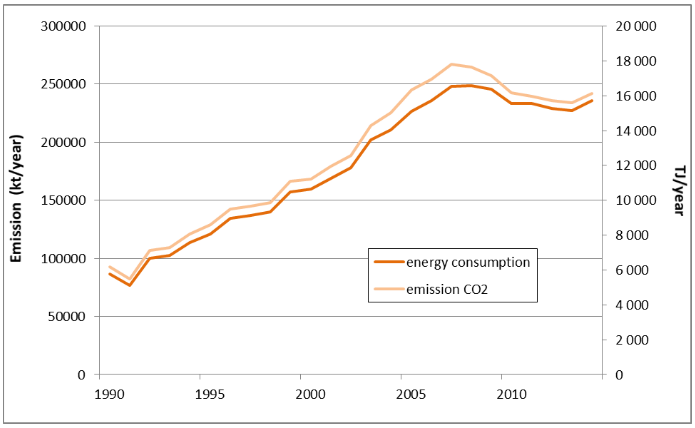


Fig. 3-22 Comparison of energy consumption and CO_2 emissions from road transport

CH_4 emissions

For road transportation, the method of methane emission calculation corresponds to the Tier 2 level, because different road vehicles produce different amounts of methane. It can be stated that methane emissions from road transportation exhibit the same differences as total hydrocarbons. Mobile emission sources were divided up into several categories according to the fuel used, the transport mode and the emission limit that a particular vehicle must meet. This division is more detailed because there are larger differences in methane production by individual vehicles. These categories are described in detail at the beginning of this chapter.

The total consumption of gasoline, diesel oil, LPG, CNG and biofuels has been determined from the statistical surveys of the CzSO. The next step consisted in separation of these fuel consumptions into the vehicle categories described above, according to their transport outputs acquired in the last National Traffic Census performed in the Czech Republic once every five years, last in 2010. The emission factors were the IPCC default values and, from 2004, the country-specific values as CDV became part of the emission inventory team.

The Czech Republic has been very successful in stabilizing and decreasing methane emissions derived from transport-related greenhouse gas emissions. The annual trends in these emissions are constantly decreasing and are very similar to other hydrocarbons emissions, which are limited in accordance with UNECE regulations. New vehicles must fulfill substantially higher EURO standards for hydrocarbons than older vehicles (currently the EURO 6 standard for passenger cars and EURO VI for heavy duty vehicles and buses). The greatest problems are associated with the slow renewal of the freight transport fleet. There has been a slight decrease in the number of older trucks in this country and these older vehicles are frequently used in the construction and food industries (Adamec et al., 2005a). A slight increase in CH_4 emissions was recorded in 2014, mainly as a result of the purchase of a large number of CNG buses, supported from national funds.

Methane emissions from mobile sources are now calculated using methane emission factors taken from the internal database, containing both data from Czech emission measurements (mostly obtained from the Motor Vehicle Research Institute - TÜV UVMV) and internationally accepted values from the IPCC methodology, European Environmental Agency - Emission Inventory Guidebook, CORINAIR, etc. The resultant emission factors were calculated using the weighted averages of all the data classified according to transport vehicle categories. The following categories were included: conventional gasoline-fuelled passenger cars, gasoline-fuelled passenger cars fulfilling EURO limits, diesel-fuelled passenger cars, light-duty vehicles, heavy-duty vehicles, diesel locomotives, diesel-fuelled watercraft, aircraft fuelled by aviation gasoline and kerosene-fuelled aircraft (Adamec et al., 2005b).

Tab. 3-23 CH_4 emissions calculation from mobile sources in 1990 – 2014 [Mg CH_4]

	Aviation (without Bunkers)	Road Transportation	Railways	Water-borne navigation	Other Transport Pipeline transport	Other Mobile Agric. and others	Total
	1.A.3.a	1.A.3.b	1.A.3.c	1.A.3.d	1.A.3.e	1.A.4.c.ii + 1.A.5.b	1.A.3 + 1.A.4.c.ii + 1.A.5
1990	0.996	1 500	37	5.35	0.10	0.13	1 544
1991	0.273	1 354	33	5.31	0.17	0.12	1 393
1992	0.278	1 757	28	5.18	0.24	0.11	1 791
1993	0.169	1 683	23	5.13	0.31	0.10	1 712
1994	0.156	1 814	19	5.05	0.38	0.10	1 839
1995	0.095	1 826	19	5.22	0.66	0.09	1 851
1996	0.108	1 924	18	4.34	1.59	0.08	1 948
1997	0.071	1 851	16	3.64	1.37	0.09	1 872
1998	0.069	1 771	20	3.57	1.06	0.10	1 796
1999	0.090	1 834	19	2.09	1.13	0.10	1 857
2000	0.077	1 703	18	1.49	1.05	0.13	1 724
2001	0.056	1 701	17	2.35	1.08	0.13	1 722
2002	0.075	1 647	16	1.17	1.12	0.13	1 665
2003	0.077	1 703	16	1.17	1.06	0.11	1 722

	Aviation (without Bunkers)	Road Transportation	Railways	Water-borne navigation	Other Transport Pipeline transport	Other Mobile Agric. and others	Total
	1.A.3.a	1.A.3.b	1.A.3.c	1.A.3.d	1.A.3.e	1.A.4.c.ii + 1.A.5.b	1.A.3 + 1.A.4.c.ii + 1.A.5
2004	0.083	1 612	16	1.76	1.02	0.11	1 631
2005	0.062	1 556	16	1.46	1.25	0.11	1 575
2006	0.067	1 473	17	1.80	1.33	0.10	1 493
2007	0.067	1 448	17	1.50	2.16	0.11	1 469
2008	0.059	1 336	19	1.20	2.65	0.11	1 359
2009	0.066	1 215	17	1.50	2.75	0.11	1 236
2010	0.062	1 060	16	1.21	2.74	0.11	1 080
2011	0.033	991	16	0.90	2.63	0.12	1 019
2012	0.052	929	16	1.50	1.62	0.11	948
2013	0.054	904	15	0.60	1.67	0.10	921
2014	0.054	933	15	0.90	1.51	0.11	951

Figure 3-23 shows the opposite trend in emission production of CH_4 and energy consumption in road transportation. The continuous decrease started in 2000 when the EURO 3 standard was implemented. Starting that year, THC had their own limit value. The decrease in the following years was intensify by toughening the THC limits in 2005 by the EURO 4 standard. Another cause of the downward trend is the increasing ratio of diesel passenger cars in the car fleet over the past few years, which produce less CH_4. 2014 was an exception, when the emissions of CH_4 were higher compared to 2013, because of the purchase of a large number of CNG buses in cities and regions of the Czech Republic with high air pollution.

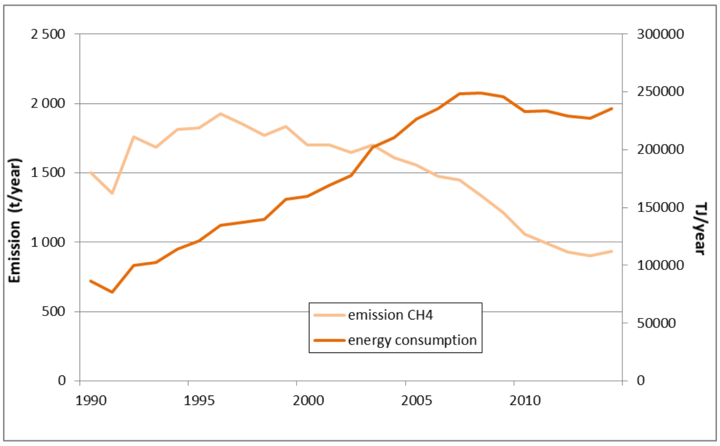


Fig. 3-23 Comparison of energy consumption and CH_4 emissions from road transport

N_2O emissions

Nitrous oxide emissions decreased in 2008 similar to carbon dioxide emissions as a consequence of reduced consumption of gasoline and diesel oil. Newer vehicles exhibit higher emissions compared to older models, because they are equipped with 3-way catalytic converters, which reduce only NO_X emissions but not N_2O emissions. However, this effect is suppressed in new vehicles as a consequence of lower fuel consumption. Between 2008 and 2013, N_2O emissions still continued to decrease, similar to carbon dioxide emissions. In 2014 nitrous oxide emissions slightly increased. This fact is caused by higher consumption of diesel oil which is influenced by progress of national economics and increase of goods and material transportation. Other factor is higher consumption of CNG connected with purchasing number of CNG busses supported from national funds.

Road transport was identified as a key source of N_2O emissions over the past 5 years, as the share of vehicles with high N_2O emissions has been increasing over this time. Consequently, N_2O emissions from mobile sources represent a somewhat more important contribution than CH_4 emissions. In calculation of N_2O emissions from mobile sources, the most important source according to the IPCC methodology seems to be passenger automobile transport, especially gasoline-fuelled passenger cars with catalysts. The vehicle categories for the nitrous oxide calculation are the same as for methane (see above).

Because of large differences between national N_2O measurement results and the values recommended in the IPCC methodology, special verification including the statistical evaluation has been performed. The resultant values of the N_2O emission factors from mobile sources approach the recommended IPCC values. The emissions factors for N_2O for vehicles with diesel motors and for vehicles with gasoline motors without catalysts are not very high and were taken in the standard manner from the methodical instructions (IPCC default values). The situation is more complex for vehicles with gasoline motors equipped with three-way catalysts. The IPCC methodology (IPCC, 2006) gives three pairs of emission factors for passenger cars with catalysts (for new and deactivated catalysts). The value for a deactivated catalyst is approximately three times that for a new catalyst. The pair of values recommended on the basis of Canadian research was selected because of the lack of domestic data; in addition, American and French coefficients are presented in the *IPCC Reference Manual*, Box 3 (IPCC, 1997). The arithmetic mean of the values for new and older used catalysts was taken as the final emission factor for passenger cars with catalysts.

A partial increase in N_2O emissions can be expected in this category in connection with the growing fraction of vehicles equipped with three-way catalysts. This approach described above was recently revised and modified by CDV, which is a member of the Czech national GHG inventory team from 2005. CDV has been providing the transport data for the official Czech inventory since 2004. The CDV approach is based on combination of measurements performed for some cars typically used in the Czech Republic with widely used EFs values taken from literature (Dufek, 2005).

The situation in relation to reporting N_2O emissions is rather complicated, as the values in some of the measurements performed in the past in the Czech Republic were substantially different from the internationally recognized emission factors. Consequently, control measurements were performed on N_2O emissions from the commonest cars in the Czech passenger vehicle fleet (Skoda Felicia, Fabia and Octavia) during 2004 – 2006. These corrections brought the results closer to those obtained using the IPPC emission factors compared to the older data, leading to better harmonization of the results of the nitrous oxide emission inventory per energy unit with those obtained in other countries. The locally measured data for measurements of N_2O emissions in exhaust gases were verified by assigning weighting criteria for each measurement; the most important of these criteria were the number of measurements, the analysis method, the type of vehicle and the fraction of these vehicles in the Czech vehicle fleet (Dufek, 2005 and Jedlicka et al., 2005).

Nitrous oxide emission factors were obtained using a similar method to that employed for methane, by statistical evaluation of the weighted averages of the emission factors for each category of vehicle, employing the interactive database. This database now encompasses the results of the Czech measurements performed in 2004 and 2005 (Adamec et al., 2005b). Emissions of N_2O are given in Tab. 3-24.

Tab. 3-24 N_2O emissions calculation from mobile sources in 1990 – 2014 [Mg N_2O]

	Aviation (without Bunkers)	Road Transportation	Railways	Water-borne navigation	Other Transport Pipeline transport	Other Mobile Agric. and others	Total
	1.A.3.a	1.A.3.b	1.A.3.c	1.A.3.d	1.A.3.e	1.A.4.c.ii + 1.A.5.b	1.A.3 + 1.A.4.c.ii + 1.A.5
1990	3.98	459	252	1.53	0.010	0.059	716.6

	Aviation (without Bunkers)	Road Transportation	Railways	Water-borne navigation	Other Transport Pipeline transport	Other Mobile Agric. and others	Total
1991	1.09	418	225	1.52	0.017	0.053	646.5
1992	1.11	543	191	1.48	0.024	0.050	736.7
1993	0.68	589	160	1.47	0.031	0.050	751.2
1994	0.63	728	129	1.44	0.038	0.053	859.2
1995	0.38	828	129	1.49	0.066	0.047	959.0
1996	0.43	996	127	1.24	0.159	0.047	1 124.9
1997	0.28	1070	109	1.04	0.137	0.051	1 180.9
1998	0.28	1132	138	1.02	0.106	0.064	1 271.6
1999	0.36	1305	128	0.60	0.113	0.065	1 434.1
2000	0.31	1376	127	0.43	0.105	0.070	1 503.9
2001	0.22	1537	116	0.67	0.108	0.073	1 654.1
2002	0.30	1683	113	0.34	0.112	0.080	1 796.8
2003	0.31	1970	110	0.34	0.106	0.079	2 080.8
2004	0.33	2090	109	0.50	0.102	0.089	2 200.0
2005	0.25	2233	110	0.42	0.125	0.094	2 343.9
2006	0.27	2251	117	0.51	0.133	0.091	2 369.0
2007	0.27	2378	116	0.43	0.216	0.100	2 495.0
2008	0.24	2308	129	0.34	0.265	0.106	2 438.0
2009	0.27	2279	117	0.43	0.275	0.105	2 397.1
2010	0.25	2146	113	0.34	0.274	0.100	2 260.0
2011	0.13	2125	111	0.26	0.263	0.109	2 236.8
2012	0.21	2061	107	0.43	0.162	0.102	2 168.9
2013	0.21	2012	104	0.17	0.167	0.101	2 116.6
2014	0.21	2049	106	0.26	0.151	0.107	2 155.7

Figure 3-24 shows higher increase of N_2O emissions from road transport till the year 2008 to compare with energy consumption trend. Implementation of EURO V standard for trucks in 2008 an EURO 5 standard in 2009 for passenger cars toughened limits for NO_x. Thanks to this fact and the economic crisis (lowering of transport of goods) the decrease in following years has been started and it is more intense than decrease of energy consumption.

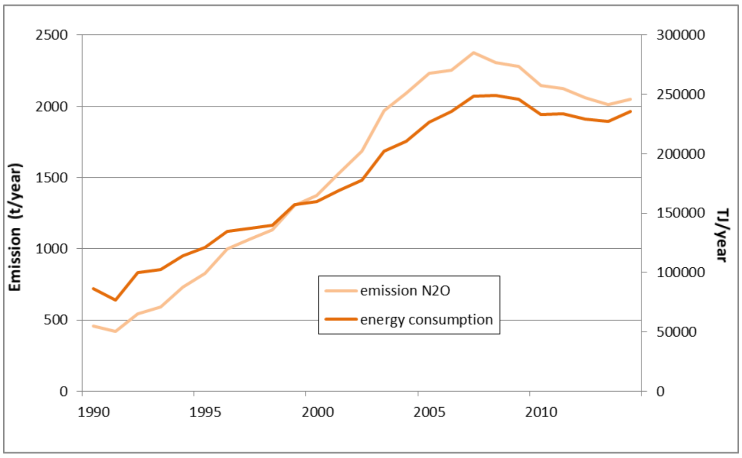


Fig. 3-24 Comparison of energy consumption and N_2O emissions from road transport

Other Transportation (CRF1.A.3.e)

Country specific CO_2 emission factor is used since this submission. For detailed information please see Annex 3.

Default emission factors are used for CH_4 and N_2O in the entire time series.

3.2.17.2 Uncertainties and time-series consistency

In spite of the fact that verification has been performed, the N_2O emission factors remain the greatest source of uncertainty for this pollutant, because the emission factors from various data sources differ. In checking the consistency of data series, attention was focused since 2006 primarily on emissions from internal air transport; particularly older data on internal flights is very difficult to obtain.

Tab. 3-25 lists source of expert judgement provided for uncertainty analysis for each category in mobile combustion.

Tab. 3-25 Uncertainty data from Energy sector (mobile combustion) for uncertainty analysis

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
CO_2	1.A.3.a Domestic Aviation	4	3.73	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.3.b Road Transportation	3	2.36	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.3.c Railways	5	1.48	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CO_2	1.A.3.d Domestic Navigation	5	1.5	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.3.a Domestic Aviation	4	21.5	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.3.b Road Transportation	3	100	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.3.c Railways	5	100	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
CH_4	1.A.3.d Domestic Navigation	5	50	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.a Domestic Aviation	4	40	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.b Road Transportation	3	100	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.c Railways	5	100	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines
N_2O	1.A.3.d Domestic Navigation	5	90	L. Pelikan, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines

3.2.17.3 Source-specific QA/QC and verification

Transport research centre (CDV) is a sector-solving institution responsible for this category. The plan of QA/QC procedures in CDV is based on the inner quality control procedure system, which is harmonised with the QA/QC system of KONEKO Ltd. company. Since the transport sector belongs to the energy sector, there is been a close co-operation of CDV and KONEKO in the field of energy and fuel consumption data as well as specific energy data used (in MJ/ kg fuel). The KONEKO Ltd. company in close co-operation with CzSO ensures that Transport research centre works with the most updated data about total energy and specific energy consumed.

The sectoral guarantor of QA/QC procedures for mobile sources, Jiri Jedlicka (Head of the Infrastructure and Environment Department in CDV):

- is responsible for the sectoral QA/QC plan and the compliance of all QA/QC procedures with 2006 IPCC Guidelines (IPCC, 2006),
- provides for the QC procedure (Tier 2) and is responsible for its implementation.

Sectoral administrator, Leos Pelikan:

- performs the emission calculations for the transport in emission model,

- provides for data import in the online CRF Reporter,
- provides for and is responsible for the storing of documents,
- carries out auto-control (1st step of QC procedure, Tier 1) and control of data consistency.

The inner quality assurance and quality control procedure consists of the designation of responsible persons for emission calculation – Researcher Mr. Leos Pelikan and Head of the Infrastructure and Environment Department, Mr. Jiri Jedlicka. Mr. Pelikan implements the calculations and is responsible for all the work with the online Common Reporting Format (CRF). This work involves data input (emissions of greenhouse gases, energy consumption) from its own emission calculation model to CRF and year-to-year comparison of implied emission factors calculated in CRF. In addition, the QC Tier 2 is planned through checking of the official GHG emission data with the data calculated according to the CORINAIR methodology. Mr. Jedlicka is responsible for checking of the results and their consistency.

3.2.17.4 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculation performed in this submission.

3.2.17.5 Source-specific planned improvements, including tracking of those identified in the review process

The planned improvements are related mainly to performance of projects to measure country-specific emission factors in key categories of road transportation. The greatest emphasis will be placed on acquisition of sufficient data for CO_2 and N_2O emission calculation and refinement of methodologies for each category of transport. Next improvement is to split activity data for PC and LDT to their own categories.

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

3.2.18.1 Category description (CRF 1.A.4.a)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.4.a, 2014								
Structure of Fuels	Activity	CO_2			CH_4		N_2O	
	data	EF	OxF	Emission	EF	Emission	EF	Emission
	[TJ]	[t CO_2/TJ]		[kt]	[kg CH_4/TJ]	[kt]	[kg N_2O/TJ]	[kt]
LPG	229.7	65.86*)	1	15.1	5	0.00115	0.1	0.00002
Other kerosene	85.6	71.9	1	6.2	10	0.00086	0.6	0.00005
Heating and Other Gasoil	42.6	74.1	1	3.2	10	0.00043	0.6	0.00003
Fuel Oil - Low Sulphur	197.5	77.4	1	15.3	10	0.00198	0.6	0.00012
Other Bituminous Coal	50.4	94.03*)	0.971*)	4.6	10	0.00050	1.4	0.00007
Brown Coal + Lignite	542.6	98.11*)	0.985*)	53.7	10	0.00543	1.4	0.00076
Coke	142.3	107	1	15.2	10	0.00142	1.4	0.00020
Natural Gas	43803.3	55.30*)	1	2424.6	5	0.21902	0.1	0.00438
Wood/Wood Waste	524.0	112	1	58.7	300	0.15720	4	0.00210
Gaseous Biomass	846.0	54.6	1	46.2	5	0.00423	0.1	0.00008
Total year 2014	46464.0			2642.7		0.39220		0.00781
Total year 2013	56956.4			3256.4		0.45110		0.01003
Index 2014/2013	0.82			0.81		0.87		0.78
Total year 1990	121 435.7			10 023.6		1.01660		0.09660
Index 2014/1990	0.38			0.26		0.39		0.08

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

2014							
Structure of Fuels	Source of Activity data	Emission factors			Method used		
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Other kerosene	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Heating and Other Gasoil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

The whole category 1.A.4 includes emissions which are not included in the 1.A.1 and 1.A.2 categories. They can be generally defined as heat production processes for internal consumption.

The main driving force for CO_2 emissions in category 1.A.4 is energy consumption for purposes of space heating. The fluctuations in consumption then can be ascribed to differences in cold winter periods. The trend of decreasing CO_2 emissions is a result of higher standards for new buildings and of successful execution of energy-efficiency-oriented modernisations of existing buildings. The trend has also been supported by shifting to fuels with lower CO_2 emissions (emission factors). The importance of Solid Fuels at the beginning of the period constantly decreases in time. On the other hand, the consumption of Natural Gas increased during the period as well as Biomass consumption. Liquid Fuels play a minor role in this category.

CO_2 emissions produced in category 1.A.4.a represent in 2014 26% of whole 1.A.4, which is 3% of CO_2 emissions from the Energy sector 1.A.

The 1.A.4.a subcategory includes all combustion sources that utilize heat combustion for heating production halls and operational buildings in institutions, commercial facilities, services and trade.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in capture Other sectors under the item:

- Commercial and Public Services
- Non-specified (Other)

Last point is included under 1.A.4.a Commercial/Institutional on the basis of an agreement with CzSO. There are embodied the fuels of economic part according to NACE Rev. 2 Commercial/Institutional: NACE Divisions 35 excluding 1.A.1.a and 1.A.3.e, 36 – 39, 45 – 99 excluding 1.A.3.e and 1.A.5.a.

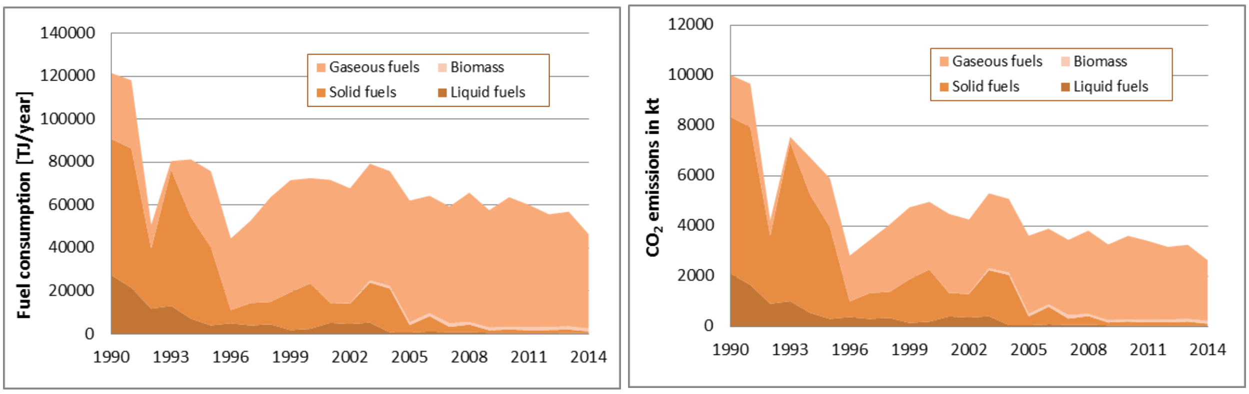


Fig. 3-25 Development of fuels consumption and CO_2 emissions in source category 1.A.4.a

The graph (Fig. 3-25) shows that the beginning of the period in subsector 1.A.4.a was characterised by a predominance of consumption of fossil fuels combined with liquid fuels, which were gradually replaced primarily by natural gas. The share of biofuels in this subsector is minor. The overall decrease in fuel consumption is about 50%, which resulted in a decrease in CO_2 emissions by about 65%. The greater decrease in emissions compared to fuel consumption is determined by the changes in the structure of fuels in favour of natural gas.

Outlier values in the fuel consumption are apparent at the beginning of the time series. This unusual trend will be the subject of detailed revision of the activity data. This aspect is also included in the Improvement plan.

3.2.18.2 Methodological issues (CRF 1.A.4.a)

During processing data for the subsector 1.A.4.a among the used fuels are also included fuels, which are in the questionnaires of CzSO, listed in section "Transport sector". The amounts of these fossil fuels is given in Tab. 3-26 in TJ.

Tab. 3-26 Quantities of fuels used in the sector transport in stationary sources

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
TJ/year	27.9	28.1	0.0	13.7	38.0	34.3	36.9	13.9	13.8	12.5	13.0	15.4	33.9

According to the communication to CzSO, this is a fuel for heating the buildings of the state-owned company Czech Railways and that is why its combustion was situated in the subsector 1.A.4.a. This is the consumption of bituminous coal, lignite and coke oven coke worth 1-2 kt per year. The amount of these fuels in the total balance of 1.A.4.a virtually has no effect.

No other sector-specific methodological issues are applied, the general issues are given in chapter 3.2.4.

3.2.18.3 Uncertainties and time-series consistency (CRF 1.A.4.a)

See chapter 3.2.5.

3.2.18.4 Category-specific QA/QC and verification (CRF 1.A.4.a)

See chapter 3.2.6.

3.2.18.5 Category-specific recalculations (CRF 1.A.4.a)

In line with official CzSO data the recalculation in consumption of natural gas in 2012 (decrease by 7.5%) and in 2013 (decrease by 9%) was performed.

3.2.18.6 Category-specific planned improvements (CRF 1.A.4.a)

Detailed research of data at the beginning of 90s is planned for the future submissions.

3.2.19 Other Sectors – Residential (1.A.4.b)

3.2.19.1 Category description (CRF 1.A.4.b)

The structure of fuels, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.4.b, 2014								
Structure of Fuels	**Activity**	**CO_2**			**CH_4**		**N_2O**	
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**		**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
LPG	183.8	65.86*)	1	12.1	5	0.00092	0.1	0.00002
Other Bituminous Coal	2318.4	94.03*)	0.971*)	212.4	300	0.69552	1.4	0.00325
Brown Coal + Lignite	15791.4	98.11*)	0.985*)	1561.6	300	4.73741	1.4	0.02211
Coke	569.1	107	1	60.9	300	0.17074	1.4	0.00080
Brown Coal Briquets	2982.0	97.5	0.985*)	286.3	300	0.89460	1.4	0.00417
Natural Gas	69021.4	55.30*)	1	3820.5	5	0.34511	0.1	0.00690
Wood/Wood Waste	49638.0	112	1	5559.5	300	14.89140	4	0.19855
Charcoal	710.4	112	1	79.6	200	0.14208	1	0.00071
Total year 2014	141214.4			11592.8		21.87777		0.23651
Total year 2013	166236.6			13315.6		24.63072		0.25325
Index 2014/2013	0.85			0.87		0.89		0.93
Total year 1990	213 400.7			19 637.1		49.05200		0.32080
Index 2014/1990	0.66			0.59		0.45		0.74

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for the individual gases are shown in details in the following outline.

		2014					
Structure of Fuels	**Source for**	**Emission factors**			**Method used**		
	Activity data	**CO_2**	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Brown Coal Briquets	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Charcoal	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

Fuel consumption in households is determined on the basis of the results of the statistical study "Energy consumption in households", published in 1997 and 2004 by the Czech Statistical Office according to the PHARE/EUROSTAT method.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in capture Other Sector under the item:

Residential

The fraction of CO_2 emissions in subsector 1.A.4.b in CO_2 emissions in sector 1.A.4 equalled 61% in 2014. It contributed 7% to CO_2 emissions in the whole Energy sector 1.A.

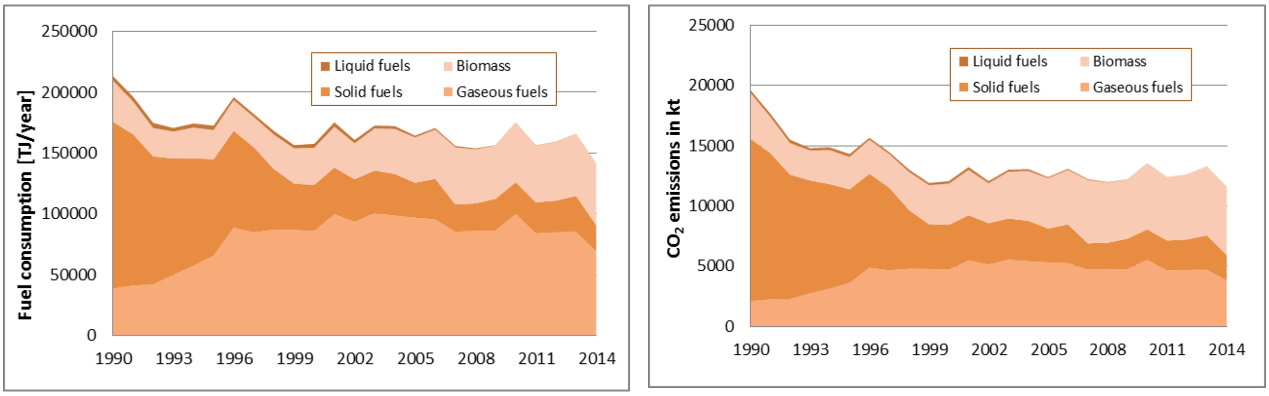


Fig. 3-26 Development of fuels consumption and CO_2 emissions in source category 1.A.4.b

At the beginning of the period, a majority of households in the Czech Republic used coal as a heating fuel (mainly brown coal + lignite). This habit has changed over time and Natural Gas began to be used more than Solid Fuels. The same trend appears in the institutional sphere. The number of households using biomass for heating (biomass boilers) in the Czech Republic has increased in the past few years. This trend is also apparent in Fig. 3-26.

The graph shows that, at the beginning of the period, consumption of fossil fuels dominated in subsector 1.A.4.b, but these were gradually replaced primarily by natural gas and also biofuels (firewood was the preferred substitute in households). The share of liquid fuels (LPG) is negligible. Small annual fluctuations in fuel consumption can be attributed to changing average annual temperatures. A slight decrease can be observed in fuel consumption throughout the Residential sector, affected by the replacement of old boilers with more modern facilities with higher efficiency and most importantly building insulation, which falls under the "Green Savings" national program. The increasing share of biomass has a positive effect in reducing CO_2 emissions, which are included in the total greenhouse gas emissions. While the total fuel consumption in this subsector is generally decreasing slightly (by only about 20%), CO_2 emissions from the combustion of fossil fuels decreased by about 50%.

3.2.19.2 Methodological issues (CRF 1.A.4.b)

No specific methodological approaches were applied - general approaches are given in section 3.2.4.

3.2.19.3 Uncertainties and time-series consistency (CRF 1.A.4.b)

See chapter 3.2.5.

3.2.19.4 Category-specific QA/QC and verification (CRF 1.A.4.b)

See chapter 3.2.6.

3.2.19.5 Category-specific recalculations (CRF 1.A.4.b)

Due to updated CzSO data the recalculation in biofuel consumption was performed in 2011, 2012, 2013, which represent increase for about 4%.

3.2.19.6 Category-specific planned improvements (CRF 1.A.4.b)

Currently there are no planned improvements in this category.

3.2.20 Other Sectors – Agriculture/Forestry/Fishing (1.A.4.c)

The subsector is further divided into:

- Stationary sources – 1.A.4.c.i
- Off-road Vehicles and Other Machinery – 1.A.4.c.ii

The structure of the fuels throughout the subsector 1.A.4.c, their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.4.c, 2014								
Structure of Fuels	**Activity**	**CO_2**			**CH_4**		**N_2O**	
	data	**EF**	**OxF**	**Emission**	**EF**	**Emission**	**EF**	**Emission**
	[TJ]	**[t CO_2/TJ]**		**[kt]**	**[kg CH_4/TJ]**	**[kt]**	**[kg N_2O/TJ]**	**[kt]**
LPG	137.8	65.86*)	1	9.1	5	0.00069	0.1	0.00001
Gasoline	311.0	69.3	1	21.6	10	0.00215	0.6	0.00599
Diesel Oil	13757.1	74.1	1	1019.4	10	0.07475	0.6	0.06795
Fuel Oil - Low Sulphur	118.5	77.4	1	9.2	10	0.00119	0.6	0.00007
Other Bituminous Coal	50.4	94.03*)	0.971*)	4.6	300	0.01512	1.4	0.00007
Brown Coal + Lignite	246.7	98.11*)	0.985*)	24.4	300	0.07402	1.4	0.00035
Coke	28.5	107	1	3.0	300	0.00854	1.4	0.00004
Natural Gas	2374.8	55.30*)	1	131.5	5	0.01187	0.1	0.00024
Wood/Wood Waste	360.0	112	1	40.3	300	0.10800	4	0.00144
Gaseous Biomass	4728.0	55	1	258.1	5	0.02364	0.1	0.00047
Total year 2014	22112.9			1521.2		0.31997		0.07664
Total year 2013	22316.7			1536.3		0.36437		0.07577
Index 2014/2013	0.99			0.99		0.88		1.01
Total year 1990	47 622.9			3 790.2		5.41400		0.08380
Index 2014/1990	0.46			0.40		0.06		0.91

*) *Country specific data*

The high emissions of CH_4 in 1990 is mainly due to the high consumption of other bituminous coal and lignite in the early periods, that have high emission factors (300 kg CH_4/TJ) compared to other fuels. At the end of the period there was a significant decrease in the consumption of solid fossil fuels.

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is detailed in the following outline.

2014							
Structure of Fuels	**Source for**	**Emission factors**			**Method used**		
	Activity data	**CO_2**	**CH_4**	**N_2O**	**CO_2**	**CH_4**	**N_2O**
LPG	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Gasoline	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Diesel Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Fuel Oil - Low Sulphur	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Other Bituminous Coal	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Brown Coal + Lignite	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Coke	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Natural Gas	CzSO	CS	D	D	Tier 2	Tier 1	Tier 1
Wood/Wood Waste	CzSO	D	D	D	Tier 1	Tier 1	Tier 1
Gaseous Biomass	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

This subcategory includes both combustion at stationary sources for heating buildings, breeding and cultivation halls and other operational facilities. These are areas from the agriculture (crop and livestock production), forest and fishing. In rural areas is also about the very energy-intensive operations, such as greenhouses, drying grain and hops.

Unlike previous submission, here are presented also the off-road means of transport and machinery. In accordance with the IPCC 2006 Gl., data on fuel consumption and emission data are divided into two subcategories, as mentioned above. In rural areas is mainly about fuel consumption for land cultivation and harvesting mechanisms, in forestry are mainly mining mechanisms. The fishing area has minor importance in the Czech Republic and is concentrated almost exclusively on fish farming.

In the CzSO Questionnaire (CzSO, 2015), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Agriculture/Forestry
- Fishing

The distribution of fuels is done according to their nature - motor fuels are allocated to the subcategory 1.A.4.c.ii, all other fuels -into subcategory 1.A.4.c.i. This division is subsequently agreed annually with the CzSO during mutual consultation.

There are embodied the fuels of economic part according to NACE Rev. 2 Agriculture/Forestry/Fisheries: NACE Divisions 01 – 03.

The fraction of CO_2 emissions in subsector 1.A.4.c in CO_2 emissions in sector 1.A.4 equalled 8.4% in 2014. It contributed 1.4% to CO_2 emissions in the whole Energy sector.

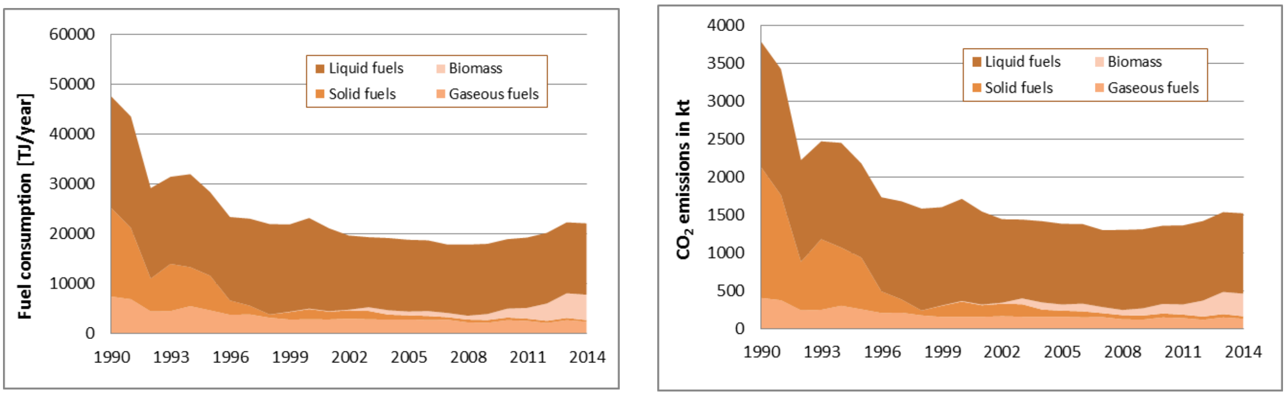


Fig. 3-29 Development of fuels consumption and CO_2 emissions in source category 1.A.4.c

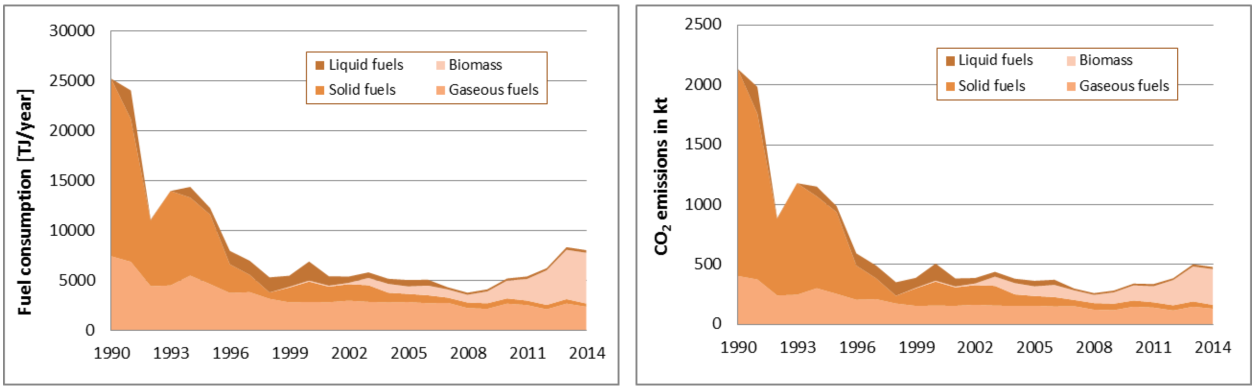


Fig. 3-28 Development of fuels consumption and CO_2 emissions in source category 1.A.4.c.i

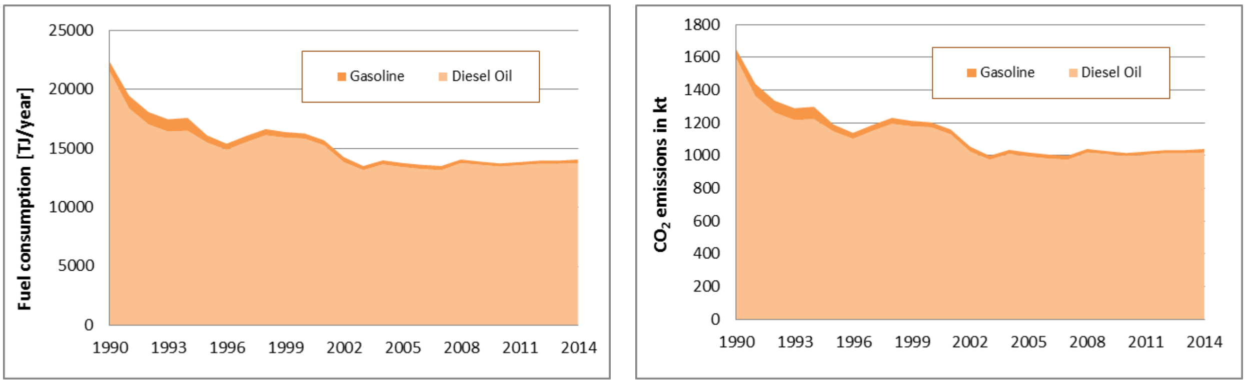


Fig. 3-27 Development of fuels consumption and CO_2 emissions in source category 1.A.4.c.ii

Development of fuel consumption and the corresponding CO_2 emissions throughout the subcategory 1.A.4.c can be seen in Fig. 3-29.

It is evident from the graph on Fig. 3-28 that the trend in the entire subsector and in the overall period is towards liquid fuel (as it will be shown later, mainly related to propellant fuel). Fossil fuels played an important role at the beginning of the period, but their consumption declined over the entire period due to modernisation of the inefficient heating of buildings and processing plants. Biofuels were increasingly used towards the end of the period.

The next chart shows the fuel consumption and the corresponding CO_2 emissions from only stationary sources and the following graphs (Fig. 3-27, Fig. 3-28) depict the consumption of fuels in off-road transportation and other mechanisms in agriculture, forestry and fisheries.

The consumption of fossil solid and liquid fuels decreased decisively in stationary sources. The role of natural gas was virtually stable throughout the period and increased use of biofuels is evident at the end of the period, especially biogas, produced in biogas stations, built on individual agricultural farms.

The consumption of diesel fuels is attributed to a large extent to mobile sources and other mechanisms, where motor gasoline has minor importance and other fuels are virtually absent. A noticeable decrease in fuel consumption was observed roughly in the first half of the period, caused by the higher technical level of engines and especially a decline in the demand in all subsectors for agricultural products.

3.2.20.1 Methodological issues (CRF 1.A.4.c)

The basic requirement for processing fuel consumption from mobile sources is their division between subsectors 1.A.3 Transport, 1.A.4.c.ii Off-road vehicles and other machinery and 1.A.5 Other. This distribution was carried out in coordination with CDV in order to ensure that no fuel is included in the balance twice and that no fuel is omitted. Therefore, the following distribution was performed:

Motor fuels which are consumed in subsector 1.A.4.c.ii are used only for off-road vehicles and other mechanisms.

Motor fuels which are consumed in subsector 1.A.5 are allocated to 1.A.3. This corresponds to fuel consumption by the army (transport on and off road, kerosene jet fuel consumption for air transport), and consumption in the fields of construction, extraction of fuels and minerals, industry (only aerial transport). Furthermore, the consumption of motor fuels for mobile sources in the public sector (ambulance, fire brigade, etc.), both on and off roads, as well as the consumption of aviation fuel are included here.

3.2.20.2 Uncertainties and time-series consistency (CRF 1.A.4.c)

See chapter 3.2.5.

3.2.20.3 Category-specific QA/QC and verification (CRF 1.A.4.c)

QA/QC procedures in this subsector must be coordinated with CDV. KONEKO, as the company responsible for processing the entire sector 1.A, performs before each submission distribution of motor fuels between the various subsectors 1.A.3, 1.A.5 and 1.A.4.c.ii. Simultaneously, after processing the data part of the submission, checks whether the predetermined distribution of fuel was properly applied and if it is necessary proposes corrections in order to avoid double counting of fuels, or their omission.

Other QA/QC and verification - see section 3.2.6.

3.2.20.4 Category-specific recalculations (CRF 1.A.4.c)

No recalculation performed in this submission.

3.2.20.5 Category-specific planned improvements (CRF 1.A.4.c)

Currently there are no planned improvements in this category.

3.2.21 Other (1.A.5)

The subsector is further divided into:

- Stationary sources – 1.A.5.a (Non specified stationary; Emissions from fuel combustion in stationary sources that are not specified elsewhere)
- Mobile sources – 1.A.5.b (Non specified mobile; Mobile Emissions from vehicles and other machinery, marine and aviation (not included in 1.A.4.c.ii or elsewhere). Includes emissions from fuel delivered for aviation and water-borne navigation to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in.)

The structure of fuels throughout the subsector 1.A.5. their consumption, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.A.5.b, 2014								
Structure of Fuels	**Activity data [TJ]**	**CO_2 EF [t CO_2/TJ]**	**OxF**	**Emission [kt]**	**CH_4 EF [kg CH_4/TJ]**	**Emission [kt]**	**N_2O EF [kg N_2O TJ]**	**Emission [kt]**
Gasoline	355.5	69.3	1	24.6	6.90*)	0.00245	19.27*)	0.00685
Kerosene Jet Fuel	686.3	71.5	1	49.1	14.38*)	0.00987	10.26*)	0.00704
Diesel Oil	3181.3	74.1	1	235.7	5.43*)	0.01729	4.94*)	0.01571
Total year 2014	4223.1			309.4		0.02961		0.02960
Total year 2013	4095.9			300.3		0.02852		0.02813
Index 2014/2013	1.03			1.03		1.04		1.05
Total year 1990	n.a.			n.a.		n.a.		n.a.
Index 2014/1990	-			-		-		-

*) *Country specific data*

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is detailed in the following outline.

2014							
Structure of Fuels	**Source of Activity data**	**Emission factors CO_2**	**CH_4**	**N_2O**	**Method used CO_2**	**CH_4**	**N_2O**
Gasoline	CzSO	D	CS	CS	Tier 1	Tier 2	Tier 2
Kerosene Jet Fuel	CzSO	D	CS	CS	Tier 1	Tier 2	Tier 2
Diesel Oil	CzSO	D	CS	CS	Tier 1	Tier 2	Tier 2

Given that all stationary sources have been reported in subsectors 1.A.1., 1.A.2. and 1.A.4., in this subsector (starting with this submission) will be reported only mobile sources, which were not disclosed in the subsectors 1.A.3. and 1.A.4.c.

In accordance with the IPCC 2006 Gl., the subsector 1.A.5.b. is subdivided into:

- 1.A.5.b.i – Mobile (aviation component)
- 1.A.5.b.iii – Mobile (other)

Subsector 1.A.5.bi corresponds to fuel consumption and the corresponding emissions of greenhouse gases from aviation, in addition to public air transport. This is primarily the consumption of aviation fuels by the army, in state institutions (aerial vehicles of the Integrated Rescue System) or private air transport.

Subsector 1.A.5.b.ii is not exploited in the submission of the Czech Republic, especially as it relates to maritime transport, which is not present in the Czech Republic.

Subsector 1.A.5.b.iii is used for reporting all the remaining fuels (and greenhouse gases) that have not been reported elsewhere; it mainly corresponds to the consumption of motor fuels for ground vehicles in the military and in governmental institutions (Integrated Rescue System). Furthermore, it includes the consumption in fields in the construction industry, mining of fuels and minerals and industry (only aerial transport).

The fraction of CO_2 emissions in subsector 1.A.5 in 2014 contributed 0.3% to CO_2 emissions in the whole Energy sector 1.A.

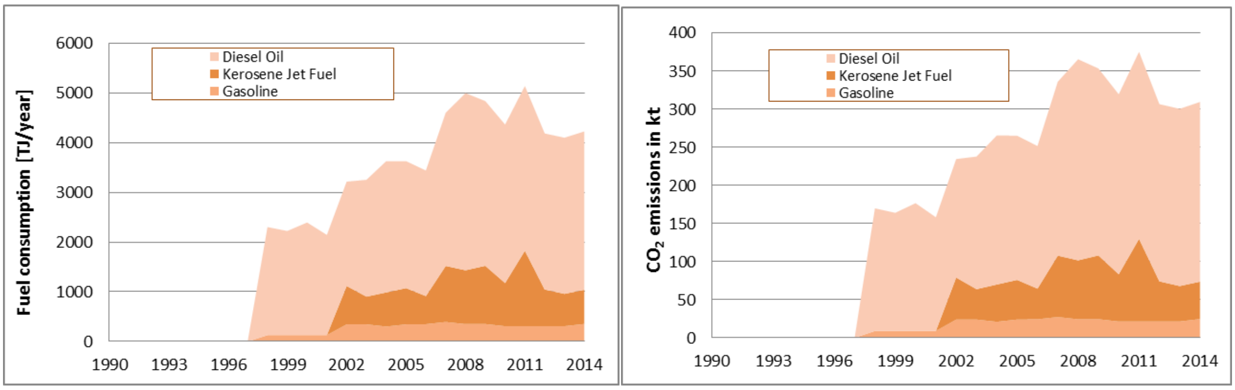


Fig. 3-30 Development of fuels consumption and CO_2 emissions in source category 1.A.5.b.

Development of fuel consumption and the corresponding CO_2 emissions throughout the subcategory 1.A.5.b. are seen in Fig. 3-30.

Data before 1998 are not available in sufficient details. Shares of fuels and corresponding emissions before 1998 are reported in the sector 1.A.3. Transport.

The graph on Fig. 3-30 shows that a decisive proportion has diesel oil, another significant share is appertain to kerosene jet fuel (mainly army), the proportion of gasoline is minor.

3.2.21.1 Methodological issues (CRF 1.A.5.b)

The basic requirement for processing fuel consumption by mobile sources is their division between subsectors 1.A.3 Transport and 1.A.4.c.ii and 1.A.5. This distribution is carried out in coordination with CDV. The aim is to ensure that no fuel is included in the balance twice and that no fuel is omitted. Therefore, the following distribution was performed:

Motor fuels which are consumed in subsector 1.A.4.c.ii are used only for off-road vehicles and other mechanisms in the agricultural sector, forestry and fisheries.

Subsector 1.A.5.b.i reports fuels from aviation, which have been reallocated from consumption in 1.A.3 since 1998. This corresponds to the consumption of kerosene jet fuel by the army and aviation in state organizations (aerial rescue equipment). Subsector 1.A.5.b.iii reports motor fuels for ground transport systems, which have been reallocated from consumption in 1.A.3 since 1998. This corresponds to the consumption of motor fuels for mobile sources by the army and the public sector (ambulance, fire brigade, etc.), both on and off road.

3.2.21.2 Uncertainties and time-series consistency (CRF 1.A.5.b)

See chapter 3.2.5.

3.2.21.3 Category-specific QA/QC and verification (CRF 1.A.5.b)

QA/QC procedures in this subsector must be coordinated with CDV. KONEKO, as the company responsible for processing the entire sector 1.A, evaluates the distribution of motor fuels among the various subsectors 1.A.3, 1.A.5 and 1.A.4.c.ii before each submission. Simultaneously, after processing the data portion of the submission, it checks whether the predetermined distribution of fuels was properly applied and, if necessary, proposes corrections in order to avoid double counting of fuels or their omission.

Other QA/QC and verification - see section 3.2.6.

3.2.21.4 Category-specific recalculations (CRF 1.A.5.b)

No recalculations performed in this submission.

3.2.21.5 Category-specific planned improvements (CRF 1.A.5.b)

Currently there are no planned improvements in this category.

3.3 Fugitive emissions from solid fuels and oil and natural gas and other emissions from energy production (CRF 1.B)

Mining, treatment and all handling of fossil fuels are sources of fugitive emissions. In the Czech Republic, CH_4 emissions from underground mining of Hard Coal are significant, while emissions from surface mining of Brown Coal, Oil and Gas production, transmission, storage and distribution are less important.

The current inventory includes CH_4 emissions for the following categories:

- 1.B.1 Solid fuels
- 1.B.2 Oil and Natural Gas

In 1.B Fugitive Emissions from Fuels category, especially 1.B.1.a Coal Mining and Handling was evaluated as a key category (Tab. 3-1). Category 1.B.2 also was identified as a key category by the latest assessment, but only in one from the four tests (LA). Moreover, identifiers placed this category just over the borderline between key and non-key categories.

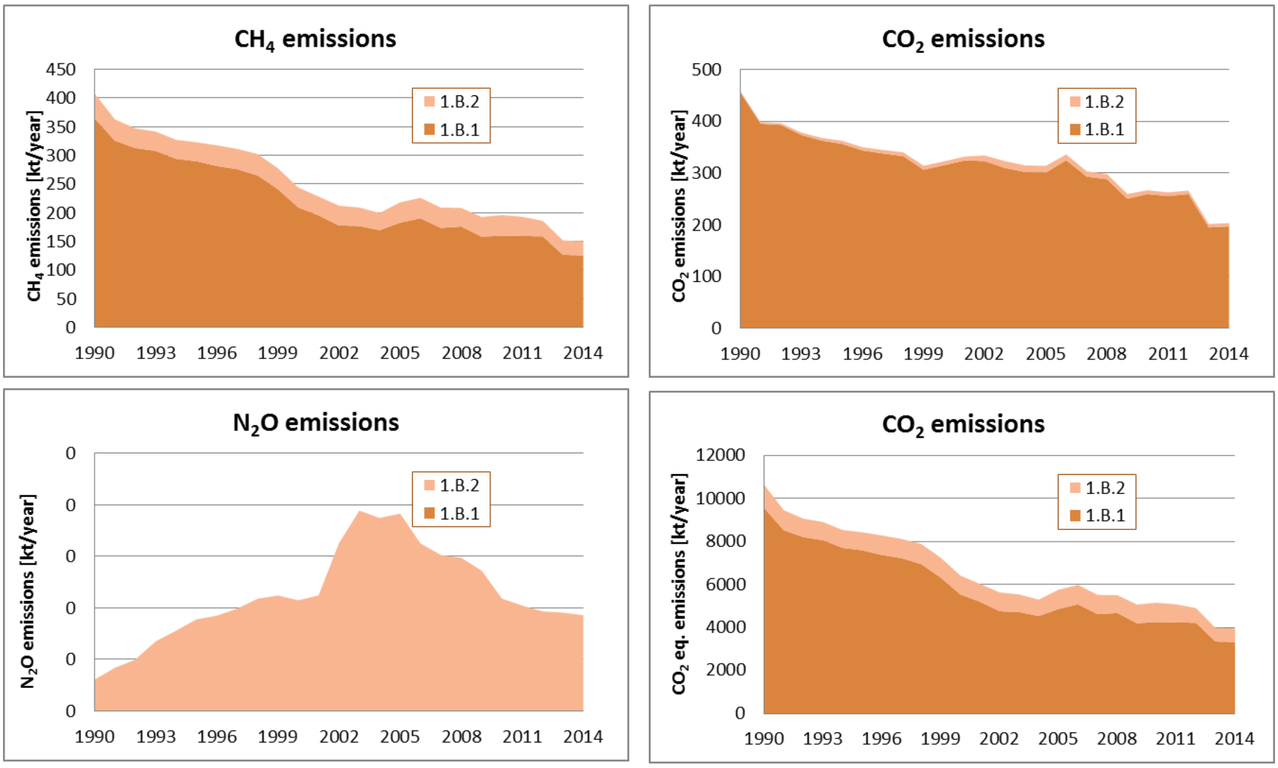


Fig. 3-31 GHG emissions trends from Fugitive emissions from fuels [kt/year]

Development of individual emissions of greenhouse gases in sector 1.B is shown on the graphs in Fig. 3-31.

Sector 1.B is dominated by methane emissions from subcategory 1.B.1. - Solid fuels, while emissions from sector 1.B.2. - Oil and Natural gas represents on average 15% of the total emissions. CO_2 emissions arise primarily in subcategory 1.B.1 - Solid fuels (share of the subcategory 1.B.2 has low importance- about 2% of total CO_2 emissions). N_2O emissions originate only from the subsector 1.B.2.a - Oil and there are insignificant.

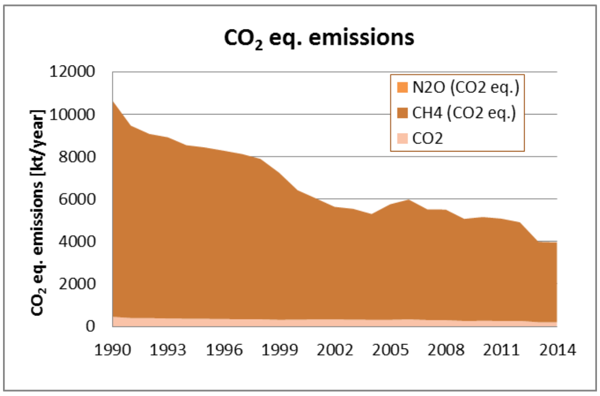


Fig. 3-32 The share of individual GHG emissions from the total emissions, expressed as CO_2 eq. (1.B.)

The importance of individual greenhouse gases from the total emissions, expressed as CO_2 equivalent, is visible from Fig. 3-32.

From the graphs on Fig. 3-31 and Fig. 3-32 is also clear that during the period occurred a significant decrease in GHG emissions across category 1.B. As it is shown below, the decrease was mainly due to a decrease in subcategory 1.B.1. - Solid fuels, in which vital source of emissions is underground mining of hard coal. For 2014, the decrease of total GHG emissions is 62.8% compared to the 1990 level.

3.3.1 Solid Fuels (CRF 1.B.1)

The category is further divided into the following subcategories according to IPCC 2006 Gl.:

- 1.B.1.a Coal mining and handling

- 1.B.1.a.1 Underground mines
  - 1.B.1.a1.i Mining
  - 1.B.1.a.1.ii Post-mining seam gas emissions
  - 1.B.1.a.1.iii Abandoned underground mines
- 1.B.1.a.2 Surface mines
  - 1.B.1.a.2.i Mining
  - 1.B.1.a.2.ii Post-mining seam gas emissions

- 1.B.1.b Solid fuel transformation
- 1.B.1.c Other

3.3.1.1 Category description (CRF 1.B.1)

The structure of the sector, corresponding activity data, used emission factors and emissions of individual greenhouse gases are shown in the following outline.

1.B.1, 2014								
Structure of sector		**Activity data [kt]**	**CH_4 EF [kg CH_4/t]**	**Emission [kt]**	**CO_2 EF [t CO_2/t]**	**Emission [kt]**	**N_2O EF [kg N_2O/t]**	**Emission [kt]**
1.B.1.a	Coal mining/handl.	46 857		125.39		196.83		NA
1.B.1.a.1	Underground mines	8 680		93.22		196.83		NA
1.B.1.a.1.i	Mining		8.75	75.96	22.7	196.83	NA	NA
1.B.1.a.1.ii	Post-mining activ.		1.64	14.25	NA	NA	NA	NA
1.B.1.a.1.iii	Abandoned mines	+)		3.02		NA	NA	NA
1.B.1.a.2	Surface mines	40 385		31.97		NA		NA
1.B.1.a.2.i	Mining		0.77	29.42	NA	NA	NA	NA
1.B.1.a.2.ii	Post-mining activ.		0.067	2.56	NA	NA	NA	NA
1.B.1.b	Solid fuel transformation	6.4	30	0.192	NA	NA	NA	NA
Total year 2014				**125.58**		**196.83**		**NA**
Total year 2013				126.21		194.88		NA
Index 2014/2013				0.99		1.01		NA
Total year 1990				364.79		456.24		NA
Index 2013/1990				0.34		0.43		NA

[*)] Country specific data; +) Methodology and emission factors are explained in 3.3.1.2.

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is shown in detail in the following outline.

2014								
Structure of sector		**Source of Activity data**	**Emission factors CH_4**	**CO_2**	**N_2O**	**Method used CH_4**	**CO_2**	**N_2O**
1.B.1.a	Coal mining/handl.	CzSO				Tier 1-2	Tier 1-2	-
1.B.1.a.1	Underground mines	CzSO				Tier 1-2	Tier 1-2	-
1.B.1.a.1.i	Mining	CzSO	CS	CS	NA	Tier 2	Tier 2	-
1.B.1.a.1.ii	Post-mining activ.	CzSO	D	D	NA	Tier 1	Tier 1	-
1.B.1.a.1.iii	Abandoned mines	various[+)]	D	D	NA	Tier 1	Tier 1	-
1.B.1.a.2	Surface mines	CzSO				Tier 1	Tier 1	-
1.B.1.a.2.i	Mining	CzSO	D	D	NA	Tier 1	Tier 1	-
1.B.1.a.2.ii	Post-mining activ.	CzSO	D	D	NA	Tier 1	Tier 1	-
1.B.1.b	Solid fuel transformation	FAOSTAT	D	D	NA	Tier 1	Tier 1	-

+) Methodology and emission factors are explained in 3.3.1.2.

The source category 1.B.1 Solid Fuels consists of three sub – source categories: source category 1B.1.a Coal mining and Handling, source category 1.B.1.b Coal transformation and source category 1.B.1.c Other.

The main process that emits more than 80% of methane emissions from the category 1.B.1 Solid Fuels category is underground mining of Hard Coal in the Ostrava-Karviná area. A lesser source consists in Brown Coal mining by surface methods and post-mining treatment of Hard and Brown Coal. Coal mining (especially Hard Coal mining) is accompanied by an occurrence of methane. Methane, as a product of the coal-formation process, is physically bonded to the coal mass or is present as the free gas in pores and cracks in the coal and in the surrounding rocks.

Besides methane, during mining of coal mass a certain amount of carbon dioxide is released, that accompanies methane in the firedamp. CO_2 is reported only for the underground mining of hard coal, for surface mining of lignite emission factor is not available.

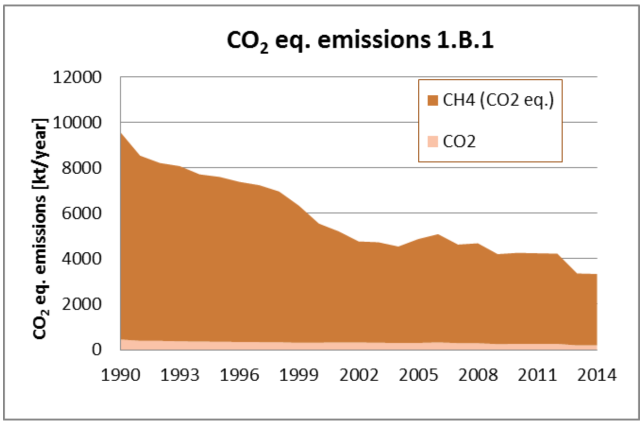


Fig. 3-33 The trend of GHG emissions and the relationship between emissions of CO_2 and CH_4 (1.B.1)

The proportion of subcategory 1.B.2 - Solid fuel transformation in the total emissions of greenhouse gases is quite minor. Subcategory 1.B.1.c - Other is not used, because for reporting the previous subcategories are used.

The graph on Fig. 3-33 shows the time trend of total emissions of greenhouse gases in the entire subsector 1.B.1. The chart also demonstrates the share of CO_2 emissions in the total GHG emissions, which on average makes about 6%.

The contribution of the individual subsectors to the total emissions of CH_4, depending on the volume of mining from underground mines (hard coal) and surface mines (lignite) in category 1.B.1 is shown on the graph in Fig. 3-34.

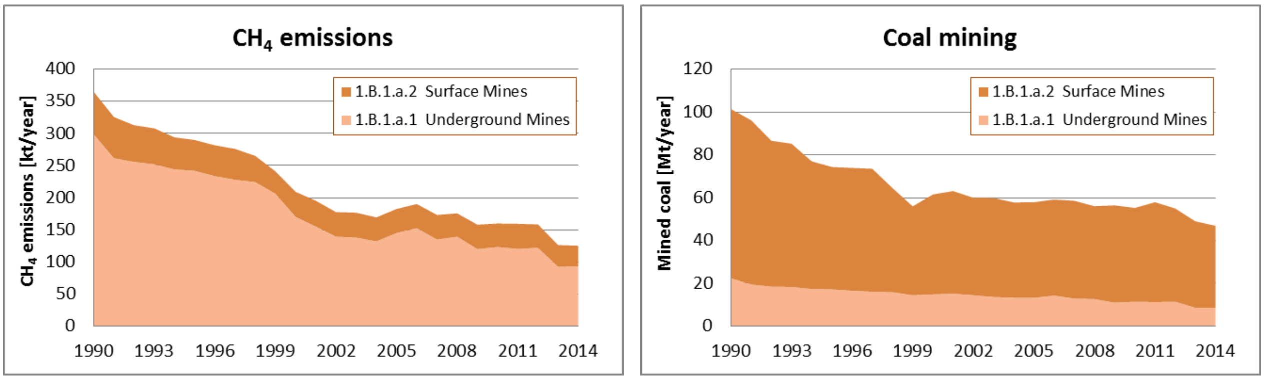


Fig. 3-34 The ratio of methane emissions from Underground mines and Surface mines and the corresponding development of mining of Hard Coal and Lignite (1.B.1)

The Czech Republic has historically mined and is still mining large volumes of lignite, primarily for energy purposes. Hard coal is used for energy purposes, as well as for the production of metallurgical coke. Hard coal mining, although its volume is about 20% of the total volume, is accompanied by considerably more significant CH_4 emissions than mining of lignite.

3.3.1.1.1 Coal Mining and Handling (CRF 1.B.1.a)

In the Czech Republic, mainly Hard Coal is mined in underground mines (i.e. Hard Coal: Coking Coal and Bituminous Coal). Currently, underground mines are in operation in the Ostrava-Karviná coalmining area.

In the past, Hard Coal was also mined in the vicinity of the city of Kladno. These mines were closed in 2003. Brown Coal is mined in only one underground mine in the Northern Bohemia. Emissions from this mine are reported together with surface mining of Brown Coal – Lignite in subcategory 1.B.1.a.2 Surface Mines.

Data for mining of various types of coal are taken from the CzSO report for the IEA/EUROSTAT (the report CZECH_COAL.xls). For control purposes are used data from the miners yearbooks issued by the State Mining Administration and the Employers' Association of Mining and Oil Industries.

Underground Mines (CRF 1.B.1.a.1)

In underground Hard Coal mining, CH_4 is released from the coal mass and from the surrounding rocks into the mine air and must be removed to the surface to prevent formation of dangerous concentrations in the mine.

Underground Mining Activities (1.B.1.a.1.i)

Hard-coal mining is the principal source of fugitive emissions of CH_4. The mine ventilation must be regulated according to the amounts of gas released to keep its concentration on safe level. At the end of 1950’s mine gas removal systems were introduced in opening new mines and levels in the Ostrava – Karviná coal-mining area, which permitted separate exhaustion of partial methane released in the mining activity in the mixture containing the mine air. The total amount of methane emitted can be balanced quite accurately from the methane concentrations in the mine air and their total annual volume.

Post-Mining Activities (1.B.1.a.1.ii)

The activity data are the same as in category 1.B.1.a.1.i Mining Activities. It is assumed that the entire mined volume undergoes manipulation during which residual methane is released.

Abandoned underground mines (1.B.1.a.1.iii)

Abandoned underground mines in the Czech Republic are located in the Kladno Basin (near Kladno, 30 km northwest of Prague) and in the Ostrava-Karvina coalfield - OKR (Northern Moravia). In terms of methane emissions, only the abandoned mines in OKR are relevant. Coal mining in the Kladno Basin was terminated in 2002. Methane was absent in these mines, so that estimation of the methane emissions was carried out only for the OKR mines.

Coal has been extracted in the Ostrava-Karvina coalfield for more than two hundred years. Crucial decline of mining in this area started in 1991, but closure of mines already occurred in the 1920s.

The Ostrava mines have always been significant sources of coal seam gas and, in terms of mine safety regulations, they were categorized under mines with greatest threat of the occurrence of methane. Methane has been observed for more than 100 years and concentrations reached a peak in the nineteen sixties when the mining in Ostrava reached its maximum values. At that time, the daily amount of gas exceeded 500 thousand. m^3 CH_4. The gas was discharged from the mines using ventilation with 17 air pits and mine degassing. The amount of gas from abandoned mines today, after the destruction of almost all the pits, has stabilized at around 40 thousand. m^3 CH_4 per day. Based on the amount of methane that has escaped in recent years and using international experience, it can be forecasted that the gas will continue to be released from the underground spaces in Ostrava for many years.

Parts of abandoned mines have CH_4 recovery systems. A company has established mining areas for mining firedamp in the Ostrava-Karviná area. The abandoned mines contain automatic suction devices and firedamp stations. Firedamp rises from abandoned mining pits and surface boreholes into abandoned areas. Mined firedamp is used at the mining site in autonomous cogeneration units (aggregate for electricity energy production with an ignition combustion engine)(http://www.dpb.cz/).

Surface Mines (CRF 1.B.1.a.2)

Surface Mining Activities (1.B.1.a.2.i)

Lignite (Brown Coal) is mined in surface mines in the Czech Republic. Lignite is mined primarily in the Northern Bohemia area. Small parts of very young Lignite mines are located in Southern Moravia.

Prior to the commencement of surface mining in northern Bohemia, where today a decisive amount of lignite in the Czech Republic is mined, there were underground mines. The abundance of methane in these mines has never been a problem. If there was an explosion in the mines, it was caused by swirling of coal dust. Surface mining began in the 50s of the 20th century and in the period after 1990 the underground mines were already not in use.

Post-Mining Activities (1.B.1.a.2.ii)

The activity data are the same as in category 1.B.1.a.2.i Mining Activities. It is assumed that the entire mined volume undergoes treatment during which residual methane is released.

3.3.1.1.2 Solid Fuel Transformation (CRF 1.B.1.b)

Production of Coke from Coking Coal

Fugitive methane emissions from coal treatment prior to the actual coking process are listed under 1.B.1.a.1.ii Post-Mining Activities. Emissions from the actual production of Coke are given under 2. Industry.

Production of briquettes from Brown Coal

Fugitive methane emissions from coal treatment prior to the actual briquetting process are listed under 1.B.1.a.1.ii Post-Mining Activities. CO_2 emissions from the actual production of briquettes are included in subcategory 1.A.2.g.

Production of charcoal

CH_4 emissions from charcoal production were estimated by using EF provided by the Revised 1996 Guidelines (IPCC, 1997); a value of 1000 kg CH_4/TJ of charcoal produced was used. Since there are no available official activity data about charcoal production in the Czech Republic, the un-official data from FAOSTAT statistics were used. The missing data were extrapolated. The default net calorific value 30 MJ/kg (Table 1-13 in Revised 1996 Guidelines) was used to convert the activity data to energy units. The resulting CH_4 emissions are listed in Tab. 3-27. Unfortunately, the IPCC 2006 Guidelines (IPCC, 2006) do not contain default emissions factors for fugitive emissions from charcoal production. Consequently, the emission factor provided in Firedamp Revised 1996 Guidelines (IPCC, 1997) is still used. Since these emissions are very low, the team considers this approach to be adequate in this case.

Tab. 3-27 CH_4 emissions from charcoal production

1.B.1.b Solid Fuel Transformation			
	Production	Production	CH_4 emissions
	kt/year	TJ/year	kt/year
1990	1.00	30.00	0.03
1991	1.00	30.00	0.03
1992	1.00	30.00	0.03
1993	1.00	30.00	0.03
1994	1.00	30.00	0.03
1995	1.00	30.00	0.03
1996	1.00	30.00	0.03
1997	1.00	30.00	0.03
1998	1.80	54.00	0.05
1999	2.60	78.00	0.08
2000	3.40	102.00	0.10
2001	4.20	126.00	0.13
2002	5.00	150.00	0.15
2003	6.00	180.00	0.18
2004	6.00	180.00	0.18
2005	6.00	180.00	0.18
2006	6.00	180.00	0.18
2007	6.00	180.00	0.18
2008	6.00	180.00	0.18
2009	6.00	180.00	0.18
2010	6.60	198.00	0.20
2011	6.40	192.00	0.19
2012	6.00	180.00	0.18
2013	6.00	180.00	0.18
2014	6.00	180.00	0.18

Fugitive CO_2 emissions are not estimated or are negligible and no known method is available for their determination in this category (notation key NE). Fugitive N_2O emissions are not estimated because, according to the current state of knowledge, these emissions cannot occur (notation key NA) and also IPCC 2006 Guidelines (IPCC, 2006) do not provide default emission factor.

3.3.1.1.3 Other (CRF 1.B.1.c)

No other subcategory of fugitive methane emissions is known in the Czech Republic.

3.3.1.2 Methodological issues

Underground Mines (CRF 1.B.1.a.1)

Underground Mining Activities (1.B.1.a.1.i)

Country specific emission factors were determined for calculation of fugitive methane emissions in underground mines in the second half of the 1990's: the ratio between mining and the volume of methane emissions is given in Tab. 3-28, see (Takla and Nováček, 1997).

Tab. 3-28 Coal mining and CH_4 emissions in the Ostrava - Karvina coal-mining area

	Coal mining	CH_4 emissions	Emission factors
	[mil. t/year]	[mil. m^3/year]	[m^3/t]
1960	20.90	348.9	16.7
1970	23.80	589.5	24.7
1975	24.11	523.8	21.7
1980	24.69	505.3	20.5
1985	22.95	479.9	20.9

	Coal mining	CH_4 emissions	Emission factors
	[mil. t/year]	[mil. m^3/year]	[m^3/t]
1990	20.60	381.1	19.0
1995	15.60	270.7	17.4
1996	15.10	276.0	18.3
Total	**167.31**	**3 375.3**	**20.2**
1990 till 1996	50.76	927.8	18.3

Only the values for 1990, 1995 and 1996 were used from this table to determine the emission factors.

The average value of the emission factor of 18.3 m^3/t was recalculated to 12.261 kg/t using a density of methane of 0.67 m^3/kg. This emission factor is used for coal mined in the Ostrava-Karviná coalmining area for years 1990 - 1999. The emission factor set by estimation at 50% of this value was used for the remaining Hard Coal from underground mines in other areas. This is valid for coal with minimum coal gas capacity (coal from the Kladno area to 2002 and coal from the Žacléř area from 1998).

For the period after 2000 were determined new, revised emission factors CH_4/t mined coal.

The management of OKD, a.s. (Ostrava-Karviná mines, joint share company) was contacted since this company monitors in very detail the issues about methane production. In response to a request from the reporting team, the company provided a document in which the total amount of gas released by OKD mines was determined, together with the amount of methane withdrawn by degassing, the amounts of methane used for industrial purposes, venting of methane from degassing and the total amount of methane released into the atmosphere. A summary of the information provided is given in Tab. 3-28.

Tab. 3-29 Methane production from gas absorption of mines and its use

year	mil.m^3 CH_4 * $year^{-1}$				
	total amount of gas	pumped out by gas absorption	industrial use	venting from gas absorption into the atmosphere	released into the atmosphere - total
2000	236.7	84.1	77.9	6.2	158.8
2001	210.7	73.9	71.1	4.0	140.8
2002	210.0	81.0	70.3	1.3	130.3
2003	200.6	74.8	72.8	2.0	127.8
2004	194.6	77.1	73.4	3.2	120.7
2005	207.7	73.9	70.3	3.6	137.4
2006	221.1	76.9	75.9	0.8	145.0
2007	194.7	71.5	71.0	0.5	123.7
2008	199.5	68.8	68.5	0.3	131.0

These data were used to calculate the emission factors and to determine the average emission factor, which is used for the period after 2000-2008.

The emission factors given in Tab. 3-30 are used for 2000 – 2008. After 2008, the emission factor calculated as the average value from the values for 2000-2008, i.e. 8.12 t/kt, is used. Research with aim to develop this emission factor was performed in 2011.

Tab. 3-30 Calculation of emission factors from OKD mines for period 2000 onwards

year	OKD mining	CH_4 emissions	EF
	[kt/year]	[t/year]	[t CH_4/kt]
2000	11 514	106 396	9.24
2001	11 844	94 336	7.96
2002	12 049	87 301	7.25
2003	11 301	85 626	7.58
2004	10 901	80 869	7.42
2005	10 822	92 058	8.51

year	OKD mining	CH_4 emissions	EF
	[kt/year]	[t/year]	[t CH_4/kt]
2006	11 656	97 150	8.33
2007	10 153	82 879	8.16
2008	10 030	87 770	8.75
2000 - 2008	100 270	814 385	8.12

For years 2000 – 2008 were used emission factors given in Tab. 3-30 for calculation of emission factors from OKD mines. For years onwards 2008 is used average emission factors from the period 2000-2008; 8.12 t/kt of mined hard coal, for period before 1999 the value is same as in previous submission 12.3 t/kt of mined coal (Takla and Nováček, 1997).

This emission factor can be considered as emissions factor on the level Tier II – it is country-specific emission factor, which is applicable for Ostrava-Karviná area.

For other mines in the Czech Republic where hard coal was also mined, the value of 6.7 t/kt was used – the same as in previous submissions. However it is necessary to remind that underground mining in the mines of other areas than OKD is really minor and at the end of the first decade of 21st century was completely stopped.

Country specific emission factors were determined for calculation of fugitive carbon dioxide emissions. An extra study was performed to determine the CO_2 emission factor for underground hard coal mining. Monthly data on the concentrations and amounts of CO_2 were processed for all the exhaust air shafts in the OKD area for 2009, 2010 and for part of 2011. These data yielded an average value of the emission factor, which is related to the volume of mining. The emission factor is equal to 22.75 t CO_2/kt of mined coal and this emission factor is country specific – Tier II level. This value is valid for the OKD area. The author of the study recommended that the determined emission factor for 1990 – 2009 be used. He determined an emission factor 22.68 t CO_2/kt of mined coal for 2010 and it was recommended that this value also be used for the subsequent years. These emission factors were used to extend the data for CO_2 emissions for underground hard coal mining; the values are given in the Tab. 3-31.

Tab. 3-31 Emission factors and emissions from underground mining of hard coal

year	production OKD	emission factor	emission of CO_2
	[kt/year]	[t CO_2/kt]	[kt CO_2/year]
1990	20 059	22.75	456.3
1991	17 371	22.75	395.1
1992	17 271	22.75	392.9
1993	16 419	22.75	373.5
1994	15 942	22.75	362.6
1995	15 661	22.75	356.2
1996	15 109	22.75	343.7
1997	14 851	22.75	337.8
1998	14 620	22.75	332.6
1999	13 468	22.75	306.4
2000	13 855	22.75	315.2
2001	14 246	22.75	324.1
2002	14 200	22.75	323.0
2003	13 614	22.75	309.7
2004	13 272	22.75	301.9
2005	13 227	22.75	300.9
2006	14 280	22.75	324.8
2007	12 886	22.75	293.1
2008	12 622	22.75	287.1
2009	11 001	22.75	250.2
2010	11 435	22.68	259.3

year	production OKD	emission factor	emission of CO_2
	[kt/year]	[t CO_2/kt]	[kt CO_2/year]
2011	11 265	22.68	255.4
2012	11 440	22.68	259.4
2013	8 594	22.68	194.9
2014	8 680	22.68	196.8

Post-Mining Activities (CRF 1.B.1.a.1.ii)

Methane emissions in the subcategory of Post-Mining Activities are calculated using a uniform emission factor based on the default value of 1.64 kg CH_4/t coal; the activity data are employed at the same level as in subcategory 1.B.1.a.1.i Mining Activities.

Tab. 3-32 contains of fugitive methane emissions from post-mining operations with Hard Coal from Underground mines.

Tab. 3-32 Used emissions factors and calculation of CH_4 emissions from underground coal mining – post mines operations in period 1990 - 2014

year	production OKD	emission factor	emission of CO_2
	[kt/year]	[t CO_2/kt]	[kt CO_2/year]
1990	20 059	1.64	34.3
1991	17 371	1.64	29.8
1992	17 271	1.64	29.1
1993	16 419	1.64	28.1
1994	15 942	1.64	27.0
1995	15 661	1.64	26.6
1996	15 109	1.64	25.7
1997	14 851	1.64	25.1
1998	14 620	1.64	24.7
1999	13 468	1.64	22.7
2000	13 855	1.64	23.3
2001	14 246	1.64	23.9
2002	14 200	1.64	23.5
2003	13 614	1.64	22.4
2004	13 272	1.64	21.8
2005	13 227	1.64	21.7
2006	14 280	1.64	23.4
2007	12 886	1.64	21.2
2008	12 622	1.64	20.8
2009	11 001	1.64	18.1
2010	11 435	1.64	18.8
2011	11 265	1.64	18.5
2012	11 440	1.64	18.8
2013	8 594	1.64	14.1
2014	8 680	1.64	14.2

Abandoned underground mines (CRF 1.B.1.a.1.ii)

Calculation of methane emissions from abandoned mines has been carried out in accordance with the IPCC 2006 Gl. methodology at the Tier 1 level. For the purposes of this calculation, the number of closed mines in the Ostrava-Karvina coalfield was determined at the prescribed intervals (1901 – 1925, 1926 – 1950, 1951 – 1975 , 1976 – 2000, 2001 to the present). Given that only mines with a large amount of gas occur in the Ostrava-Karvina coalfield, values for the percentage of coal mines that are gassy from the high column were used (2006 IPCC Guidelines for National Greenhouse Gas Inventories: Tab. 4.1.5: TIER 1 – ABANDONED UNDERGROUND MINES, DEFAULT VALUES - PERCENTAGE OF COAL MINES THAT ARE GASSY, page 4.24.), the following:

1901 – 1925: 0%

1926 – 1950: 50%

1951 – 1975: 75%

1976 – 2014: 100%

Emission factors from Table 4.1.6, p. 4.25 were used for calculating the emissions (TABLE 4.1.6: TIER 1 - Abandoned UNDERGROUND MINES - EMISSION FACTOR, MILLION M3 methane/MINE).

Since 2005, total emissions of methane from abandoned mines have gradually decreased in the context of increased degassing of abandoned mines by the Green Gas company (electricity generation at cogeneration units, stationed for on-site extraction of methane). The overall data and the calculation procedure are shown in Tab. 3-33.

Tab. 3-33 Emission of CH_4 on abandoned mines

year	CH_4 emission in period [kt/year]				Calculated emission	Use of CH_4 [%]	Total emission
	1926 - 1950	1951 - 1975	1976 - 2000	2001 - 2013			
1990	0.46	2.40	0.00		2.86		2.86
1991	0.46	2.36	1.79		4.60		4.60
1992	0.45	2.32	3.96		6.73		6.73
1993	0.45	2.28	7.18		9.90		9.90
1994	0.44	2.24	9.27		11.95		11.95
1995	0.44	2.21	10.49		13.13		13.13
1996	0.43	2.17	10.43		13.04		13.04
1997	0.43	2.14	9.87		12.43		12.43
1998	0.43	2.11	9.38		11.92		11.92
1999	0.42	2.08	9.46		11.96		11.96
2000	0.42	2.05	9.55		12.03		12.03
2001	0.42	2.02	9.19		11.63		11.63
2002	0.41	1.99	8.86		11.27		11.27
2003	0.41	1.97	8.56	1.18	12.12		12.12
2004	0.41	1.94	8.31	0.97	11.63		11.63
2005	0.40	1.92	8.05	0.85	11.22	5.0	10.66
2006	0.40	1.90	7.84	0.76	10.90	7.5	10.08
2007	0.40	1.87	7.62	0.69	10.59	20.0	8.47
2008	0.40	1.85	7.44	0.64	10.33	25.0	7.75
2009	0.39	1.83	7.26	1.80	11.29	50.0	5.65
2010	0.39	1.81	7.09	1.70	10.99	60.0	4.40
2011	0.39	1.79	6.94	1.61	10.73	70.0	3.22
2012	0.38	1.77	6.79	1.53	10.48	70.0	3.15
2013	0.38	1.76	6.65	1.47	10.25	70.0	3.08
2014	0.38	1.74	6.53	1.41	10.05	70.0	3.02

Surface Mines (CRF 1.B.1.a.ii)

Total emissions, used activity data and emission factors for proper extraction of lignite (Brown Coal) from surface mines and post-mining related adjustments are presented in the Tab. 3-34.

Tab. 3-34 Used activity data, emissions factors and calculation of CH_4 emissions from surface coal mining and post mines operations in period 1990 - 2014

year	Brown Coal production	Emission factors for activities		emission of CH_4
		mines	post-mines	
	[kt/year]	[t CH_4/kt]	[t CH_4/kt]	[kt CH_4/year]
1990	78 983	0.77	0.067	66.1
1991	76 680	0.77	0.067	64.2
1992	68 084	0.77	0.067	57.0
1993	66 884	0.77	0.067	56.0
1994	59 568	0.77	0.067	49.9
1995	57 163	0.77	0.067	47.9
1996	57 356	0.77	0.067	48.0
1997	57 446	0.77	0.067	48.1
1998	48 619	0.77	0.067	40.7
1999	41 524	0.77	0.067	34.8
2000	46 655	0.77	0.067	39.1
2001	47 960	0.77	0.067	40.2
2002	45 480	0.77	0.067	38.1
2003	46 240	0.77	0.067	38.7
2004	44 498	0.77	0.067	37.3
2005	44 619	0.77	0.067	37.4
2006	44 849	0.77	0.067	37.6
2007	45 664	0.77	0.067	38.2
2008	43 362	0.77	0.067	36.3
2009	45 416	0.77	0.067	38.0
2010	43 774	0.77	0.067	36.7
2011	46 639	0.77	0.067	39.1
2012	43 533	0.77	0.067	36.5
2013	40 385	0.77	0.067	33.8
2014	38 177	0.77	0.067	32.0

Determination of activity data and emission factors for mining and post-mining treatment is given in the description of the individual activities on surface mines.

Surface Mining Activities (1.B.1.a.2)

Post-Mining Activities (1.B.1.a.2.ii)

Data from the source part of the questionnaire completed in the CzSO Questionnaire (CzSO, 2015), was employed to determine activity data on extraction of Brown Coal and Lignite. The mining yearbooks and other data sources continue to be used only for control purposes.

During surface mining, escaping methane is not related to specific flow of air and thus it is far more difficult to monitor the amount of methane escaping into the air. Consequently, default IPCC emission factors are employed to calculate methane emissions from surface mining and from post-mining treatment (IPCC, 1997).

3.3.1.2.1 Solid Fuel Transformation (CRF 1.B.1.b)

Emission calculation was performed for the production of wood charcoal at Tier I, using default emission factors - see chapter 3.3.1.1.2.

CH_4 emissions from charcoal production were estimated using EF provided by the Revised 1996 Guidelines (IPCC, 1997); a value of 1000 kg CH_4/TJ of charcoal produced was used. Since there are no available official activity data about charcoal production in the Czech Republic, the un-official data from FAOSTAT statistics were used. The missing data were extrapolated. The default net calorific value 30 MJ/kg (Table 1-13 in Revised 1996 Guidelines) was used to convert the activity data to energy units.

Unfortunately IPCC 2006 Guidelines (IPCC, 2006) do not contain default emissions factors for fugitive emissions from charcoal production. the emission factor provided in Revised 1996 Guidelines (IPCC, 1997) is still used. Since these emissions are very low the team consider this approach to be relevant in this case.

3.3.1.3 Uncertainties and time-series consistency

The inventory methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2014. The uncertainties in the activity rate result primarily from inaccuracies in weighing of extracted coal. Extensive research concerning new evaluation of uncertainties was performed last year. Uncertainties in determining the activity data were estimated at 4%.

Uncertainties in calculating methane emissions further follow from the emission factors employed. The emission factors for determining emissions from underground mining of hard coal are based on measurement of the methane concentrations in the air ventilated from underground mines in the second half of the 1990’s. The uncertainty in the emission factors is considered to be at the level of 12.9%.

The uncertainty in the CO_2 emission factor is considered to be at the level of 25%.

Summary of uncertainty estimates provides Tab. 3-35.

Tab. 3-35 Uncertainty estimates for fugitive emissions from Solid Fuels

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
CO_2	1.B.1.a Coal Mining and Handling	4	25	V. Neuzil, P. Fott, AD unc. in line with 2006 Guidelines, EF unc. expert judgement
CH_4	1.B.1.a Coal Mining and Handling	4	13	V. Neuzil, P. Fott, AD unc. in line with 2006 Guidelines, EF unc. expert judgement

3.3.1.4 Category-specific QA/QC and verification

General quality control and source-specific quality control (Tier 1 and Tier 2), in conformance with the requirements of the QSE handbook and its associated applicable documents, have been performed to the full extent.

QC activities at the level of Tier 1 were performed according to the QA/QC plan by the sector compiler. Routine control was performed in the framework of the following activities:

- activity data employed,
- emission factors employed,
- calculation procedures employed,
- transfer of numerical data from the working set to the CRF Reporter.

During control of the activity data, the CzSO data were compared with the data from the Mining Yearbook. Good agreement was found.

In control of the emission factors employed, the emission factors used in the Czech Republic methodology were compared with the emission factors of Slovakia, Poland and Germany in the context with the default emission factors. It was found that the emission factors employed for calculation of emissions in the Czech Republic methodology correspond, in their range, to the emission factors employed in the other countries.

Furthermore, the correct usage of the methodology at Tier I level for the calculation of CH_4 emissions from abandoned mines and the performance of own calculations were checked. The calculation procedure was consulted with an independent expert from the VSB-Technical University of Ostrava. It was concluded that the input data and the method of calculation are in line with the methodology.

Control that the transfer of numerical data from the working set to the CRF Reporter does not reveal any differences. The final working set in EXCEL format is locked to prevent intentional rewriting of values and archived at the coordination workplace. The protocols on the performed QA/QC procedures are stored too.

3.3.1.5 Category-specific recalculations

No recalculations were performed in this submission.

3.3.1.6 Category-specific planned improvements

Given that the issue of emissions from abandoned mines was included in the same time as the transition to new methodology IPCC 2006 Gl., Tier 1 approach was used. Planned improvements assume a change to a higher level, at least Tier II. In terms of the planned improvements, was ensured a cooperation with the specialist on the issue of leakage of methane from abandoned mines in the Ostrava-Karvina coalfield.

In the other sub-sectors no improvements are planned at the present.

3.3.2 Oil and Natural Gas (CRF 1.B.2)

The category is divided according to IPCC 2006 Gl. and CRF Reporter into subcategories:

- 1.B.2.a Oil
  - 1.B.2.a.1 Exploration
  - 1.B.2.a.2 Production
  - 1.B.2.a.3 Transport
  - 1.B.2.a.4 Refining/Storage
  - 1.B.2.a.5 Distribution of Oil Products
  - 1.B.2.a.6 Other
- 1.B.2.b Natural Gas
  - 1.B.2.b.1 Exploration
  - 1.B.2.b.2 Production
  - 1.B.2.b.3 Processing
  - 1.B.2.b.4 Transmission and Storage
  - 1.B.2.b.5 Distribution
  - 1.B.2.b.6 Other
- 1.B.2.c Venting and Flaring
  - 1.B.2.c.1 Venting
  - 1.B.2.c.2 Flaring

3.3.2.1 Category description (CRF 1.B.2)

The structure of the sector, the corresponding activity data, the used emission factors and emissions of individual greenhouse gases can be seen on the following outline.

1.B.2, 2014									
Structure of sector		**Activity data [PJ]**	**CH_4 EF [t CH_4/PJ]**	**CH_4 Emission [kt]**	**CO_2 EF [t CO_2/PJ]**	**CO_2 Emission [kt]**	**N_2O EF [kg N_2O/PJ]**	**N_2O Emission [kt]**
1.B.2.a.1	Exploration	NO						
1.B.2.a.2	Production and Upgr.	6.36	4.746	0.030	7.576	0.048	NA	-
1.B.2.a.3	Transport	317.0	0.146	0.046	0.013	0.004	NA	-
1.B.2.a.4	Refining	317.0	0.585	0.185	NA	-	NA	-
1.B.2.a.5	Distrib. of Oil Prod.	316.9824	NA	-	NA	-	NA	-
1.B.2.a.6	Other	NO						
1.B.2.b.1	Exploration	NO						
1.B.2.b.2	Production	8.819	38.649	0.341	+)	0.0001	NA	-
1.B.2.b.3	Processing	NO						
1.B.2.b.4	Transmission and	1 398.3	4.314	6.032	+)	0.024	NA	-
	Storage	145.6	4.372	0.637	+)	0.003	NA	-
1.B.2.b.5	Distribution	115.0	141.3	16.25	+)	0.065	NA	-
1.B.2.b.6	Other	I.E.						
1.B.2.c.1	Venting - Oil	6.36	235.4	1.497	48.70	0.310	NA	-
1.B.2.c.2	Flaring - Oil	6.36	0.568	0.004	919.9	5.851	0.015	0.0001
Total year 2014				**25.02**		**6.30**		**0.0001**
Total year 2013				25.12		6.47		0.0001
Index 2014/2013				0.996		0.97		0.97
Total year 1990				43.2		2.202		0.00003
Index 2014/1990				0.58		2.86		3.05

*) *Country specific data;*
+) As emission factor is used the average annual CO_2 content in natural gas

The origin of the data, the emission factors used and the method of calculating the level of emissions for each gas is shown in details in the following outline.

2014								
Structure of sector		**Source of Activity data**	**Emission factors CH_4**	**Emission factors CO_2**	**Emission factors N_2O**	**Method used CH_4**	**Method used CO_2**	**Method used N_2O**
1.B.2.a.1	Exploration	NA						
1.B.2.a.2	Production and Upgrading	CzSO	CS	D	NA	Tier 2	Tier 1	-
1.B.2.a.3	Transport	CzSO	D	D	NA	Tier 1	Tier 1	-
1.B.2.a.4	Refining	CzSO	D	NA	NA	Tier 1	-	-
1.B.2.a.5	Distribution of Oil Products	NA						
1.B.2.a.6	Other	NO						
1.B.2.b.1	Exploration	NO						
1.B.2.b.2	Production	CzSO	CS	CS	NA	Tier 2	Tier 2	-
1.B.2.b.3	Processing	NO						
1.B.2.b.4	Transmission and	CzSO	CS	CS	NA	Tier 2	Tier 2	-
	Storage	ERU	CS	CS	NA	Tier 2	Tier 2	-
1.B.2.b.5	Distribution	ERU	CS	CS	NA	Tier 2	Tier 2	-
1.B.2.b.6	Other	NO						
1.B.2.c.1	Venting - Oil	CzSO	D	D	NA	Tier 1	Tier 1	-
1.B.2.c.2	Flaring - Oil	CzSO	D	D	D	Tier 1	Tier 1	Tier 1

Approximately 93% of emissions are formed in the Czech Republic from gas industry in extraction, storage, transport and distribution of Natural Gas and in its final use. Crude Oil extraction and refining processes are very less important.

Determination of methane emissions from the processes of refining of Crude Oil is based on the recommended (default) emission factors according to the 2006 IPCC methodology.

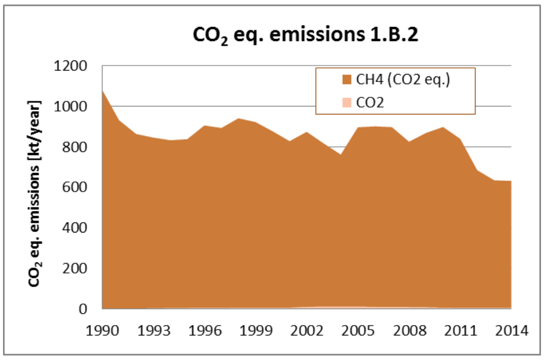


Fig. 3-35 The trend of GHG emissions and the relationship between CO_2 and CH_4 emissions (1.B.2)

Methane emissions from the gas industry were determined using national emission factors based on the specific emission factors for the individual parts of the gas industry system.

The graph in Fig. 3-35 gives an overview of the trend in emissions in this category in the time series since 1990.

The graph on Fig. 3-35 shows that the proportion of total CO_2 emissions from the total GHG emissions is negligible (approximately 0.1%).

The contribution of the individual subsectors (Oil and Natural Gas) to the total CH_4 emissions throughout the period in the category 1.B.2 is shown on Fig. 3-36.

As shown on Fig. 3-36 for the amount of CH_4 emissions in sector 1.B.2. Oil and Natural Gas are therefore crucial the emissions, produced in the gas industry.

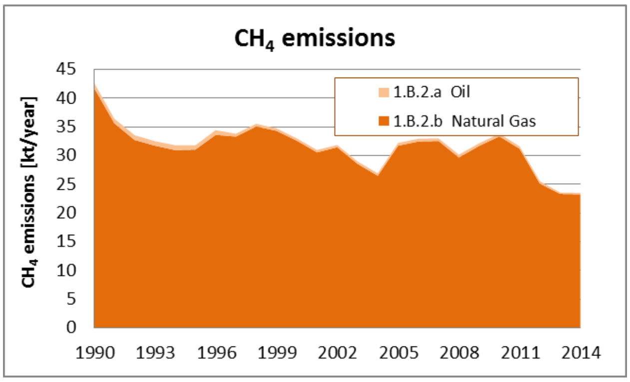


Fig. 3-36 The ratio of methane emissions from subsector Oil (1.B.2.a) and Natural Gas (1.B.2.b)

3.3.2.1.1 Oil (CRF 1.B.2.a)

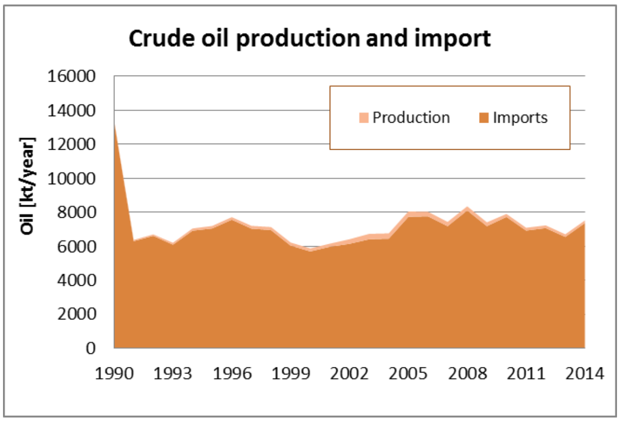


Fig. 3-37 Crude Oil production end import in the CR in 1990 – 2014

In subcategory Oil are reported emissions from mining, processing of domestic crude oil and emissions from refining of imported crude oil. The share of domestic crude oil is very small - about 3% (from 0.7 to 4.8%). The time profile of domestic production and imports of crude oil in the Czech Republic is shown on Fig. 3-37.

GHG emissions from Crude Oil transport and refining and from Crude Oil production, which is performed in the Czech Republic in combination with mining of Natural Gas, are reported in this category. CO_2 emissions from the refinery resulting from combustion processes (including flaring) are included in 1.A.1.b Crude Oil Refining.

Exploration (1.B.2.a.iii.1)

Exploration is not systematically performed in the Czech Republic.

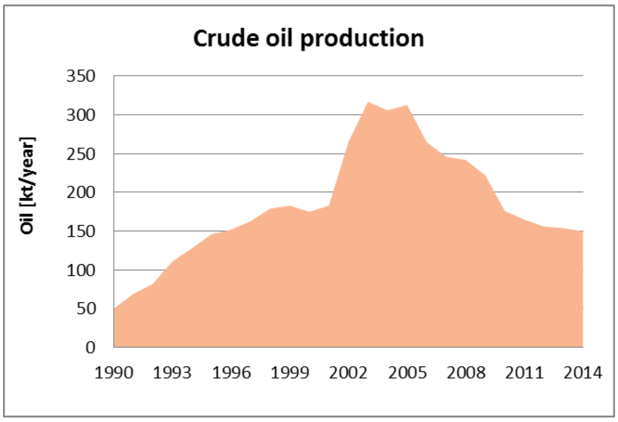


Fig. 3-38 Crude Oil production in the CR in 1990 – 2014

Production and Upgrading (1.B.2.a.iii.2)

Crude Oil is mined in the Czech Republic in Southern Moravia. The following Fig. 3-38 gives the amount of mined Crude Oil in the territory of the Czech Republic.

The quantity of crude oil extracted in each year depends on the amount of recoverable reserves. From Fig. 3-38 is visible that the maximum extraction was in the period from 2003 to 2006. It is expected that the decline in production until 2014 will continue.

Transport (1.B.2.a.iii.3)

Transport of Crude Oil in the territory of the Czech Republic is performed only in closed systems (pipeline transport – Oil pipeline Družba from Russia and Ingolstat from Germany). Default emission factors were used to calculate fugitive CH_4 and CO_2 emissions in this subsector.

Refining (1.B.2.a.iii.4)

Crude Oil is processed in the territory of the Czech Republic in two main refinery facilities. The total volume of Crude Oil processed in the Czech Republic is presented in Fig. 3-38.

Distribution of Oil Products (1.B.2.a.iii.5)

The final products after processing Crude Oil no longer contain dissolved methane or carbon dioxide and thus fugitive emissions are not considered in this subcategory. For completeness, activity data corresponding to the volume of processed Crude Oil in the individual years were recorded in CRF.

Other (1.B.2.a.iii.6)

No other operations are considered.

3.3.2.1.2 Natural Gas (CRF 1.B.2.b)

In the subcategory Natural Gas are reported GHG emissions from domestic natural gas production and emissions related to the operation of individual parts of the gas system (import, transit, storage and distribution to end users). The share of the domestic natural gas production is very

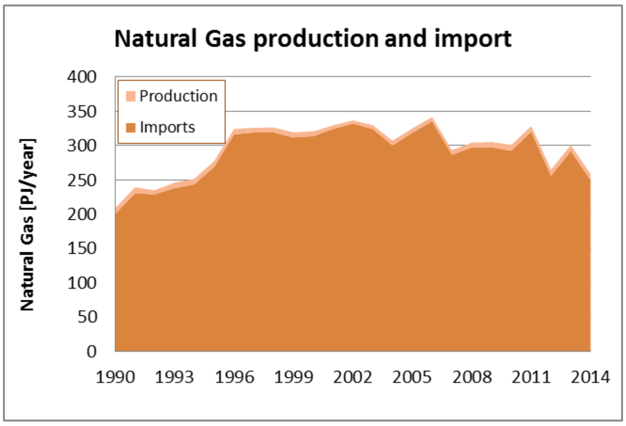


Fig. 3-39 Natural Gas production end import in the CR in 1990 – 2014

small - about 3% (from 1.4 to 4.8%). The time profile of domestic production and import of natural gas in the Czech Republic is shown on Fig. 3-39.

Exploration (1.B.2.b.iii.1)

Emissions formed in exploratory boreholes are reported in this subcategory. This activity is not performed in the Czech Republic, or only completely random.

Production (1.B.2.b.iii.2)

Natural Gas is extracted in the Czech Republic in the area of Southern Moravia, accompanying extraction of Crude Oil, and in Northern Moravia, where it is derived from degassing of hard coal deposits. The following Fig. 3-40 gives the amount of production Natural Gas in the territory of the Czech Republic.

The development of domestic extraction is relatively stable over time. Fluctuations in individual years are due to technical and geological conditions of mining and market demand.

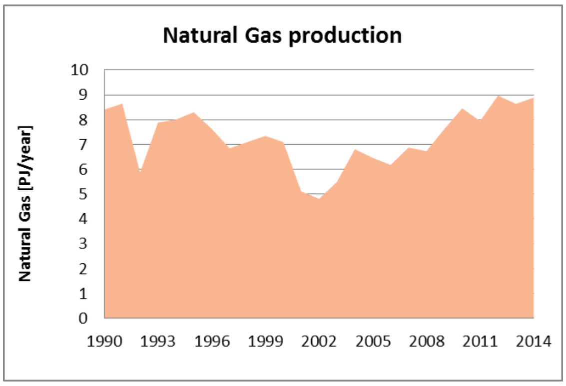


Fig. 3-40 Natural Gas production in the area of CR in 1990 – 2014

Processing (1.B.2.b.iii.3)

Gas treatments, except for drying, are not performed in the Czech Republic. The drying process is not a source of GHG emissions.

Transmission and Storage (1.B.2.b.iii.4)

The calculation of GHG emissions in this subcategory, is carried out in two steps: independently in the first step is carried out an estimation of the emissions for the transit system and high-pressure gas pipelines, and in the second step emissions from underground gas storage facilities are estimated. For each part of the gas system is used a different methodological approach.

A transit gas pipeline runs through the territory of the Czech Republic, transporting Natural Gas from Russia to the countries of Western Europe, with a length of 3,779 km. In addition to this central gas pipeline, a system of high-pressure gas pipelines is in operation in the territory of the Czech Republic, providing supplies of Natural Gas from the transit gas pipeline and underground gas storage areas to centres of consumption. In 2014, the high-pressure gas pipelines had an overall length of 13,028 km.

This subcategory also includes all the technical equipment on high-pressure gas pipelines. On the transit gas pipeline, this consists primarily of compressor stations and transfer stations, while measuring and regulation stations are located on domestic long-distance gas pipelines.

Methane emissions formed during controlled technical discharge of Natural Gas at compressor stations, during inspections and repairs to pipelines and emissions from pipeline accidents are estimated. These emissions are recorded by the gas companies. In addition, escapes of Natural Gas from leaks in the entire pipeline system, including technical equipment, are also evaluated.

Emissions from storage (injection and mining) of Natural Gas in the territory of the Czech Republic are reported in this subcategory. The total turnover (injection and mining) of Natural Gas in underground storage areas corresponded to 4,277 mil. m^3 in 2014.

Distribution (1.B.2.b.iii.5)

Emissions from distribution gas pipelines, with an overall length in 2014 of 48,334 km, and during consumption at the end consumer are reported in this category. The distribution networks are being continuously lengthened and the number of customers is increasing.

Other (1.B.2.b.iii.6)

No additional emissions are reported.

3.3.2.1.3 Venting and Flaring (CRF 1.B.2.c)

In the Czech Republic there is only one deposit, which is in South Moravia. Crude oil extraction takes place there, along with natural gas production.

Tab. 3-35 gives the CH_4 and CO_2 emissions from Venting for domestic production (mining) of Crude Oil; N_2O emissions are not included in this subcategory since no emission factor is available for their calculation. Tab. 3-36 further contains values of emissions CH_4, CO_2 and N_2O from Flaring in domestic production of Crude Oil. From the table it is clear that this is a minor proportion from the total emissions in whole subcategory Oil and Gas (1.B.2.a).

Tab. 3-36 Emissions of CH_4, CO_2 and N_2O from Venting and Flaring in 1990 – 2014

	Venting - emissions [t/year]		Flaring - emissions [t/year]		
	CH_4	CO_2	CH_4	CO_2	N_2O
1990	0.49	0.10	0.001	1.92	0.00003
1991	0.68	0.14	0.002	2.64	0.00004
1992	0.80	0.17	0.002	3.14	0.00005
1993	1.09	0.23	0.003	4.25	0.00007
1994	1.25	0.26	0.003	4.90	0.00008
1995	1.43	0.30	0.003	5.59	0.00009
1996	1.49	0.31	0.004	5.82	0.00009
1997	1.60	0.33	0.004	6.24	0.00010
1998	1.75	0.36	0.004	6.85	0.00011
1999	1.81	0.37	0.004	7.06	0.00011
2000	1.73	0.36	0.004	6.76	0.00011
2001	1.81	0.37	0.004	7.06	0.00011
2002	2.62	0.54	0.006	10.24	0.00016
2003	3.13	0.65	0.008	12.23	0.00019
2004	3.02	0.62	0.007	11.78	0.00019
2005	3.08	0.64	0.007	12.05	0.00019
2006	2.62	0.54	0.006	10.23	0.00016
2007	2.44	0.50	0.006	9.52	0.00015
2008	2.39	0.50	0.006	9.35	0.00015
2009	2.19	0.45	0.005	8.58	0.00014
2010	1.76	0.36	0.004	6.86	0.00011
2011	1.65	0.34	0.004	6.44	0.00010
2012	1.56	0.32	0.004	6.08	0.00010
2013	1.54	0.32	0.004	6.01	0.00010
2014	1.50	0.31	0.004	5.85	0.00009

3.3.2.2 Methodological issues

During the 1990's, Czech refineries have undergone a quite extensive process of innovation and reconstruction, to decrease technical losses of raw materials and final products. Comprehensive verification has been carried out of the seals of the individual fittings, pumps and all the technical equipment. This entire process, which was carried out mainly for economic reasons, also led to a decrease in overall emissions, especially of NMVOCs. Consequently, the emission factors taken from the

IPCC methodology (IPCC, 2006) can be considered to correspond to the current technical condition of refineries in this country. In this connection, it should be pointed out that fugitive emissions from refinery technology couldn't be determined by direct measurements, as they are not connected with specific air outlets or chimneys. Thus, they can be determined only on the basis of professional estimates from balance losses or using emission factors. The resultant emissions of the individual substances were compared with the data in the national emission database and are of the same order of magnitude.

In general, it can be stated that fugitive greenhouse gas emissions occur in this subcategory only in operations in which Crude Oil saturated in carbon dioxide and methane is in contact with the atmosphere. All operations involving Crude Oil in the Czech Republic are hermetically sealed. Thus, fugitive emissions are formed only through leaks in the technical equipment. Following thermal treatment of Crude Oil, the resultant products no longer contain any dissolved gases and no fugitive emissions need be considered in subsequent operations.

3.3.2.2.1 Oil (CRF 1.B.2.a)

CH_4 emissions from Crude Oil transport and refining and from Crude Oil mining, which is performed in the Czech Republic in combination with mining of Natural Gas, are reported in this category. CO_2 emissions from the refinery resulting from combustion processes (including flaring) are included in 1.A.1.b Crude Oil Refining.

Exploration (1.B.2.a.iii.1)

Exploration is not systematically performed in the Czech Republic. For this reason, there are no known procedures for the determination of emissions in this subsector.

Activity data: number of mined boreholes – notation key NO, default emission factors have not been published for CO_2 and CH_4 – notation key NO. N_2O emissions: notation key NA: N_2O emissions are practically not formed in exploratory work.

Production and Upgrading (1.B.2.a.iii.2)

Activity data for determining CH_4 and CO_2 emissions are taken from the CzSO – IEA questionnaires and controlled using data from the Mining Yearbook.

CH_4 emissions are determined as the product of annual Crude Oil mining and the emission factor. The emission factor has a value of 4,792 kg/PJ and was determined on the basis of published data in (Zanat et al.,1997). The emission factor was determined as the sum of the individual emission factors from pumping of raw Crude Oil and from storage of raw Crude Oil. These data were obtained by direct measurement. The resultant emission factor was increased by an estimate of fugitive emissions at mining boreholes (probes).

CO_2 emissions are estimated based on the default emission factor (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 4.2.4, Tier 1 Emission factors for fugitive emissions from Oil and Gas operation in developed countries, page 4.52).

EF CO_2: 2.8E-04 kt per 10^3 m^3 total oil production = 7 576 kg/PJ

For the estimation of N_2O emissions, no emission factor was available.

Transport (1.B.2.a.iii.3)

In this case, the activity data correspond to the total amount of petroleum transported through the territory of the Czech Republic by the pipeline system in the individual years. This amount corresponds to the Total Crude Oil input to refineries. The default emission factors from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 4.2.4, Tier 1 Emission factors for fugitive emissions from Oil and Gas operation in developed countries, page 4.52 are employed to calculate the CH_4 and CO_2 emissions.

EF CH_4: 5.4E-06 kt per 10^3 m^3 oil transported by pipeline = 146 kg/PJ

EF CO_2: 4.9E-07 kt per 10^3 m^3 oil transported by pipeline = 13 kg/PJ

These emission factors were used to calculate fugitive emissions for the years since 1990.

For the estimation of N_2O emissions, no emission factor was available.

Refining (1.B.2.a.iii.4)

Methane emissions from refining are calculated using IPCC Tier 1 methodology (Table 4.2.4 in 2006 IPCC Guidelines). Emissions are calculated by multiplying the amount of Crude Oil input to refinery by the emission factor. The emission factor value used was 585 kg/PJ.

This emission factor is based on the data from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Table 4.2.4, Tier 1 Emission factors for fugitive emissions from Oil and Gas operation in developed countries, page 4.52

EF CH_4: 2.6×10^{-6} to 41.0×10^{-6} kt per 10^3 m^3 oil refined = 585 kg/PJ (average)

The IPCC method does not give any EF for CO_2 or N_2O. Consequently, the notation key NA is used in CRF.

Distribution of Oil Products (1.B.2.a.iii.5)

The available IPCC methodology does not provide any EF for CO_2, CH_4 or N_2O – notation key – NA. The products which originate during oil processing cannot contain CO_2 or CH_4. There isn't known process by which could arise fugitive CO_2 or CH_4 emissions during the distribution of oil products.

Other (1.B.2.a.iii.6)

Activity data: notation key: NO; CH_4, CO_2 and N_2O emissions – notation key NO.

3.3.2.2.2 Natural Gas (CRF 1.B.2.b)

Leakages in the distribution network and household distribution pipes can be considered to constitute the most serious source of emissions. In the 1990's, the distribution network was newly constructed almost entirely from welded plastics and the old pipeline was reconstructed to a major degree in the same manner. Household distribution pipes are subject to strict standards and any poor seals can be identified by the characteristic smell. In addition to safety aspects, all leakages also have an economic impact both for the distribution company and for the end user, so this aspect is carefully monitored and, as soon as possible, immediately remedied. As a whole, the gas distribution in the CR is at a high technical level and it can be stated that all leakages are carefully sought out and eliminated.

As a method was developed in the last few years for determining methane emissions in the gas industry using specific emission factors, this sophisticated method of calculation continues to be used, although, from the standpoint of ref. (IPCC, 2006), calculation using default values would probably suffice. Qualified estimation of methane emissions is thus carried out using specific emission factors for the individual parts of the gas industry system (Table 4.2.8. Classification of Gas losses as low, medium or high at selected types of Natural gas facilities, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, page 4.71)

The total emission value given corresponds to about 0.3% of the total consumption of Natural Gas in the Czech Republic. The detailed calculation given corresponds to Tier 2.

In general, it can be stated that the determined methane emissions in category 1.B.2 Gas are basically formed in several ways:

- through poor seals in the flanges and joints, fittings, probes in mining and storage fields and other parts of the pipeline system,
- through pipeline perforation,
- through technical discharge of gas into the air,
- through accidents.

Exploration (1.B.2.b.iii.1)

Exploration is not performed in the Czech Republic and thus the notation key NO is used in the CRF Report for the emissions and activity data.

Production (1.B.2.b.iii.2)

Transmission and Storage (1.B.2.b.iii.4)

Distribution (1.B.2.b.iii.5)

Fugitive methane emissions are calculated in these subcategories using an internal calculation model based on the methodology proposed in 1997 in IGU (Alfeld, 1998). Calculations of emissions are supplemented by data from the national Integrated Pollution Register (IPR) and investigations at individual distribution companies on registered units of Natural Gas.

Tab. 3-37 Model calculation of CH_4 emissions in the Natural Gas sector (2014)

	EF		Activity data		Losses of NG
	value	units	value	units	mil.m^3/year
production	0.2	% vol.	259	mil. m^3	0.51
high pressure pipelines	600	m^3/km.year	13 028	km	7.68
transmission pipelines*)					1.15
compressors)**					0.20
storage*)**					1.10
regulation stations	1 000	m^3/station	4 465	pcs	4.39
distribution network	300	m^3/km.year	48 428	km	14.27
final comsumption	2	m^3/consumer	2 849 164	pcs	5.60
Total					**34.71**
	Emissions in kt (0.67 kg/m^3)				**23.34**

*) *data from IRZ (Integrated Pollution Register of Czech Republic – Czech version of E-PRTR) - company NET4GAS*
**) *data from operating records of leakage Natural Gas - company RWE*
***) *data from operating records of leakage Natural Gas - company RWE Gas Storage*

Emissions calculated in this model are then transformed to the structure of the sectors and subsectors according to the IPCC methodology.

3.3.2.2.3 Venting and Flaring (CRF 1.B.2.c)

The estimations of CO_2, CH_4 and N_2O emissions from venting and flaring in the course of oil production were obtained by using the default EFs provided by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (see table 4.2.4, pages 4.48 – 4.54). In this case the following EFs were taken:

Venting (Default Weighted Total)

CH_4: 8.7E-03 kt per 10^3 m^3 total oil production

CO_2: 1.8E-03 kt per 10^3 m^3 total oil production

N_2O: NA

Flaring (Default Weighted Total)

CH_4: 2.1E-05 kt per 10^3 m^3 total oil production

CO_2: 3.4E-02 kt per 10^3 m^3 total oil production

N_2O: 5.4E-07 kt per 10^3 m^3 total oil production

Owing to the fact that activity data are required in kg/PJ, the value was converted to kg/PJ by using the typical value of density for crude oil of 880 kg/t and value NCV was taken from CzSO questionnaires IAE as a simple average for domestic oil (42 MJ/kg):

Venting

CH_4: 235 390 kg/PJ

CO_2: 48 701 kg/PJ

Flaring

CH_4: 568.2 kg/PJ

CO_2: 919 913 kg/PJ

N_2O: 14.61 kg/PJ

3.3.2.3 Uncertainties and time-series consistency

The inventory methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2009. Uncertainties in determining the activity data are estimated at 7%. This estimate is based on the precision of measurement of the volumes of Crude Oil, Crude Oil products and Natural Gas.

The emission factors for determining emissions in extraction of Natural Gas and Crude Oil are based on specific measurements, accompanied by an error of approx. 10%. Emission factors used to determine emissions in transport and distribution of Natural Gas are based on isolated measurements and estimates by experts in the gas industry. The uncertainty in these emission factors is considered to be at the level of 25%. Determination of gas leaks in technical operations, starting-up of compressors and accidents, as appropriate, are evaluated on the basis of calculations with knowledge of the necessary technical parameters, such as the gas pressure, pipeline volume, etc. The uncertainties then correspond to knowledge of these technical parameters – 10%. The other emission factors were taken from the IPCC methodology as default values, considered to have an uncertainty of 80% in this methodology. Overall, the uncertainty in the emission factors in category 1.B.2 Oil and Natural Gas is estimated to equal 75%.

Summary of uncertainty values provides Tab. 3-38.

Tab. 3-38 Uncertainty estimates for fugitive emissions from Oil and Natural Gas

Gas	Source category	AD uncertainty [%]	EF uncertainty [%]	Origin of actual level of uncertainty
CO_2	1.B.2 Oil and Natural Gas	7	75	V. Neuzil, P. Fott, AD and EF unc. in line with 2006 Guidelines
CH_4	1.B.2 Oil and Natural Gas	7	75	V. Neuzil, P. Fott, AD unc. in line with 2006 Guidelines, EF unc. expert judgement

3.3.2.4 Category-specific QA/QC and verification

General quality control and source-specific quality control (Tier 1 and Tier 2), in conformance with the requirements of the QSE handbook and its associated applicable documents, have been performed to the full extent.

QC activities at the level of Tier 1 were performed according to the QA/QC plan by the sector compiler. Routine control was performed in the framework of the following activities:

- activity data employed,
- emission factors employed,
- calculation procedures employed,
- transfer of numerical data from the working set to the CRF Reporter.

In control of the activity data, the CzSO data were compared with the data from the Mining Yearbook (Mining Yearbook, 2015) and with data obtained by an investigation at the individual gas distribution companies. Good agreement was found. In control of the emission factors employed, the emission factors used in the Czech Republic methodology were compared with the emission factors of Slovakia, Poland and Germany in the context with the default emission factors. It was found that the emission factors employed for calculation of emissions in the Czech Republic methodology correspond, in their range, to the emission factors employed in the other countries. Comparison of the emission factors used in the Czech Republic with the emission factors of the surrounding countries corresponds to the level of Tier 2.

Control of the transfer of numerical data from the working set to the CRF Reporter did not reveal any differences.

The final working set in EXCEL format was locked to prevent intentional rewriting of values and archived at the coordination workplace.

The protocols on the performed QA/QC procedures are stored in the archive of the sector compiler.

3.3.2.5 Category-specific recalculations

No recalculations were performed in this submission.

3.3.2.6 Category-specific planned improvements

Currently there are no planned improvements in this category.

3.4 CO_2 transport and storage (CRF 1.C)

Not performed in the Czech Republic.

4 Industrial processes and product use (CRF Sector 2)

The sector of industrial processes of GHG emission inventory includes emissions from technological processes and not from fuel combustion used to supply energy for carrying out these processes. Consistent emphasis is put on the distinction between the emissions from fuel combustion in the Energy sector and the emissions from technological processes and production.

For example, in the production of cement, consideration is given only to emissions derived from the thermal decomposition of mineral raw materials (specifically CO_2 emissions from the decomposition of limestone) and not from fuel used to heat the rotary kiln (considered in category 1.A.2.f). However, the situation in iron and steel production is more complicated. Evaluation of the CO_2 emissions is based on consumption of metallurgical coke in blast furnaces, where coke is used dominantly as a reducing agent (iron is reduced from iron ores), even though the resulting blast furnace gas is also used for energy production, mainly in metallurgical plants.

In 2014, the total aggregate GHG emissions from industrial processes were 15 283.26 kt of CO_2 equivalents, which represent increase of 4.69% compared to the previous year. Emissions decreased by 10.55% compared to the reference year 1990.

4.1 Overview of sector

4.1.1 General description and key categories identification

The major share of CO_2 emissions in this sector comes from sub-source categories 2.C.1 Iron and Steel Production and 2.A Mineral Products. F- gas emissions are also significant.

N_2O emissions coming from 2.B Chemical Industry are less significant. Iron and steel, Cement production, F-gases Use, Lime production and Nitric acid production can be considered to be key categories (KC) according to IPCC 2006 Guidelines (IPCC, 2006). Tab. 4-1 gives a summary of the main sources of direct greenhouse gases in this sector, shows share of national emissions in 2014 and lists type of key category analysis for key categories.

Tab. 4-1 Overview of key categories in sector Industrial Processes (2014)

Category	Gas	Character of category	% of total GHG*
2.C.1 Iron and Steel Production	CO_2	LA	5.26
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	LA, TA	2.26
2.A.1 Cement Production	CO_2	LA	1.20
2.B.8 Petrochemical and carbon black production	CO_2	LA, TA	0.87
2.B.1 Ammonia Production	CO_2	LA	0.56
2.A.2 Lime Production	CO_2	LA	0.51
2.C.2 Ferroalloys Production	CH_4	TA	0.41
2.B.2 Nitric Acid Production	N_2O	TA	0.21

** assessed without considering LULUCF*
KC: key category, LA, LA: identified by level assessment with and without considering LULUCF, respectively*
TA, TA: identified by trend assessment with and without considering LULUCF, respectively*

4.1.2 Emissions trends

This chapter describes the emissions of greenhouse gases in more disaggregated way than chapter 2: Trends in Greenhouse Gas emissions.

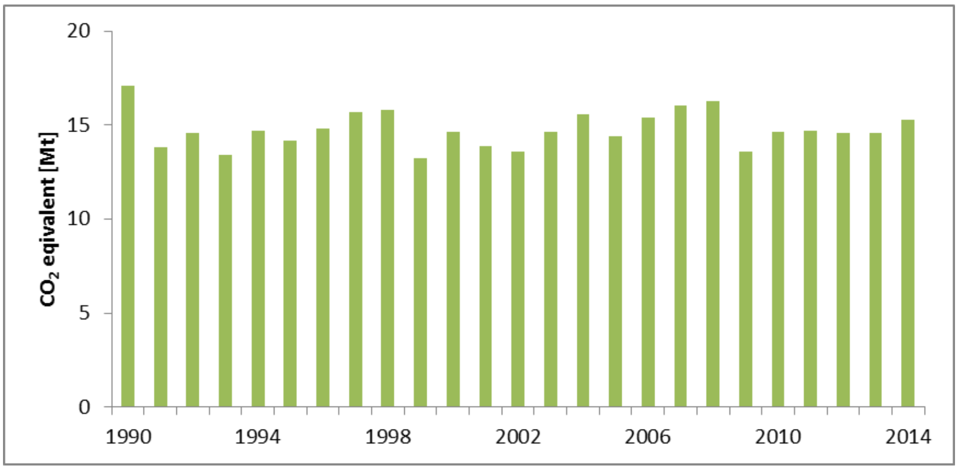


Fig. 4-1 GHG emissions trend from Industrial Processes, 1990 – 2014 [Tg CO_2 eq.]

GHG emissions in this category are driven mainly by economic development, supply and demand of products, where abatement technology is used only in specific cases (e.g. nitric acid production) or the driving force is different (e.g. ozone depleting substances).

GHG emission trends for the principal categories of industrial processes are depicted on Fig. 4-1 and Fig. 4-2 . Emissions in 2009 and 2010 were rather influenced by

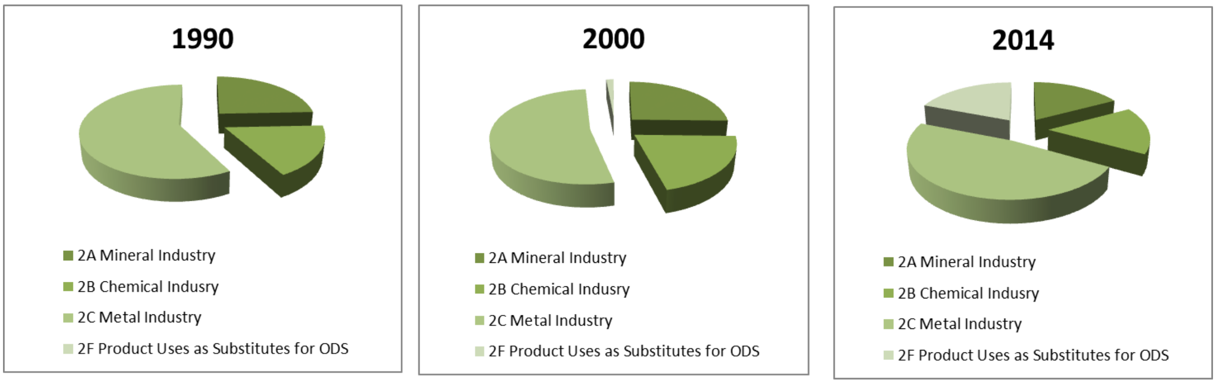


Fig. 4-2 Share of GHG emissions from individual subcategories on the whole sector of Industrial Processes in 1990, 2000, 2014 [kt CO_2 eq.]

the economic crisis. A brief description of the relevant category trends is provided for all the categories in the following chapters.

Category 2.A Mineral Products includes practically only emissions of CO_2 as well as category 2.C Metal Production. CO_2 emissions from the 2.B Chemical Industry comes from 2.B.1 Ammonia Production, while N_2O emissions originate from 2.B.2 Nitric Acid Production. Industrial CH_4 emissions are insignificant. Emissions from the use of F-gases (2.E, mainly category 2.F and 2.G) are classified in greater detail in the Fig. 4-2.

4.2 Mineral Industry (CRF 2.A)

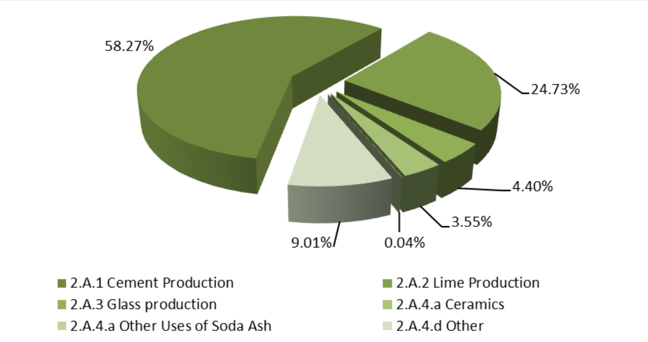


Fig. 4-3 The share of individual categories in CO_2 emissions from category 2.A Mineral Products in 2014 [kt CO_2]

This category describes GHG emissions from the non-combustion processes from the following categories: 2.A.1 Cement Production, 2.A.2 Lime Production, 2.A.3 Glass Production, 2.A.4 Other Process Uses of Carbonates.

Fig. 4-3 depicts the share of CO_2 emissions in this category. The major share (58.27%) belongs to 2.A.1 Cement Production, 24.73% belongs to 2.A.2 Lime Production, 4.40% 2.A.3 Glass Production and 12.60% to 2.A.4 Other Process Uses of Carbonates. Tab. 4-2 lists the CO_2 emissions in the individual subcategories in 2.A Mineral Products in 2014.

Tab. 4-2 CO_2 emissions in individual subcategories in 2.A Mineral Products category in 1990 – 2014

	Category 2.A - CO_2 emissions [kt]					
	2.A.1 Cement Production	2.A.2 Lime Production	2.A.3 Glass production	2.A.4.a Ceramics	2.A.4.b Other use od Soda Ash	2.A.4.d Other
1990	2 489.18	1 336.65	123.66	109.15	NO	NO
1991	2 308.92	844.66	106.02	86.26	NO	NO
1992	2 468.42	831.46	104.61	81.82	NO	NO
1993	2 194.55	778.67	101.47	101.12	NO	NO
1994	2 208.38	806.53	109.71	103.83	NO	NO
1995	2 005.01	817.53	83.20	96.33	NO	NO
1996	2 116.49	830.73	87.50	118.01	NO	76.00
1997	2 083.36	852.73	97.00	140.79	NO	240.63
1998	2 067.65	797.00	101.20	192.31	NO	417.31
1999	1 962.91	787.47	104.20	139.84	NO	536.94
2000	1 936.86	828.53	119.70	169.70	NO	539.69
2001	1 628.84	827.06	120.30	149.86	0.10	551.38
2002	1 403.48	815.33	134.90	108.33	0.21	551.38
2003	1 484.85	808.00	141.60	114.87	0.33	560.04
2004	1 626.76	808.73	166.20	113.61	0.44	551.06
2005	1 624.53	762.82	165.40	135.53	0.47	588.79
2006	1 748.45	758.02	175.00	107.24	0.35	586.55
2007	2 043.08	794.07	168.80	129.04	0.50	659.02
2008	1 996.15	742.01	151.92	109.83	0.56	648.19
2009	1 566.08	625.43	132.93	90.84	0.41	639.40
2010	1 469.27	655.77	102.25	100.57	0.86	694.57
2011	1 664.53	676.44	138.08	100.63	1.06	800.71
2012	1 517.03	597.44	108.84	101.50	1.09	740.41
2013	1 331.79	612.99	115.76	117.02	1.03	215.79
2014	1 482.00	629.04	111.93	90.20	1.12	229.19

Tab. 4-3 gives an overview of the emission factors used for computations of emissions in category 2.A Mineral Products in 2014.

Tab. 4-3 CO_2 emission factors used for computations of 2014 emissions in category 2.A

	Emission factor CO_2	unit	Source or type of EF
2.A.1 Cement Production	0.5387	t CO_2/t sinter	EU ETS
2.A.2 Lime Production	0.7575	t CO_2/t CaO	CS
2.A.3 Glass production	0.10	t CO_2/t Glass	Default (IPCC, 2006)
2.A.4.a Ceramics	1.26	t CO_2/tiles thousand m^2	CS
	0.09	t CO_2/brick unit	CS
	0.028	t CO_2/t roofing tiles	CS
2.A.4.b Other use od Soda Ash	0.415	t CO_2/t soda ash	IEF
2.A.4.d Other (Flue-gas desulfurisation)	C	t CO_2/t desulfurated flue-gas	CS (EU ETS)
(Mineral wool production)	0.225	t CO_2/t mineral wool	Default (IPCC, 2006)

The column source or type of EF indicates the way how was the certain emission factor determined. Detailed information for each emission factor is given in the relevant chapters.

4.2.1 Cement Production (CRF 2.A.1)

CO_2 emissions from cement production have decreased since 1990 by 40.46%. The decrease in the emissions during 1990's was caused by the transition from planned economy to market economy. This led to decline in industrial production and consequently to decrease in emissions. Since 2003, the cement production began to recover and production has increased. Decrease in emissions since 2008 was caused by the economic crisis and related construction constraints.

4.2.1.1 Source category description

Cement production is one of the traditional anthropogenic sources of carbon dioxide included in inventories; however, its importance is incomparably smaller than the total combustion of fossil fuels. Approx. 60% of the CO_2 is emitted during transformation of raw materials (mainly decarbonisation of limestone). Process-related CO_2 is emitted during the production of clinker (calcination process) when calcium carbonate ($CaCO_3$) is heated in a cement kiln up to temperatures of about 1 500 °C. During this process, calcium carbonate is converted into lime (CaO - calcium oxide) and carbon dioxide. CO_2 emissions from combustion processes taking place in the cement industry (especially heating of rotary kilns) have been reported in IPCC category 1.A.2.f Limestone (and dolomite). This category contains also small amount of magnesium carbonate ($MgCO_3$) and fossil carbon (C), which will also calcinate or oxidize in the process causing CO_2 emissions.

4.2.1.2 Methodological issues

CO_2 emissions from 2.A.1 Cement Production can be calculated according to the IPCC 2006 Guidelines (IPCC, 2006). This methodology describes an approach based on direct data from individual operators of cement kilns (Tier 3). Since 2006 submission methodology Tier 3 has been employed. CO_2 emissions are based on data submitted by the cement kiln operators in the EU ETS system. EU ETS system covers all cement kiln operators in the Czech Republic. Information submitted directly by the cement kiln operators is available for years 1990, 1996, 1998 - 2002 and 2005 - 2014. For these years, the emission factor value was derived from individual installation data collected for EU ETS (emissions) and from CCA (Czech Cement Association) data (activity data about production of clinker). For other years the EFs were interpolated. The content of calcium/magnesium oxide (CaO/MgO) and composition of the limestone and dolomite are measured and independently verified. These parameters are used for calculation of the CO_2 emissions and, therefore, substantial attention is devoted to their determination.

The methodology used for CO_2 emissions must be in accordance with national legislation (Zákon 383/ 2012 o podmínkách obchodování s povolenkami na emise skleníkových plynů/Act No. 383/2012 Coll., the Greenhouse Gas Emission Allowance Trading Act) and the EU legislation (Commission Decision of 18 July

2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council).

All operating cement plants in the Czech Republic are equipped with dust control technology and the dust is then recycled to the kiln. Only in one cement plant is a small part of the CKD discarded, for technical reasons. Use of dolomite or amount of magnesium carbonate in the raw material, as well as fissile carbon (C) content is known, all above mentioned variables are used for emissions estimates in the EU ETS system.

Data on cement clinker production is published by the Czech Cement Association (CCA) (CCA, 2015), which associates all Czech cement producers. Clinker production data together with interpolated EF was used for years without direct data from cement kiln operators. IEF, which is calculated based on CO_2 emissions and clinker production, varies from 0.527 to 0.553 t CO_2/t clinker.

Tab. 4-4 introduces the activity data for clinker production, emission factor and CO_2 emissions for the whole time series.

Tab. 4-4 Activity data, CO_2 emission factor and CO_2 emissions in 2A1 Cement Production category in 1990 - 2014

	unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Clinker production	kt	4 726	4 368	4 653	4 122	4 134	3 740	3 934	3 829	3 758	3 547
EF CO_2	t CO_2/t clinker	0.527	0.529	0.531	0.532	0.534	0.536	0.538	0.544	0.550	0.553
Emissions CO_2	kt	2 489	2 309	2 468	2 195	2 208	2 005	2 116	2 083	2 068	1 963

	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Clinker production	kt	3 537	2 954	2 549	2 725	3 017	3 045	3 288	3 837	3 759	2 923
EF CO_2	t CO_2/t clinker	0.548	0.551	0.551	0.545	0.539	0.533	0.532	0.532	0.531	0.536
Emissions CO_2	kt	1 937	1 629	1 403	1 485	1 627	1 625	1 748	2 043	1 996	1 566

	unit	2010	2011	2012	2013	2014
Clinker production	kt	2 748	3 132	2 838	2 472	2 792
EF CO_2	t CO_2/t clinker	0.535	0.531	0.535	0.539	0.531
Emissions CO_2	kt	1 469	1 665	1 517	1 332	1 482

4.2.1.3 Uncertainties and time-series consistency

In 2012 a research was conducted in order to develop new uncertainty estimates. The uncertainties for this category are based on the 2006 Guidelines (IPCC, 2006). Since Tier 3 method is used for determining emissions in this category the uncertainties were estimated at the level of 2% both for activity data and emission factors. Overall uncertainty data are given in Chapter 1.6.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2014.

4.2.1.4 Source-specific QA/QC and verification

The input information and calculations are archived by the sectoral expert and the coordinator of NIS. In addition to verification of the input data, the inter-annual changes of the implied emission factors are analysed. Comparison of clinker production data provided by CzSO and CCA is displayed in Fig. 4-4. The quality control was held by fulfilling the QA/QC form presented in Annex 5.

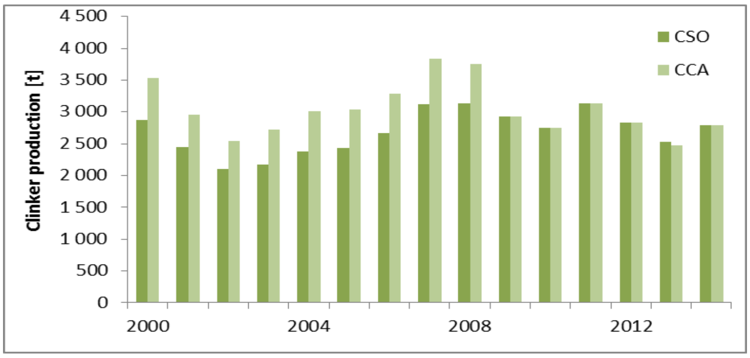


Fig. 4-4 Comparison of clinker production data provided by CzSO and CCA

4.2.1.5 *Source-specific recalculations, including changes made in response to the review process and impact on emission trend*

No recalculations performed in this submission.

4.2.1.6 *Source-specific planned improvements, including tracking of those identified in the review process*

Since the Tier 3 method is used for emission calculations in this category, no significant improvements are planned.

4.2.2 Lime Production (CRF 2.A.2)

EU ETS data will be used for the 2010-2014 period in this year's submission. For this period, the ETS data are available in electronic form for each lime factory and each process. EU ETS data are also available for the 2005-2009 period, but only in the form of total emissions for each plant (including emissions which are reported in the Energy sector) and this is not sufficient for their use for this submission. EU ETS data are at the Tier 3 level. For the 1990 – 2009 period, in which EU ETS was not implemented in the Czech Republic, data were kept from CLA (Czech Lime Association) at the Tier 1 level.

In 2015, research was carried out related to the country-specific emission factor from lime production (Beck, 2015). This research clarified the very small fluctuation of the emission factor (depending on the composition of the limestone) and further successfully defended the connection between Tier 1 data for the 1990 – 2009 period and Tier 3 data for the 2010 – 2014 period. Detailed information about the research is provided in Annex 3.

CO_2 emissions from lime production have decreased considerably since 1990 by 52%. The decrease in emissions between 1990 and 1991 was caused by the transition from a planned economy to a market economy and closing of lime kilns, together with a decrease in industrial production. Since then, lime production has varied slightly around 1 100 kt/year. In 2012 the production of lime dropped to a minimum for the whole period of 758 kt. After that in 2014 production of lime slightly increased to 814 kt.

4.2.2.1 Source category description

From a chemical point of view, lime is calcium oxide. CO_2 is released during calcination. During the production of lime, the limestone is heated up which leads to decomposition (i.e. calcination) of $CaCO_3$/$MgCO_3$ to the lime (CaO, CaO·MgO) and CO_2 is being released into the atmosphere.

4.2.2.2 Methodological issues

Emissions from lime production are calculated in line with the IPCC 2006 Guidelines (IPCC, 2006). Only CO_2 emissions generated in the process of the calcination step of lime treatment are considered in this category. CO_2 emissions from combustion processes (heating of kilns and furnaces) are reported under category 1.A.2.f. The national EF reflects the production of lime and quick lime (0.7884 t CO_2/t lime) (Vácha, 2004). Furthermore, it takes into account the average purity (93%) (Vácha, 2004) of the lime produced in the Czech Republic.

The activity data are based on data from EU ETS (EU ETS, 2015), which publishes data on pure lime production. These data were considered to be more accurate than the data provided by CzSO, which do not differentiate between lime and hydrated lime.

Tab. 4-5 lists activity data for lime production, emission factors and CO_2 emissions for the whole time series.

Tab. 4-5 Activity data, CO_2 emission factor and CO_2 emissions in 2.A.2 Lime Production category in 1990 - 2014

	unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Lime production	**kt**	1 823	1 152	1 134	1 062	1 100	1 115	1 133	1 163	1 087	1 074
EF CO_2	**t CO_2/t $CaCO_3$**	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733
Emissions CO_2	**kt**	1 337	845	831	779	807	818	831	853	797	787

	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Lime production	**kt**	1 130	1 128	1 112	1 102	1 103	1 040	1 034	1 083	1 012	853
EF CO_2	**t CO_2/t $CaCO_3$**	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733
Emissions CO_2	**kt**	829	827	815	808	809	763	758	794	742	625

	unit	2010	2011	2012	2013	2014
Lime production	**kt**	832	858	758	778	814
EF CO_2	**t CO_2/t $CaCO_3$**	0.788	0.788	0.788	0.788	0.772
Emissions CO_2	**kt**	656	676	597	613	629

4.2.2.3 Uncertainties and time-series consistency

The uncertainties for this category are in line with the 2006 Guidelines (IPCC, 2006). Since activity data are based on the EU ETS, which include all the lime producers in the Czech Republic, the uncertainty in the activity data was estimated at the level of 2%. The country-specific emission factor is used and the uncertainty was estimated to be at the same level as that for the activity data, i.e. 2%. The overall uncertainty data are given in Chapter 1.6.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2014.

4.2.2.4 Source-specific QA/QC and verification

Sector-specific QA/QC plan was formulated, closely related to the QA/QC plan of the National Inventory System.

The calculations in the lime production category are based on data taken from the EU ETS and Czech Lime Association and are used for verification of the CO_2 emissions. The EU ETS reports are proved by independent verifiers. The lime production data provided by the Czech Lime Association are compared with data provided by the Czech Statistical Office. Emission estimates are compared with the sum of the emissions from technological processes reported by individual kiln operators. The country-specific emission factor was compared with the emission factors used by individual operators for the calculation. Differences in the last year indicate that the country-specific emission factor is slightly overestimated. Verification of this difference is planned for future submissions.

4.2.2.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

2.A.2 Lime production was recalculated in the 2010-2013 time series since new specific data were obtained. Fig. 4-5 presents impact of this recalculation.

Fig. 4-5 Recalculation in category Lime Production

4.2.2.6 Source-specific planned improvements, including tracking of those identified in the review process

Since the Tier 3 method is used for emission calculations in this category, no significant improvements are planned.

4.2.3 Glass production (CRF 2.A.3)

4.2.3.1 Source category description

CO_2 emissions from Glass Production (2.A.3*)* are derived particularly from the decomposition of alkaline carbonates added to glass-making sand.

4.2.3.2 Methodological issues

The emission factor value for Tier 1 method of 0.20 t CO_2/t glass was taken from the 2006 Guidelines (IPCC, 2006). Cullet ratio of 50% was taken likewise from 2006 Guidelines (IPCC, 2006).

Activity data were collected and published by the Association of the Glass and Ceramic Industry of the Czech Republic in previous years. Starting 2014 submission, the activity data are available and used from CzSO.

4.2.3.3 Uncertainties and time-series consistency

The uncertainties for this category are in line with the IPCC 2006 Guidelines (IPCC, 2006), i.e. at the level of 5% for the activity data and 10% for the CO_2 emission factor. Overall uncertainty data are given in Chapter 1.7.

4.2.3.4 Source-specific QA/QC and verification

The data on glass production provided by CzSO were discussed with a representative of the Association of the Glass and Ceramic Industry, who confirmed their reliability.

Sector-specific QA/QC plan is formulated, closely related to the QA/QC plan of the National Inventory System.

4.2.3.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations performed in this submission.

4.2.3.6 Source-specific planned improvements, including tracking of those identified in the review process

In further submissions it is planned to implement EU ETS (European Union Emission Trading System) data which are available since 2010. This data are on Tier 3 level. However this data are not available for the whole time series thus using these data leads to a problem with consistency of the time series. This issue will be resolved in future research in an upcoming submissions. After comprehensive solution to this problem is available, it will be possible to implement EU ETS data not only in this category but also in 2.A.2 Lime Production and 2.A.4.a Ceramics.

4.2.4 Other process uses of carbonates (CRF 2.A.4)

The 2.A.4 category Other Process Uses of Carbonates (2.A.4) summarizes, in the Czech Republic, emissions from Ceramics (2.A.4.a – CO_2), Other uses of Soda Ash (2.A.4.b – CO_2) and from Other (2.A.4.d – CO_2). CO_2 emissions from 2.A.4.a Ceramics equalled to 90.20 kt in 2014. CO_2 emissions from Other uses of Soda Ash (2.A.4.b) amounted to 1.12 kt CO_2 in 2014. CO_2 emissions from Other (2.A.4.d) amounted to 229.19 kt CO_2 in 2014.

4.2.4.1 Source category description

CO_2 emissions from 2.A.4.a Ceramics are derived particularly from the decomposition of alkaline carbonates, fossil and biogenic carbon-based substances included in the raw materials. The EF value was derived from the individual installation data collected for EU ETS (emissions and AD) since 2010. Activity data from CzSO (production) were used for the 1990-2010 period and the average of EU ETS emission factors was used for country specific emission factor within the same time frame. The calculation is based on the total production of ceramic products (fine ceramics, tiles, roofing tiles, and bricks) and the emission factor value.

CO_2 emissions from Other Uses of Soda Ash (2.A.4.b - CO_2) category come from soda ash use for the Glass production category, soda ash is used in only one other installation. CO_2 emissions from this category are small and insignificant (varied between 0.1 and 1.1 kt CO_2) compared to the other categories. The maximum value of the emissions reported in this category is 1.12 kt CO_2 in 2014.

CO_2 emissions from the Other (2.A.4.d - CO_2) category include emissions from mineral wool production and flue-gas desulphurisation. Emissions from mineral wool production are estimated according to Tier 1 methodology, using default EF. Emissions from flue-gas desulphurization are obtained from EU ETS forms, which correspond to Tier 3 methodology with CS EF. The CRF reporter does not allow separation of these two categories by adding new nodes under Other category 2.A.4.d. Consequently, these two categories are reported collectively. Activity data for this category are reported as C (NK), because data from EU ETS are used, and these are confidential. Division of each category is displayed in Fig. 4-6.

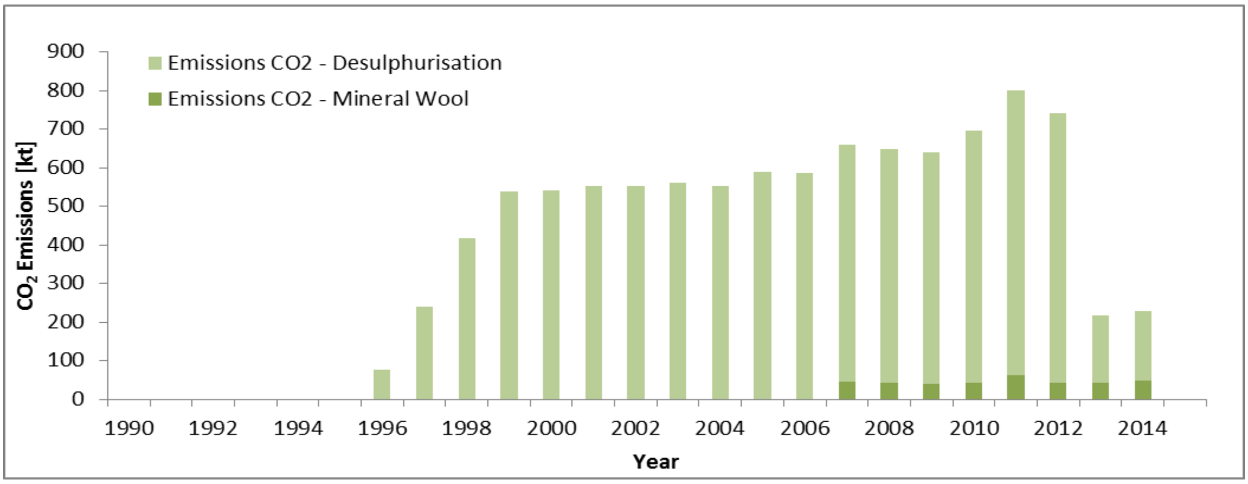


Fig. 4-6 Division of CO_2 emissions from flue-gas desulphurisation and mineral wool production

CO_2 emissions from sulphur removal were calculated from coal consumption for electricity production, the sulphur content and the effectiveness of sulphur removal units between 1996, when the first sulphur removal units came into operation, and 2005. In 2005, these data were verified by comparison with data from the individual operators, which were collected for EU ETS preparation and cover the years 1999 – 2005. The EU ETS data form have been used since 2006. The methodology used for estimation of the CO_2 emissions must be in accordance with the national legislation (Zákon č. 383/2012 Sb. Zákon o podmínkách obchodování s povolenkami na emise skleníkových plynů /Act No. 383/2012 Coll. The Act on conditions for trading in greenhouse gas emission allowances) and the EU legislation (Commission Decision of 18 July 2007 establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council).

Tab. 4-6 Emissions from flue-gas Desulphurisation and Mineral wool production in 1990 – 2014

	CO_2 from flue-gas desulphurisation [kt]	CO_2 from Mineral wool production [kt]
1990	NO	NO
1991	NO	NO
1992	NO	NO
1993	NO	NO
1994	NO	NO
1995	NO	NO
1996	76.00	NO
1997	240.63	NO
1998	417.31	NO
1999	536.94	NO
2000	539.69	NO
2001	551.38	NO
2002	551.38	NO
2003	560.04	NO
2004	551.06	NO

	CO_2 from flue-gas desulphurisation [kt]	CO_2 from Mineral wool production [kt]
2005	588.79	NO
2006	586.55	NO
2007	613.93	45.08
2008	607.00	41.19
2009	600.00	39.40
2010	651.00	43.57
2011	739.40	61.31
2012	698.78	41.63
2013	172.96	42.83
2014	182.30	46.89

4.2.4.2 Methodological issues

For each mole of soda ash use, one mole of CO_2 is emitted, so that the mass of CO_2 emitted from the use of soda ash can be estimated from a consideration of the consumption data and the stoichiometry of the chemical process.

The data, considering the amount and purity of the soda ash used, were obtained directly from the installation operator.

4.2.4.3 Uncertainties and time-series consistency

The uncertainties for this category are in line with the IPCC 2006 Guidelines (IPCC, 2006), i.e. at the level of 5% for the activity data and 10% for the CO_2 emission factor. Overall uncertainty data are given in Chapter 1.6.

For 2.A.4.b Other uses of Soda Ash the time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year of 2001, when the use of soda started, to 2014.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2014.

4.2.4.4 Source-specific QA/QC and verification

Sector-specific QA/QC plan is formulated, closely related to the QA/QC plan of the National Inventory System.

The calculations are based on data provided directly by the operators, who verify the data annually.

4.2.4.5 *Source-specific recalculations, including changes made in response to the review process and impact on emission trend*

The subcategory 2.A.4.a Ceramics was also recalculated by using EU ETS data in the 2010-2014; 1990 – 2010 was calculated by using activity data provided by CzSO and country specific emission factor calculated from EU ETS data.

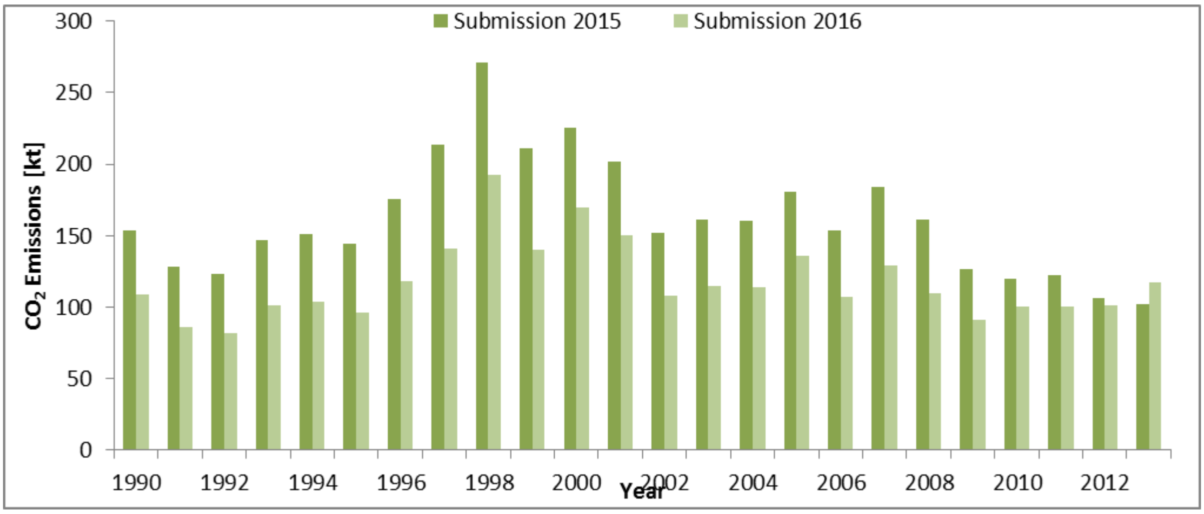


Fig. 4-7 Recalculation of CO_2 emissions from ceramic production

The subcategory 2.A.4.d Other (please specify) newly includes emissions from mineral wool production.

4.2.4.6 *Source-specific planned improvements, including tracking of those identified in the review process*

It is planned to verify emission estimates with data from the EU ETS system and other available sources.

Since plant-specific data and simple stoichiometry are used for computation in this category there is no significant improvement planned in this category.

4.3 Chemical Industry (CRF 2.B)

From the categories of sources classified under the Chemical industry (2.B), categories 2.B.1, 2.B.2, 2.B.4.a, 2.B.6 and 2.B.8 are relevant for the Czech Republic, while Adipic Acid Production (2.B.3), Glyoxal (2.B.4.b), Glyoxylic Acid (2.B.4.c), Carbide Production (2.B.5), Soda Ash Production (2.B.7) and Fluorochemical Production (2.B.9) are not occurring. The subcategory 2.B.10 Other (please specify) includes two new subcategories: Other non-energy use in chemical industry and Non selective catalytic reduction. Emission trend for the category 2.B Chemical Industry is depicted on Fig. 4-8.

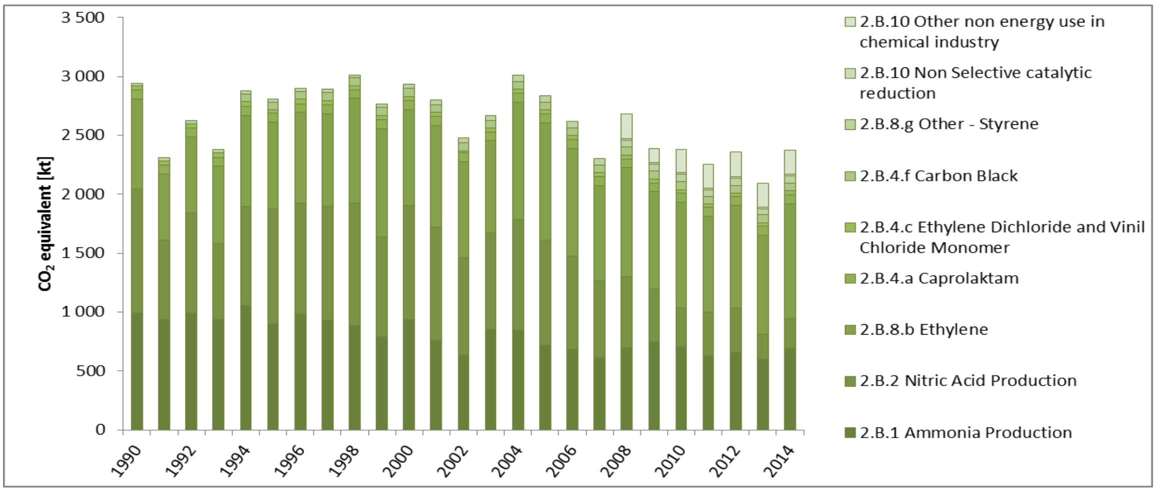


Fig. 4-8 Trend of emissions from Chemical Industry and share of specific subcategories [kt CO_2 eq.]

4.3.1 Ammonia production (CRF 2.B.1)

The production of ammonia constitutes an important source of CO_2 derived from non-energy use of fuels in the chemical industry. CO_2 emissions from ammonia production in 2014 equalled to 689.1 kt of CO_2, corresponding to approx. 0.56% of total greenhouse gas emissions without LULUCF. These emissions decreased by 37.3% compared to 1990; however, emissions in period 2005 - 2012 are almost constant, with slight fluctuations. In 2014, slight increase of emissions from ammonia production compare to previous year was noticed. Ammonia production (CO_2 emissions) was identified as a key category in this year’s submission, however only on level assessment.

4.3.1.1 Source category description

Industrial ammonia production is based on the catalytic reaction between nitrogen and hydrogen:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

Nitrogen is obtained by cryogenic rectification of air and hydrogen is prepared using starting materials containing bonded carbon (such as, e.g., Natural Gas, Residual Oil, Heating Oil, etc.). Carbon dioxide is generated in the preparation of these starting materials.

In the Czech Republic, hydrogen for ammonia production is derived from residual oil from petroleum refining, which undergoes partial oxidation in the presence of water vapour. In order to increase the hydrogen production, the second step involves conversion of carbon monoxide, which is formed by partial oxidation, in addition to carbon dioxide and hydrogen. The final products of this two-step process are hydrogen and carbon dioxide. The production technology has practically not changed since 1990.

4.3.1.2 Methodological issues

Emissions are calculated from the corresponding amount of ammonia produced, using the default emission factor provided in IPCC 2006 Gl 3.273 kt CO_2/kt NH_3. This emission factor was obtained from IPCC 2006 Gl. Volume 3, Chapter 3 page 3.15 table 3.1, corresponding to the total fuel requirement, which was 44.65 GJ (NCV)/tonne NH_3 in 2014. Total CO_2 emissions from ammonia production where lowered by CO_2 used in urea production, consequently / therefore the portion of CO_2 emissions to NH_3 is not constant as mentioned in the study (Bernauer and Markvart, 2015).

A potential uncertainty in the emission factor for ammonia would not influence the total sum of CO_2 emissions, because a corresponding amount of oil is not considered in the energy sector. The relevant activity data and corresponding emissions are given in Tab. 4-7. Activity data and CO_2 emissions from ammonia production in 1990 – 2014.

Tab. 4-7 Activity data and CO_2 emissions from ammonia production in 1990 – 2014

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Residual fuel oil used for NH_3 product., *[TJ]*	14 997	14 534	14 985	14 012	15 644	13 812	14 865	13 623	14 044	11 963
Ammonia produced, *[kt]*	335.86	325.51	335.59	313.8	350.35	309.32	332.91	305.1	314.52	267.91
CO_2 from 2.B.1, *[kt]*	990.8	933.44	989.89	933.98	1055.82	903.19	989.2	931.15	886.5	788.9
CO_2 consumed in urea production [kt]	108.48	131.94	108.48	93.09	90.89	109.22	100.42	67.44	142.94	87.96

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Residual fuel oil used for NH_3 product., *[TJ]*	13 690	11 522	10 052	13 084	12 987	11 326	10 802	10 119	11 453	11 793
Ammonia produced, *[kt]*	306.59	258.04	225.12	293.03	290.84	253.65	241.91	226.62	256.49	264.10
CO_2 from 2.B.1, *[kt]*	936.02	761.75	638.58	850.60	843.43	721.70	683.27	617.11	700.21	744.18
CO_2 consumed in urea production [kt]	67.44	82.83	98.22	108.48	108.48	108.48	108.48	124.61	139.27	120.21

Year	2010	2011	2012	2013	2014
Residual fuel oil used for NH_3 product., *[TJ]*	11 484	10 278	10 659	8 212	9 400
Ammonia produced, *[kt]*	257.19	230.18	238.72	183.91	210.53
CO_2 from 2.B.1, *[kt]*	705.45	628.05	653.79	601.13	689.05
CO_2 consumed in urea production [kt]	136.34	125.34	127.54	0.81	NO

4.3.1.3 Uncertainties and time consistency

Uncertainty estimates of activity data and emission factors have been so far based mainly on expert judgment.

In 2014, estimates of the uncertainty parameters were again verified in the study (Bernauer and Markvart, 2015) which, in addition to an expert opinion, also takes into account data given in the 2006 Guidelines (IPCC, 2006). The uncertainty in the activity 0data remains unchanged at 5% and the uncertainty in the emission factor (CO_2 EF) was also left at a value of 7%.

Time series consistency is ensured as the above mentioned methodology are employed identically across the whole reporting period from the base year 1990 to 2014.

4.3.1.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. Attention was focused on identifying gaps and imperfections using the reporting software (CRF Reporter), specifically by observing trends in figures and by checking IEFs. Attention was also focused on checking sources from inter-sector boundaries (Energy, Industry) that they are neither omitted nor counted twice. Therefore CO_2 emissions from residual oil used for ammonia production are not taken into account in Energy sector. This part of QA/QC procedure is carried out in cooperation with KONEKO marketing, Ltd. (see Chapter 3.6).

4.3.1.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, no recalculations were performed in this sector.

4.3.1.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvement is planned for the next submission.

4.3.2 Nitric acid production (CRF 2.B.2)

The production of nitric acid constitutes one of the most important sources of N_2O in the chemical industry. N_2O emissions from production of nitric acid in 2014 equalled to 0.86 kt N_2O, corresponding to approx. 0.21% of total greenhouse gas emissions without LULUCF. These emissions have decreased by 75% compared to 1990; the substantial decrease in recent years has been a consequence of the gradual introduction of mitigation technology and improving its effectiveness. In 2014, the production of nitric acid (N_2O emissions) was identified as a key category by trend assessment. In former years, when N_2O emissions reached greater values, this category was identified as a key source by level assessment.

4.3.2.1 Source category description

The production of nitric acid is one of the traditional chemical processes in the Czech Republic. It is carried out in three factories, where one of them manufactures more than 60% of the total amount. Nitric acid is produced using the classical method, high-temperature catalytic oxidation of ammonia (Ostwald process) and subsequent absorption of nitrogen oxides in water. Nitrous (dinitrogen) oxide is formed at ammonia oxidation reactor as an unwanted side product.

The nitric acid is manufactured at three pressure levels (at atmospheric pressure, slightly elevated pressure (approx. 0.4 MPa) and at elevated pressure (0.7 - 0.8 MPa). While production processes prior to 2003 mostly progressed at atmospheric pressure and only to a lesser degree at medium elevated pressure, the process at elevated pressure had predominated since 2004.

All the nitric acid production processes in the Czech Republic are equipped with technologies for removal of nitrogen oxides, NO_X, based on selective or non-selective catalytic reduction. Non-selective catalytic reduction also makes a substantial contribution to removal of N_2O. Since 2004, the technology to reduce N_2O emissions, based on catalytic decomposition of this oxide, has been gradually introduced at units working at elevated pressure. It has been possible to substantially improve the effectiveness of this process in recent years.

4.3.2.2 Methodological issues

Nitrous oxide emissions from 2.B.2 Nitric Acid Production are generated as a by-product in the catalytic process of oxidation of ammonia. It follows from domestic studies (Markvart and Bernauer, 1999, 2000, 2003), describing conditions prior to 2004, that the resulting emission factor depends on the technology employed: higher emission factor values are usually given for processes carried out at normal pressure, while lower values are usually given for medium-pressure processes. Two types of processes were carried out in this country before 2004, at pressures of 0.1 MPa and 0.4 MPa. The amount of nitrous oxide in the exit gases is also affected by the type of process employed to remove nitrogen oxides, NO_X (i.e. NO and NO_2). In this country, the process of Selective Catalytic Reduction (SCR) is mostly used, which slightly increases the amount of N_2O, and also to a certain degree Non-Selective Catalytic Reduction (NSCR), which also removes N_2O to a considerable degree.

Studies (Markvart and Bernauer, 2000, 2003) recommend the following emission factors for various types of production technology and removal processes that are given in Tab. 4-8. The emission factors for the basic process (without $DENO_X$ technology) are in accord with the principles given in the above-cited IPCC methodology. The effect of the NO_X removal technology on the emission factor for N_2O was evaluated on the basis of the balance calculations presented in studies (Markvart and Bernauer, 2000, 2003).

Tab. 4-8 Emission factors for N_2O recommended by (Markvart and Bernauer, 2000) for 1990 - 2003

Pressure in HNO_3 production	**0.1 MPa**			**0.4 MPa**		
Technology $DENO_X$	--	SCR	NSCR	--	SCR	NSCR
Emission factors N_2O *[kg N_2O/t HNO_3]*	9.05	9.20	1.80	5.43	5.58	1.09

Collection of activity data for HNO_3 production is more difficult than for cement production, because of the present legislation, which complicates the releasing of statistical data on manufactured products where the number of producers is smaller than (or equal to) three. Therefore, it was necessary to obtain them by questioning/interviewing all three producers in the Czech Republic, see (Markvart and Bernauer, 2000, 2003, 2004).

During 2003, conditions changed substantially as a result of the installation of new technologies operating under higher pressure of 0.7 MPa. At the same time, some older units operating under atmospheric pressure of 0.1 MPa were phased out. These changes in technology were monitored in the study of Markvart and Bernauer (Markvart and Bernauer, 2005). This study presents a slightly modified table of N_2O emission factors, while those for new technologies were obtained from a set of continuous emission measurements lasting several months. Other values are based on several discrete measurements. A table of these technology-specific emission factors is given below.

Tab. 4-9 Emission factors for N_2O recommended by Markvart and Bernauer, for 2004 and thereafter

Pressure	**0.1 MPa**	**0.4 MPa**	**0.4 MPa**	**0.7 MPa**
$DENO_X$ process	SCR	SCR	NSCR	SCR
EF, kg N_2O/t HNO_3 (100%)	9.05	4.9	1.09	7.8 [a)]

[a)] EF without N_2O mitigation. Cases of N_2O mitigation in 2005 -2008 are shown in Tab. 4-11

In the last quarter of 2005, a new N_2O mitigation unit based on catalytic decomposition of N_2O was experimentally installed for 0.7 MPa technology, and became the most important such unit in the Czech Republic. As a consequence of this technology, the relevant EF decreased from 7.8 to 4.68 kg N_2O/t HNO_3 (100%). Therefore, the mean value in 2005 for the 0.7 MPa technology was equal to 7.02 kg N_2O/t HNO_3 (100%), (Markvart and Bernauer, 2006).

In 2006 - 2014, the mitigation unit described above was utilized in a more effective way, see Markvart and Bernauer, 2007 - 2015. The decrease in the emission factor for 0.7 MPa technology as a result of installation of the N_2O mitigation unit and gradual improvement of the effectiveness is given in Tab. 4-8.

Two high temperature N_2O decomposition catalytic systems were used in the above-mentioned high pressure nitric acid technology (0.7 MPa) in 2009; these systems were more efficient in comparison with the catalytic systems used in previous years. The first system consisting of Raschig rings provided by Heraeus was used in the January-June 2009 period and the measured EF N_2O was 3.10 kg N_2O/ t HNO_3 (100%); in the July-November 2009 period, EF N_2O was 3.30 kg N_2O/ t HNO_3 (100%). The second system consisting of high temperature N_2O decomposition catalyst developed by YARA company, decreased EF N_2O in the November-December 2009 period to the value 0.95 kg N_2O/ t HNO_3 (100%) in a high-pressure nitric plant. The catalytic activity of the high temperature decomposition system has decreased slightly due to both increasing selectivity of the Pt-Rh ammonia oxidation catalyst towards N_2O and slow deactivation of the N_2O decomposition catalyst. Thus, the mean value of EF N_2O for this high pressure nitric acid technology in 2009 was assessed at a value of 2.85 kg N_2O/ t HNO_3 (100%) (Tab. 4-10).

The most efficient decomposition catalyst provided by YARA was used in this high pressure nitric acid technology during whole year of 2010. It is expected that, if high temperature N_2O decomposition catalyst (i.e. YARA catalyst) is employed, the EF N_2O would be approximately close to 1.3 kg N_2O/ t HNO_3 (100%).

YARA's catalyst, which was also used in 2012, exhibits excellent stability with respect to N_2O conversion and the catalyst efficiency was practically constant during the last three years in the high-pressure (0.7 MPa) nitric acid unit.

Tab. 4-10 Decrease in the emission factor for 0.7 MPa technology due to installation of the N_2O mitigation unit

Year	2004 [a)]	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
EF, kg N_2O/t HNO_3 (100%)	7.8	7.02	5.94	4.37	4.82	2.85	1.29	1.30	1.45	1.65	2.51
Effectiveness of mitigation,%	-	10	23.9	43.9	38.2	63.4	83.4	83.3	81.4	78.8	67.8

[a)] EF without N_2O mitigation.

The emission factors used in the Czech Republic are compared with the EFs presented in the IPCC methodology (IPCC, 2006) in the Tab. 4-11.

Tab. 4-11 Comparison of emission factors for N_2O from HNO_3 production

Production process	N_2O Emission factor (kg N_2O/t 100% HNO_3)	Reference
Plants with NSCR (all processes) Plants with processed integrated or tailgas N_2O destruction Atmospheric presssure plants (low pressure) Medium pressure combustion plants High pressure plants	2 ± 10% 2.5 ± 10% 5 ± 10% 7 ± 20% 9 ± 40%	(IPCC, 2006)
Czech Republic Atmospheric pressure plants Medium pressure plants with SCR Medium pressure plants with NSCR High pressure plants SCR (no N_2O decomposition) High pressure plants SCR (with N_2O decomposition)	 9.05 4.9 1.09 7.8 4.82 – 1.29	(Markvart and Bernauer, 2009, 2010)

Tab. 4-12 gives the N_2O emissions from production of nitric acid, including the production values.

Tab. 4-12 Emission trends for HNO_3 production and N_2O emissions

	Production of HNO_3, *[kt HNO_3 (100%)]*	Emissions of N_2O *[kt N_2O]* from HNO_3 production	Implied Emission Factor IEF *[Mg N_2O/ kt HNO_3]*
1990	530.00	3.52	6.65
1991	349.56	2.26	6.46
1992	439.39	2.87	6.52
1993	335.95	2.16	6.44
1994	439.79	2.83	6.43
1995	498.34	3.26	6.55
1996	484.80	3.13	6.45
1997	483.10	3.23	6.69
1998	532.50	3.48	6.53
1999	455.00	2.84	6.24
2000	505.00	3.25	6.43
2001	505.08	3.21	6.35
2002	437.14	2.76	6.32
2003	500.58	2.75	5.50
2004	533.73	3.16	5.92
2005	532.21	2.98	5.59
2006	543.11	2.65	4.88
2007	554.22	2.17	3.91
2008	506.96	2.02	3.99
2009	505.17	1.52	3.01
2010	441.70	1.09	2.48
2011	561.82	1.24	2.21
2012	550.46	1.27	2.30
2013	514.94	0.71	1.38
2014	550.15	0.86	1.56

While the slight fluctuations in IEF to 2004 were caused by slow changes in the relative contributions of the individual technologies with various technologically specific emission factors given in Tab. 4-7 and Tab. 4-8., since 2005 the reduction in IEF has been caused mainly by the gradual increase in the effectiveness of the mitigation units employed for the dominant technology (see Tab. 4-9) to 2010. A further reduction in IEF in 2011 was then caused by an increasing contribution of this dominant technology (0.7 MPa) to 56% of the annual production of HNO_3.

4.3.2.3 Uncertainties and time-series consistency

All uncertainty estimates for the activity data and emission factors have so far been based on expert judgment. Their improvement is ongoing and some uncertainty values for HNO_3 production have been recently revised and used in the two last submissions: uncertainty in activity data was lowered from 10% to 5% and uncertainty of the mean N_2O EF was lowered from 25% to 20%.

This year, the estimates of the uncertainty parameters were again refined on the basis of in the study (Markvart and Bernauer, 2013), which takes into account the data in the 2006 Guidelines (IPCC, 2006). The uncertainty in the activity data following adjustment equalled to 4% and the uncertainty in the average emission factor (N_2O EF) was reduced to 15% in relation to the increasing number of direct measurements.

Time series consistency is ensured as inventory approaches concerned are employed identically across the whole reporting period from the base year of 1990 to 2014.

4.3.2.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. Attention is focused on identifying gaps and imperfections using the reporting software (CRF Reporter), specifically by observing trends in figures and by checking IEFs.

According to the QA/QC plan, data and calculations are provided by the external consultants (M. Markvart and B. Bernauer) are checked by the experts from CHMI and vice versa.

Technology-specific methods for N_2O emission estimates have been improved by incorporating direct emission measurements, especially for new technology (0.7 MPa), which is now predominant in the Czech Republic.

4.3.2.5 Source-specific recalculations, including changes made in response to the review process and impact on emissions trend

In this year, no recalculations were performed in this sector.

4.3.2.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvement is planned for the next submission.

4.3.3 Adipic acid production (CRF 2.B.3)

Adipic Acid production is not occurring in the Czech Republic.

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

4.3.4.1 Source category description

There is only one facility for production of caprolactam in the Czech Republic. Glyoxal and Glyoxylic Acid are not produced in the Czech Republic. Information provided in this chapter is related to caprolactam production.

4.3.4.2 Methodological issues

As mentioned in the references (Markvart and Bernauer, 2004 – 2013) and (Bernauer and Markvart, 2014-2015), there is only one caprolactam production plant in the Czech Republic; this is not a very important source of N_2O emissions. CzSO does not monitor production data on the production of caprolactam; however, the series of studies by Bernauer and Markvart (Bernauer and Markvart, 2014-2015), based on a study in the production factory, yield an approximate value of 0.25 kt N_2O which is reported as a constant value for each year.

4.3.4.3 Uncertainties and time-series consistency

In relation to the relatively insignificant greenhouse gas emissions from category 2.B.4, uncertainties derived from the sources included in this category have no great impact on the overall uncertainty in the determination of GHG emissions in the Czech Republic. Thus, it does not matter greatly that the uncertainty in emissions from these sources was determined by an expert estimate.

4.3.4.4 Category-specific QA/QC and verification

In relation to the relatively unimportant greenhouse gas emissions from category 2.B.4, only QC, Tier 1 procedures were used, in accordance with the QA/QC plan.

4.3.4.5 Category-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, no recalculations were performed in this sector.

4.3.4.6 Category-specific planned improvements, including tracking of those identified in the review process

More exact data on N_2O emissions should be available in the coming years, when the N_2O emissions from the production of caprolactam will be continuously measured beginning 2012 as a consequence of inclusion of the production in the emission trading scheme (EU ETS) and thus recording in the relevant register. No further improvements are planned for methane emissions in this category.

4.3.5 Carbide production (CRF 2.B.5)

Carbides are not produced in the Czech Republic.

4.3.6 Titanium dioxide production (CRF 2.B.6)

In the Czech Republic titanium dioxide is produced using sulphate route process and as it is stated in the IPCC 2006 Guidelines that this process does not give rise to process greenhouse gas emissions that are of significance.

4.3.7 Soda ash production (CRF 2.B.7)

Soda Ash is not produced in the Czech Republic.

4.3.8 Petrochemical and Carbon Black Production (CRF 2.B.8)

4.3.8.1 Source category description

This category includes carbon dioxide and methane emissions from the production of carbon black, ethylene, ethylene dichloride and styrene. These are all less important sources (excluding emission of CO_2 from ethylene production).

4.3.8.2 Methodological issues

Default emissions from the IPCC 2006 Guidelines (IPCC, 2006) are employed to determine carbon dioxide and methane emissions from the production of carbon black, ethylene, ethylene dichloride and styrene.

CO_2 and CH_4 emissions from the production of ethylene

Ethylene in the Czech Republic is produced by pyrolysis of petroleum fractions, composed of a very wide range from fractions of C3-C4 (propane) to the higher boiling fractions. The ethylene unit contains several pyrolysis furnaces that process raw gas (LPG, ethane and propane) and liquids (HCVD - hydrocracked vacuum distillate, naphtha, and in very limited quantities of diesel fuel). Basically, a thermal, non-catalytic fission in the presence of steam is performed and its major products are ethylene, propylene, benzene and C4 fraction. Reliable data for the production of ethylene are available from CzSO. The IPCC methodology provides a value of 1.73 tonnes CO_2/tonne ethylene produced (with correction factor 110% for countries of Eastern Europe) and 3 kg CH_4/tonne ethylene produced as default emission factors. In the period 1990 – 2014, CO_2 emissions varied between 545 to 959 kt CO_2 and methane emissions varied between 0.9 and 1.5 kt CH_4, detailed values for each year are available in Tab 4-13.

Tab. 4-13 Emission trends from CO_2 and CH_4 emissions from production of ethylene

	Ethylen Production	CO_2 Emissions	CH_4 Emissions
	[kt]	*[kt]*	*[kt]*
1990	388	738	1.16
1991	286	545	0.86
1992	325	619	0.98
1993	333	633	1.00
1994	390	741	1.17
1995	373	710	1.12
1996	391	744	1.17
1997	399	759	1.20
1998	449	854	1.35
1999	466	887	1.40
2000	412	783	1.23
2001	439	836	1.32
2002	412	784	1.24
2003	397	755	1.19
2004	504	959	1.51
2005	504	959	1.51
2006	462	879	1.39
2007	409	777	1.23
2008	465	884	1.39
2009	416	792	1.25
2010	455	866	1.36
2011	412	784	1.24
2012	441	839	1.32
2013	426	810	1.28
2014	492	936	1.47

CO_2 and CH_4 emissions from the production of ethylene dichloride

1,2-dichloroethane known, also as ethylene dichloride, is produced in the Czech Republic at the same integrated facility as vinyl chloride monomer (VCM), which is subsequently used for PVC production (Bernauer and Markvart, 2015). The data on production of PVC are obtained from CzSO. While CzSO does not publish information on the amount of VCM, it does give data on the amount of PVC produced, which are practically the same as VCM data. The IPCC 2006 Guidelines methodology provides a value of emissions of carbon dioxide 0.294 tonne CO_2/tonne VCM produced and for methane 0.0226 kg CH_4/tonne VMC produced as default emission factors. Carbon dioxide emissions varied in the period 1990 - 2014 between 16.7 kt CO_2 and 40.3 kt CO_2. Due to the low emission factors' value, the values of methane emissions varied in the period 1990 – 2014 between 0.001 and 0.003 kt CH_4, which is considered as insignificant value. In 2014, emissions of carbon dioxide equalled to 38.31 kt and methane emissions equalled to 0.0029 kt CH_4.

CO_2 and CH_4 emissions from the production of carbon black

The production of carbon black is approximately 26 kt of p.a. Exact information on activity data is available since 2013; thus, the data for other years were taken from the study (Bernauer and Markvart, 2015). The emission factor taken from the IPCC 2006 Gl. methodology equals to 0.06 kg CH_4/tonne carbon black produced and 2.62 t CO_2 /t carbon black produced. The highest value of methane emissions over the past few years is practically insignificant (0.00153 kt).

CO_2 and CH_4 emissions from the production of styrene

Because of the growing consumption of polystyrene, the production of styrene has gradually increased since 1990. CzSO also does not publish any information on the production of styrene. Thus, the necessary activity data were estimated on the basis of production capacities:

1990-1998	70 kt styrene p.a.
1999	80 kt styrene p.a.
2000-2003	110 kt styrene p.a.
2004	140 kt styrene p.a.
2005-2010	150 kt styrene p.a.
from 2011	exact production from yearbook of producer

These estimates on the amount of styrene produced, mentioned in the study (Bernauer and Markvart, 2015), are based on the data given in the article (Dvořák and Novák, 2010). The emission factor taken from the IPCC methodology equals to 0.004 kt CH_4/kt styrene. The emission factor for CO_2 emissions is 0.27 kt CO_2/kt styrene (Bernauer and Markvart, 2015). In the period 1990 – 2014, methane emissions varied between 0.3 and 0.7 kt CH_4 and carbon dioxide emissions varied between 18.9 and 45.9 kt CO_2 (emissions equalled to 43.86 kt CO_2 and 0.65 kt CH_4 in 2014).

4.3.8.3 Uncertainties and time-series consistency

In relation to the relatively insignificant greenhouse gas emissions from category 2.B.8, uncertainties derived from the sources included in this category have no great impact on the overall uncertainty in the determination of GHG emissions in the Czech Republic. Thus, it does not matter greatly that the uncertainty in emissions from these sources was determined by an expert estimate.

4.3.8.4 Source-specific QA/QC and verification

In relation to the relatively unimportant greenhouse gas emissions from category 2.B.8, only QC, Tier 1 procedures were used, in accordance with the QA/QC plan.

4.3.8.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

In this year, no recalculations were performed in this sector.

4.3.8.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvements are planned.

4.3.9 Fluorochemical Production (2.B.9)

Fluorinates are not produced in the Czech Republic.

4.3.10 Other (2.B.10)

Subcategory 2.B.10 Other is reported in this submission for the first time. It includes CO_2 emissions from non-energy use of natural gas (NG) in the chemical industry since 2008, when CzSO began to report activity data for NG consumption in the chemical industry for non-energy use separately from energy use. Only aggregated data for non-energy and energy use of NG are available for the 1990 – 2007 period. Therefore all CO_2 emissions from NG in the chemical industry for the 1990 – 2007 period are reported under 1A2c (combustion in chemical industry). Owing to the lack of reliable information concerning processes of non-energy use of NG in the chemical industry, this way of reporting emissions under 1.A.2.c continued until the 2014 submission. Thanks to intensive consultation with experts from CzSO and the Institute of Chemical Technology in Prague (VSCHT), it is now possible to reliably specify emissions from non-energy use and thus reallocate activity data, which were reported under 1.A.2.c in previous submissions, in accordance with IPCC 2006 Gl.

Newly introduced subcategory 2.B.10 Other is divided into two subcategories. The first sub-category includes CO_2 emissions from non-selective catalytic reduction (NSCR) of output gases from nitric acid production; the second one includes emissions for hydrogen production by steam reforming in the petrochemical and chemical industry (excluding hydrogen used for NH_3 production, which is based on other feedstock than NG, see section 4.3.1). Emissions from NSCR are not very significant (about 15 kt of CO_2). Emissions from steam reforming of NG are somewhat more significant (about 200 kt of CO_2)).

4.4 Metal Industry (CRF 2.C)

This category includes mainly CO_2 emissions from 2.C.1 Iron and Steel Production. CO_2 emissions from iron and steel are identified as a key category (by both level and trend assessments). A small amount of CH_4 is also emitted. Ferro-alloys were manufactured in limited amounts in a small production unit in the Czech Republic; this process could constitute an unsubstantial source of CO_2 emissions. Unfortunately, CzSO does not monitor any data on this production process. This year specific data from Ministry of Industry and Trade were obtained for the Ferroalloys Production for 2008 - 2014. CzSO does not monitor production of Lead nor Zinc. The data about production was obtained from Ministry of Industry and Trade.

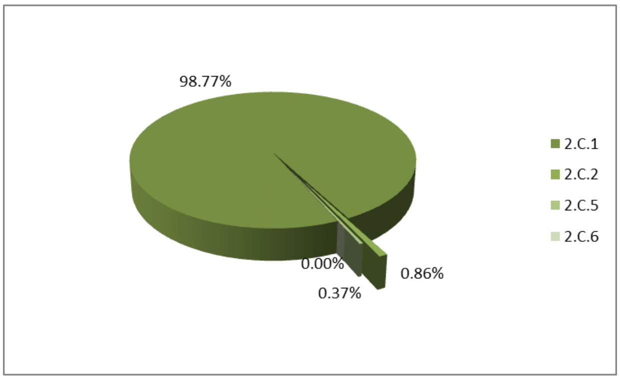


Fig. 4-9 e share of individual categories in CO_2 emissions from category 2.C Metal Industry in 2014 [kt CO_2]

Investigation revealed one smaller production plant, which reported that aluminium was used as a reducing agent; this did not lead to CO_2 emissions. In 2009 this production was stopped.

Fig. 4-9 indicates the share of emissions of each subcategory in 2.C. There is apparent major share of 2.C.1 category.

4.4.1 Iron and Steel Production (CRF 2.C.1)

4.4.1.1 Category description

Iron is produced in the Czech Republic in two large metallurgical facilities located in the cities of Ostrava and Třinec in the Moravian-Silesian Region, in the north-eastern part of the Czech Republic. Both these metallurgical works employ blast furnaces and also lines for the production of steel, coking furnaces and other supplementary technical units. Another large steel plant is located immediately next to the metallurgical works in Ostrava, taking raw iron (in the liquid state) from the nearby blast furnaces (located in the area of the Ostrava metallurgical works).

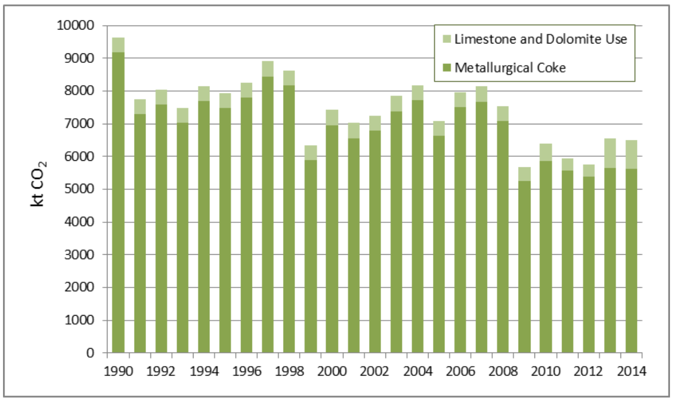


Fig. 4-10 Trend of CO_2 emissions in 2.C.1, 1990 – 2014 [kt CO_2]

4.4.1.2 Methodological issues

The CO_2 emissions from iron and steel production were calculated using the national approach which can be considered as Tier 2. However, Tier 2 emission estimations based in IPCC 2006 Guidelines (IPCC, 2006) include recommendations to also include emissions arising from combustion of Blast Furnace and Oxygen Steel Furnace Gas in other than metallurgical complexes (for instance in Energy category 1.A.1.a). However, it is expected in the Czech Republic that all Blast Furnace and Oxygen Steel Furnace Gases are combusted directly in the metallurgical complexes. This means that the national approach to emission estimations contains a few aspects from Tier 1, as some parts of the equation are available for the computation. An important aspect of the computation is the amount of carbon in the reducing agent (i.e. in metallurgical coke) and thus also the amount of carbon in scrap and in steel. Thus, the approach used is considered to be as close to Tier 2 based on IPCC 2006 Gl. (IPCC, 2006) as possible.

The calculation in IPCC 2006 Gl. (IPCC, 2006) also includes CO_2 emissions from limestone and dolomite used in iron and steel metallurgy. Since the last submission, these emissions have been reported under 2.C.1. Data reported under EU ETS were used for these emissions, i.e. Tier 3.

The computational approach as well as the parameters used were consulted in general with a representative of The Steel Federation, Inc.

Tab. 4-14 The amounts of metallurgical coke consumed and CO_2 emissions in 1990 – 2014

	Coke consumed in blast furnaces	Use of limestone and dolomite [kt]	CO_2 from 2.C.1 [kt]
1990	3 211	891.04	9 642.54
1991	2 559	891.03	7 750.98
1992	2 624	891.03	8 049.44

	Coke consumed in blast furnaces	Use of limestone and dolomite [kt]	CO_2 from 2.C.1 [kt]
1993	2 426	891.04	7 479.70
1994	2 663	891.03	8 143.88
1995	2 587	891.04	7 930.90
1996	2 701	891.05	8 257.45
1997	2 846	891.01	8 907.86
1998	2 750	891.05	8 625.62
1999	1 941	891.08	6 346.94
2000	2 327	890.88	7 418.03
2001	2 175	891.20	7 016.95
2002	2 252	891.16	7 251.30
2003	2 459	890.29	7 846.70
2004	2 628	892.15	8 176.00
2005	2 260	891.06	7 084.34
2006	2 480	887.65	7 952.48
2007	2 570	897.73	8 154.22
2008	2 366	887.78	7 539.39
2009	1 742	877.45	5 674.72
2010	2 004	927.97	6 402.85
2011	1 910	857.92	5 936.01
2012	1 825	846.47	5 752.28
2013	1 900	1 079.53	6 543.14
2014	1 886	1 051.93	6 498.79

The amounts of blast furnace coke consumed and corresponding emissions are given in Tab. 4-14.

Estimation of CH_4 from metal production is based on the IPCC 2006 Guidelines Tier 1 methodology. Default emission factors 0.1 g CH_4 per tonne of coke produced and 0.07 kg CH_4 per tonne of sinter produced were used. In this case, the relevant activity data correspond to the amount of coke produced from the Energy Balances of the CR are given in CRF Tables and official statics data of sinter produced.

Emission estimates of precursors for the relevant subcategories have been transferred from NFR to CRF, as described in previous chapters and in Chapter 9.

4.4.1.3 Uncertainties and time consistency

The uncertainty estimates have so far been based on expert judgment. Their improvement is ongoing and some uncertainty estimates for Iron and steel production have been revised in previous submissions (CHMI, 2012b). The new estimate of EF (CO_2) is now 10%, which is in accordance with the 2006 Guidelines (IPCC, 2006) and is slightly higher than the former value (5%). The estimate for AD (7%) remained unchanged, because this value is in good agreement with the recommendation in the Regulation of Commission (EU) No. 601/2012 (EU, 2012). Further improvement of uncertainty estimates is planned for the next submission.

Consistency of the time series is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year of 1990 to 2014.

4.4.1.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. The greatest attention was focused on identifying gaps and imperfections using the new reporting software (CRF Reporter), specifically by observing trends in figures and by checking IEFs. Attention was also focused on checking sources from inter-sector boundaries (Energy, Industry) that they are neither omitted nor counted twice. CO_2 emissions from coke used in blast furnaces are not considered in Energy sector (see Chapter 3.2).

Activity data available in the official CzSO materials in relation to QA/QC were independently determined by experts from CHMI and KONEKO and were mutually compared. Experts at CHMI additionally checked most of the calculations carried out by experts at KONEKO and vice versa. For another QA, especially QA of computational approach, is also used former coordinator of National Inventory System.

The quality control was held by fulfilling the QA/QC form presented in Annex 5.

4.4.1.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations performed in this submission.

4.4.1.6 Source-specific planned improvements, including tracking of those identified in the review process

In future submissions is planned to investigate data relevant for potential implementation of Tier 3 methodology in this category.

4.4.2 Ferroalloys Production (CRF 2.C.2)

4.4.2.1 Source category description

Ferroalloys Production is production of concentrated alloys of iron and or more metals such as silicon, manganese, chromium, molybdenum, vanadium and tungsten.

Only limited amounts of Ferroalloys are produced in the Czech Republic.

4.4.2.2 Methodological issues

The activity data were obtained from the Ministry of Industry and Trade for the 2011-2014 time series. In this submission, new data for 2008 – 2010 were also obtained. However the data has to be displayed as confidential. The data for 1990-2003 were obtained from the original CzSO database.

The composition of ferroalloys produced in the facility of main producer of ferroalloys was used for consideration of the composition of ferroalloys in the Czech Republic. Default emission factors from table 4.5 in IPCC 2006 Guidelines (IPCC, 2006) were used for CO_2 emission estimations. Tier 1 methodology for CH_4 emission estimation was used based on default emission factors from Table 4.7 in the IPCC 2006 Guidelines (IPCC, 2006).

4.4.2.3 Uncertainties and time consistency

Since default emission factors were used for emission computations, the uncertainty of emission factors were considered default, i.e. provided in table 4.9 in IPCC 2006 Guidelines (IPCC, 2006) as 25%. The uncertainty of activity data is estimated on the level of 5%.

4.4.2.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. General QC procedures were applied in this sector. The activity data and composition of ferroalloys were discussed with representative of The Steel Federation, Inc.

4.4.2.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Recalculation due to new obtained activity data was performed for 2008 - 2010. The transparency of reporting was increased due to this recalculation. In the previous submission the data were reported as NE.

4.4.2.6 Source-specific planned improvements, including tracking of those identified in the review process

Further investigation of activity data is planned for the future submissions.

4.4.3 Lead Production (2.C.5)

4.4.3.1 Source category description

In the Czech Republic there is no primary production of lead, however secondary production and recycling is happening. There is one major installation specialised for this production.

4.4.3.2 Methodological issues

Research was performed on potential Lead producers in the Czech Republic. The data were obtained from the Ministry of Industry and Trade: detailed data were obtained for 2011 – 2014. However the data has to be displayed as confidential. A constant value 20 kt lead production was estimated for 1900 – 2007. In this submission, the data for 2008 – 2010 were also updated using the statistics of the Ministry of Industry and Trade. Updated activity data were also used for 2014. The CO_2 emissions were estimated at the level of Tier 1 methodology based on the IPCC 2006 Guidelines (IPCC, 2006) using the default CO_2 emission factor 0.52 t CO_2/t of lead. CO_2 emissions in 2014 equalled 24.1 kt.

4.4.3.3 Uncertainties and time consistency

Since default emission factors were used for emission computations, the uncertainties were based in IPCC 2006 Gl. recommendation, i.e. 10% for activity data and 50% for emission factor.

4.4.3.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. General QC procedures were applied in this sector. The activity data and composition of ferroalloys were discussed with representative of The Steel Federation, Inc.

4.4.3.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Recalculation of 2008 – 2010 and 2013 was performed in this submission due to new updated activity data. Impact of this recalculation on CO_2 emissions is apparent from Fig. 4-11.

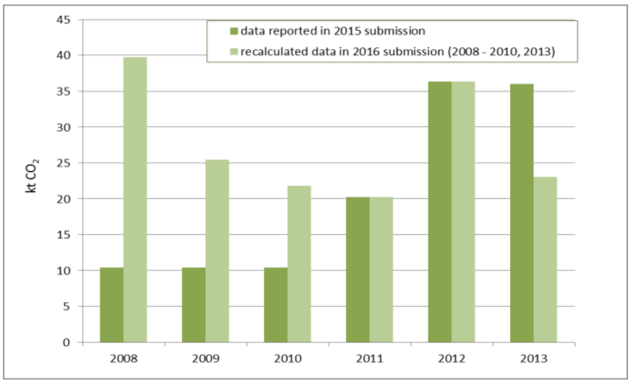


Fig. 4-11 Recalculation performed due to updated activity data for 2008 – 2010, 2013, [kt CO_2]

4.4.3.6 Source-specific planned improvements, including tracking of those identified in the review process

Further investigation of activity data is planned for the future submissions.

4.4.4 Zinc Production (2.C.6)

4.4.4.1 Source category description

There is no primary production of Zinc in the Czech Republic, however secondary production is occurring. The reported emission are all from secondary production.

4.4.4.2 Methodological issues

The research of potential Zinc producers in the Czech Republic were performed. Detailed data were obtained from Ministry of Industry and Trade for 2011-2014. This year data updated data for 2008 – 2010 was also obtained. However the data has to be displayed as confidential. For 1990-2007 no reliable data were obtained. The CO_2 emissions were estimated on the level Tier 1 methodology based on IPCC 2006 Guidelines (IPCC, 2006) using default CO_2 emission factor 1.72 t CO_2/t of zinc. CO_2 emissions in 2014 equalled 0.29 kt, which presents negligible share in the whole inventory.

4.4.4.3 Uncertainties and time consistency

Since default emission factors were used for emission computations, the uncertainties were based in IPCC 2006 Gl. recommendation, i.e. 10% for activity data and 50% for emission factor.

4.4.4.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. General QC procedures were applied in this sector. The activity data and composition of ferroalloys were discussed with representative of Ministry of Industry and Trade.

4.4.4.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Recalculation due to new obtained activity data was performed for 2008 - 2010. The transparency of reporting was increased due to this recalculation. In the previous submission the data were reported as NE.

4.4.4.6 Source-specific planned improvements, including tracking of those identified in the review process

In future submissions is planned further investigation of activity data.

4.5 Non-energy products from fuels and solvent use (CRF 2.D)

This subcategory includes the emissions from the first use of fossil fuels as products, where their primary use is other than combustion for energy production or use as a reducing agent in industrial processes.

Products reported in this subcategory include Lubricants, Paraffins, Asphalts and Solvents. Emissions from other (secondary) use or disposal of these products are included in the relevant sectors (e.g. Energy, Waste).

Fig. 4-8 shows the share of individual subcategories in 2.D. 79% of 2.D CO_2 emissions are produced from Lubricant Use, followed by Urea used as catalysts (15%) and the use of Paraffin Wax (6%).

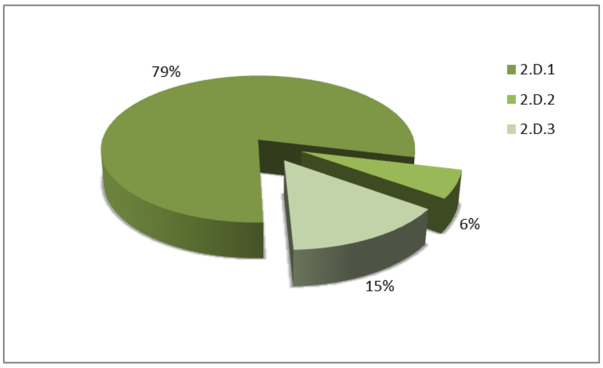


Fig. 4-12 The share of individual subcategories for CO_2 emissions in 2.D in 2014 [kt CO_2]

4.5.1 Lubricant Use (2.D.1)

4.5.1.1 Source category description

Lubricants are produced from refining of crude oil in petrochemical installations. There can be distinguished between engine oils and industrial oil or grease.

4.5.1.2 Methodological issues

The activity data are provided by CzSO in the official Energy balance of the Czech Republic. The non-energy use of fuels is also included. The amount of lubricants used for other than energy production is included in this category as activity data.

Tier 1 methodology from the IPCC 2006 Guidelines was used for CO_2 emission estimations. The default emission factor 20 kg C/GJ was used; the Oxidised During Use (ODU) factor was used as a default value equal to 0.2. CO_2 emissions from this category in 2014 were equal to 92.6 kt CO_2.

4.5.1.3 Uncertainties and time consistency

Since the activity data used are from official statics, the suggested 5% uncertainty (IPCC, 2006) was applied for this category. Since default ODU factor was used, suggested 50% uncertainty from IPCC 2006 Gl. was applied for emission factor uncertainty.

4.5.1.4 Source-specific QA/QC and verification

Standard QA/QC procedures were applied for this subcategory. Special attention was paid to cross-sectoral issues (Energy x IPPU), so no emissions are omitted, nor counted twice.

4.5.1.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculation performed in this submission.

4.5.1.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvements are planned in this subcategory.

4.5.2 Paraffin Wax Use (2.D.2)

4.5.2.1 Source category description

This category includes use of products separated from fossil fuels called paraffins, waxes or vaseline. From chemical point of view they are mixtures of solid paraffinated hydrocarbons obtained from crude oils. Different types are characterised by point of solidification and amount of oil contained.

4.5.2.2 Methodological issues

Activity data reported in official Energy balance of CzSO as non-energy use are used for emission estimation in this category. Tier 1 methodology from IPCC 2006 Guidelines was used for CO_2 emission estimation. Default emission factor 20 kg C/GJ was used, Oxidised During Use (ODU) factor was used default equal to 0.2. CO_2 emissions in 2014 from this category were equal to 7.1 kt CO_2.

4.5.2.3 Uncertainties and time consistency

Since the activity data used are from official statics, the suggested 5% uncertainty (IPCC, 2006) was applied for this category. Since default ODU factor was used, suggested 50% uncertainty from IPCC 2006 Gl. was applied for emission factor uncertainty.

4.5.2.4 Source-specific QA/QC and verification

Standard QA/QC procedures were applied for this subcategory. Special attention was paid to cross-sectoral issues (Energy x IPPU), so no emissions are omitted, nor counted twice.

4.5.2.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculation performed in this submission.

4.5.2.6 Source-specific planned improvements, including tracking of those identified in the review process

No improvements are planned in this subcategory.

4.5.3 Other (2.D.3)

4.5.3.1 Source category description

Solvent Use

This category includes particularly emissions of NMVOC (ozone precursor) from the use of solvents, which based in IPCC 2006 Guidelines (IPCC, 2006) are not considered to be a source of direct CO_2 emissions.

Road Paving With Asphalt

This category includes particularly emissions of ozone precursors in 1990 – 2005 time - series. Based on the IPCC 2006 Gl. (IPCC, 2006) only NMVOC emission should be reported. Data in reporting for the UNECE/CLRTAP inventory in NFR are used. Emissions from Road Paving with Asphalt are not considered to be a source of CO_2 emissions (IPCC, 2006).

Urea used as catalyst

IPCC 2006 Gl. incorporate this category as source of CO_2 emissions. However, based on methodology temissions from this process should be included in Energy sector, 1.A.3. Since the emissions does not arise from fuel combustion, the emissions are covered under IPPU sector.

4.5.3.2 Methodological issues

Solvent Use

The IPCC methodology (IPCC, 2006) uses the CORINAIR methodology (EMEP/CORINAIR Guidelines, 1999) for processing NMVOC emissions in this category. This manual also gives the following conversions for the relevant activities, which can be used in conversion of data from the CORINAIR (i.e. SNAP) structure to the IPCC classification.

Inventory of NMVOC emissions for 2014 for this sector is based on a study prepared by SVÚOM Ltd. Prague (Geimplová, 2014). This study is elaborated annually for the UNECE/CLRTAP inventory in NFR and is also adopted for the National GHG inventory.

Solvent Use activity data are based on the following sources of information:

- statistical information on producers and imports from the Czech Statistical Office,
- REZZO data,
- annual reports of the Association of Coatings Producers and Association of Industrial Distilleries,
- information from the Customs Administration,

- regular monitoring of economic activities and economic developments in the CR, knowledge and monitoring of important operations in the sphere of surface treatments, especially in the area of application of coatings, degreasing and cleaning,
- regular monitoring of investment activities is performed in the CR for technical branches affecting the consumption of solvents and for overall developmental technical trends of all branches of industry,
- monitoring of implementation of BAT in the individual technical branches,
- technical analysis of consumption of solvents in households; NMVOC emissions from households are entirely fugitive and, according to qualified estimates, contribute approximately 16.5% to total NMVOC emissions.

The activity data for Solvent Use were extracted from the official Energy balance. Form the whole amount of non-energy use of Other oil products were extracted the Oil needed for NH_3 production. Sum of the rest of Other Oil and non-energy use of White spirit was considered as the best available data for Solvent Use. This approach was approved with relevant experts from CzSO.

Road Paving With Asphalt

The activity data from last submission were used. Emissions are used from UNECE/CLRTAP inventories.

Urea used as catalyst

Since no detailed data about urea used as catalyst is available, the default approach was used, i.e. the activity level is 1% to 3% of diesel consumption by the vehicle. For the Czech Republic conservative estimate of 2% was used. 2% of the amount of diesel used in road transport was used as activity data. This approach was used for the emission estimates for 1998 – 2014 time series, which was consulted as appropriate time series, when this process can occur. The computational approach presented in Eq. 3.2.2 in IPCC 2006 Gl. was applied to estimate CO_2 emissions. CO_2 emissions in 2014 from this category were equal to 17.02 kt CO_2.

4.5.3.3 Uncertainties and time consistency

Solvent Use

Uncertainty of NMVOC emissions is considered to be quite large, based on IPCC 2006 Gl. (IPCC, 2006) it is considered as 50%. The uncertainty of activity data is considered based on expert judgement as 25%.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2014.

Road Paving With Asphalt

Since no CO_2, CH_4 or N_2O emission were estimated in this category, no uncertainties were considered in this category.

Urea used as catalyst

Suggested default range for uncertainty was applied for 2.D.3 category, i.e. 5% for activity data and 5% for emission factor uncertainty. However even though the emission are reported under 2.D.3, the range was applied based on IPCC 2006 Gl. Vol. 2 Energy, where methodology for emission estimation from urea used as catalyst is provided.

4.5.3.4 Source-specific QA/QC and verification

Solvent Use

The emission data in this section were taken from the UNECE/CLRTAP inventories in NFR. Annual reports are available on the method of calculation for the individual years since 1998. Following transfer of the emission data to the new CRF Reporter, it was apparent that trends in the emissions did not exhibit any significant deviations.

A control was performed of the company processing the data (SVÚOM Ltd. Prague) and the coordinator of processing of UNECE/CLRTAP inventories in NFR.

Road Paving With Asphalt

No specific QA/QC or verification procedures is applied.

Urea used as catalyst

Standard QA/QC procedures were applied for this subcategory. Activity data estimate was discussed with the expert for transport.

4.5.3.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Solvent Use

No recalculations performed in this submission.

Road Paving With Asphalt

No recalculations performed in this submission.

Urea used as catalyst

This category is newly incorporated in the reporting since this submission.

4.5.3.6 Source-specific planned improvements, including tracking of those identified in the review process

Solvent Use

No improvements are planned in this category.

Road Paving With Asphalt

No improvements are planned in this category.

Urea used as catalyst

Further investigation of activity data is planned for the future submissions.

4.6 Electronics industry (CRF 2.E)

4.6.1 Integrated Circuit or Semiconductor (CRF 2.E.1)

4.6.1.1 Source category description

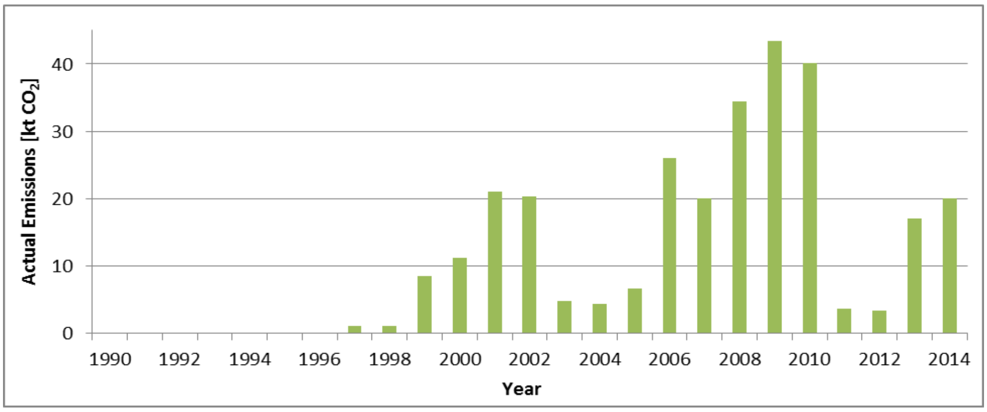


Fig. 4-13 Trend of F-gases actual emissions from Integrated Circuit or Semiconductors [kt CO_2 eq]

Basic data about new equipment and services was obtained from questionnaires, conducted by Řeháček, 2015. This equipment is produced by only one company and is serviced by several other companies. The share of 2.E. category in the total actual emissions has decreased rapidly since 1995 due to a decrease in the use of SF_6 in this category.

The manufacturers of electrical equipment maintain very eco-friendly policies (involving treatment, training of staff, certificate etc.). Operational leakages are not measured (legislation does not force operators to do so) but can be estimated based on stock change. After a consultation with the main operator in the country the leakages are virtually non-existent and depend solely on accidents. Leakages represent less than 100 kg/yr in total. Such a low amount of SF_6 is not required to be reported from the operator into national database "Integrated system of reporting obligations" (*Integrovaný systém plnění ohlašovacích povinností* - ISPOP).

4.6.2 Methodological issues

This category includes the gases HFC-23, CF_4, C_2F_6, SF_6 and NF_3. Because of the lack of detailed information, the data are reported for category 2.E.1 Integrated Circuit or Semiconductor. Emissions from this category are calculated using Tier 2a described in IPCC 2006 Gl. equation 6.2 without using fractions a_i and d_i, which are considered by expert judgement to be negligible and further using equation 6.3 (the only relevant gases used in the Czech Republic were HFC-23, CF_4, C_2F_6, SF_6 and NF_3) for estimation of by-product emissions of CF_4. By-product emissions of CF_4 are reported together with regular CF_4 emissions. The emission factors employed are summarized in Tab. 4-15. The default emission factors for the gases HFC-23, CF_4, C_2F_6, SF_6 and NF_3 were chosen from IPCC, 2006, volume 3, part 2 Electronic Industry emissions, Table 6.3. The trend in emissions of F-gases from category 2.E.1 Integrated Circuit or Semiconductor is illustrated in Fig. 4-5.

Tab. 4-15 EFs for F-gases from 2.E electronic industry

F-gas	2006 Guidelines (IPCC)			
	(1-Ui)	B_{CF4}	B_{C2F6}	B_{C3F8}
HFC-23 (CHF_3)	0.4	0.07	NA	NA
CF_4	0.9	NA	NA	NA
C_2F_6	0.6	0.2	NA	NA
SF_6	0.2	NA	NA	NA
NF_3	0.2	0.09	NA	NA

The 2016 submission, applies methodology, based on 2012 submission model.

In this category are included gases C_2F_6, CF_4, SF_6, CHF_3 (HFC-23) and NF_3. All of these gases are used for manufacturing of semiconductors. As the GWPs of these gases indicate, they are persistent pollutants with the time of presence in the atmosphere reaching up to thousands of years.

In 2.E category SF_6 is used in semiconductor industry for etching and melting Mg and Al. Huge energy companies are the main contributors to the SF_6 emissions. The main environmental concern connected with SF_6 is its presence in the atmosphere for a long time.

4.6.3 Uncertainties and time-series consistency

Gases SF_6 and NF_3 are significant for semiconductor manufacturing. SF_6 consumption can be considered as stagnant in the last years. For semiconductor manufacturing (etching, cleaning), this year a new substance NF_3 was added.

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

4.6.4 Source -specific QA/QC and verification

Validation was performed by comparing the data obtained from the customs authorities, questionnaires and reports from Ministry of the Environment. This comparison revealed a number of errors that were subsequently corrected.

4.6.5 Source -specific recalculations, including changes made in response to the review process and impact on emission trend

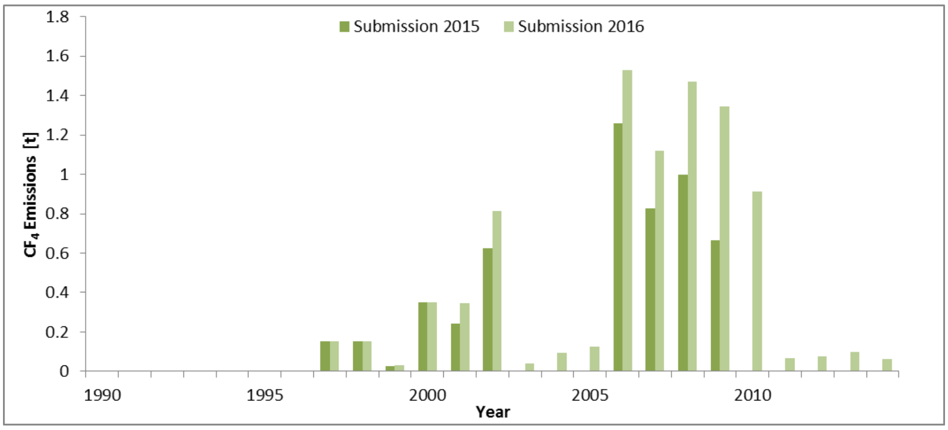


Fig. 4-14 Recalculation for 2.E.1 category - adding of by product emissions

Electronic Industry includes emissions of fluorinated carbon gases, SF_6 and NF_3 used predominantly for manufacturing of semiconductors. Subsector 2.E.1 Integrated Circuits or Semiconductors was recalculated including by-product emissions. In subsector 2.E.4 Heat Transfer Fluids the notation keys were changed to NE. Research of data for these issues is planned for future submissions.

4.6.6 Source -specific planned improvements, including tracking of those identified in the review process

Although the current survey considered factors a_i and d_i in Tier 2a methodology as negligible, it is planned to explore this technology further in more details in future submissions, no later than the introduction of F-gases in the EU ETS trading.

Furthermore, planned improvement for this category is to contact industry facilities which use SF_6 or NF_3 for detailed information about stocks and emissions.

Improvement of uncertainty estimation is in progress.

4.7 Product uses as substitutes for ozone depleting substances (ODS) (CRF 2.F)

4.7.1 Source category description

Emissions of F-gases (HFCs, PFCs, SF_6) in the Czech Republic are at relatively low level due to the absence of large industrial sources. Furthermore all of the F-gases in the Czech Republic are imported; therefore there are no fugitive emissions from manufacturing. Additionally, there is no production of other fluorinated gases (CFCs, HCFCs, etc.) that could lead to by-product F-gases emissions and there is no primary aluminium and magnesium industry in the Czech Republic.

In 2014 actual emissions increased by 208.22 kt in CO_2 equivalent. The higher level in 2014 compared to 2013 could be explained by growth of large users, such as automotive industry and manufacturing of stationary air-conditioning. The vast majority of F-gases remain from production of refrigerators and air conditioners. Other categories carry only a small proportion of F-gases emissions.

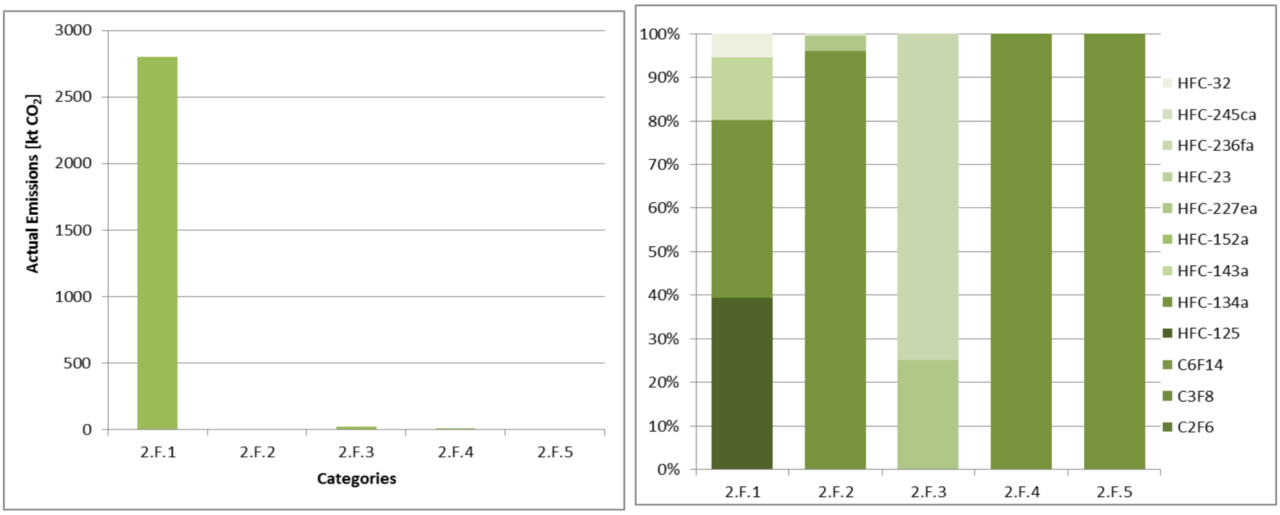


Fig. 4-15 Comparison of actual emissions for individual categories of HFCs, PFCs kt CO_2 eq. in 2014

HFC emissions from 2.F.1 category dominate F-gases emissions as illustrated on Fig. 4-15. In 2014 only actual emissions have been calculated. The actual emissions in 2.F show modest growth.

No official statistics that would allow easy disaggregated reporting or use of the higher tiers are currently available in the Czech Republic. Inventory of actual emissions of F-gases is based on customs statistics, "Integrated system of reporting obligations" (ISPOP) and individual verification of this data by sectoral experts. Detailed data on the use of F-gases are collected on the basis of voluntary cooperation between sectoral experts and private companies.

Actual emissions of F-gases increased from 0.24 kt CO_2 eq. in 1995 to 2 835.27 kt CO_2 eq. in 2014. This significant leap forward by orders of magnitude has been driven mainly by substantial increase in the use of HFCs in refrigeration and much less by the already in 2010 peaked use of PFCs. Detailed information about actual emissions is given in Tab. 4-16 and in the CRF Tables. For detailed Information please examine Fig. 4-15.

Tab. 4-16 Actual emissions of HFCs and PFCs in 1995 - 2014 [kt CO_2 eq.]

	Total	PFCs	HFCs
	[kt CO_2 eq.]	[kt CO_2 eq.]	[kt CO_2 eq.]
1995	0.24	0.01	0.23
1996	35.14	0.47	34.68
1997	99.44	0.43	99.02
1998	134.54	0.39	134.15
1999	147.94	0.63	147.32
2000	205.34	1.36	203.99
2001	310.74	2.16	308.59
2002	403.12	2.54	400.58
2003	514.08	5.44	508.64
2004	609.31	6.84	602.47
2005	707.98	7.22	700.77
2006	945.00	7.77	937.23
2007	1290.13	8.47	1281.66
2008	1521.13	9.26	1511.87
2009	1648.45	9.32	1639.13
2010	1956.83	9.12	1947.71
2011	2226.09	8.39	2217.70
2012	2402.52	7.14	2395.39
2013	2627.05	5.87	2621.18
2014	2835.27	4.89	2830.38

4.7.2 Methodological issues

Currently, the national F-gas inventory is based on the method of actual emissions, according to the IPCC 2006 Guidelines (IPCC, 2006). Due to the relatively short time of use of F-gases, the disposed amount is rather small and considered negligible for the inventory process. In 2014, a small amount of destroyed F-gases was reported. They were usually mixtures of old CFC-12 and HCFC-22. Five companies in the country are reported to provide disposal services for used F-gases. One of these is reported to experiment with regeneration using the distilling process but is still not officially operating on the market. The main part of F-gases was imported to CR for destruction and did not come from equipment operating in CR. The actual emissions methodology is specified for each category.

As these substances are not produced nationally, import and export information coming from official customs authorities is of key importance. Individual F-gases do not have separate custom codes in the customs tariff list as individual chemical substances. HFCs and PFCs are listed as totals in the cluster of halogen derivatives of acyclic hydrocarbons. In order to determine the exact amounts of these substances, it is essential to obtain information from the customs statistics and from individual importers and exporters, about (a) the imported and exported amounts and (b) types of substances (or their mixtures), (c) the amounts and types of disposed F-gases and also (d) the areas of usage. Data about direct import/export, use and destruction were also obtained from ISPOP. ISPOP is the national system of environmental reporting; all importers, exporters and users of more than a threshold amount of

100 kg are obliged to report information about the type and amount of F-gas used. All the importers, exporters and users were requested to complete a specific questionnaire on export and import of F-gases and to support the questionnaire by additional information on the quantity, composition and use. More detailed description of the methodology is available under separate document (Řeháček and Michálek, 2005) - a study which also contains all the relevant information on calculations of actual emissions.

4.7.2.1 Refrigeration and Air conditioning (CRF 2.F.1)

This chapter specifies the actual emission methodology used for a given category. In the following chapters, individual categories with similar methodology are combined. Detailed information on the data and methodology used are included in a special report prepared by external sector expert, Ing. Řeháček (Řeháček, 2015).

The most important category in the range of actual emissions is Refrigeration and Air Conditioning Equipment (CRF 2.F.1), which is responsible for 98.82% of actual F-gases emissions.

In the CRF Tables, emissions from this category are divided into only two sub-categories:

2.F.1.a Commercial Refrigeration

This sub-category includes emissions from: Domestic Refrigeration, Stand-alone Commercial Applications, Medium & Large Commercial Refrigeration, Transport Refrigeration, Industrial Refrigeration including Food Processing and Cold Storage, Chillers and Residential and Commercial Air-Conditioning including Heat Pumps.

This sub-category includes the following gases: HFC-125, HFC-152a, HFC-32, HFC-143a, HFC-134a, HFC-23, C3F8, C2F6, C6F14, HFC-227ea and HFC-245fa

Emissions from Commercial Refrigeration include emissions from servicing old equipment and emissions from production of new air-conditioning equipment. This category has the largest share in the total actual emissions of 2.F, which equalled to 70.95% in 2014. The development of emissions of F-gases from Commercial Refrigeration and Mobile Air-Conditioning is illustrated on Fig. 4-7.

2.F.1.e Mobile Air-Conditioning

This sub-category includes emissions from Mobile Air-Conditioning.

This sub-category includes only gas HFC-134a.

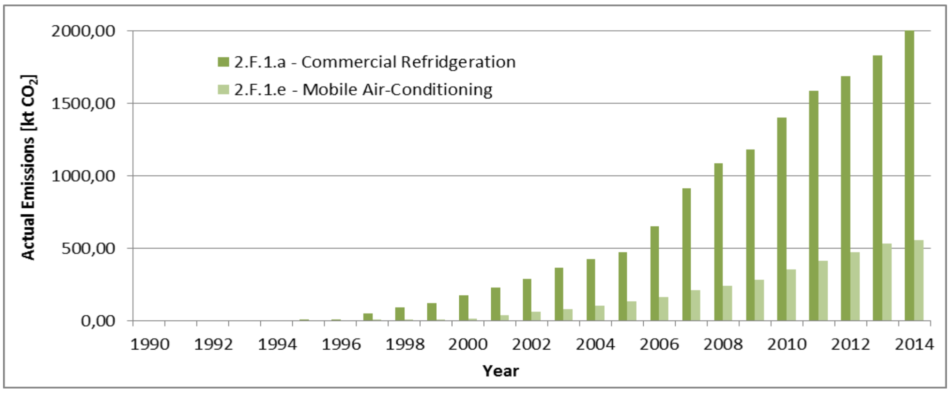


Fig. 4-16 Trend of F-gases actual Emissions for Commercial Refrigeration and Mobile Air-Conditioning [kt CO_2 eq]

Emissions from Mobile Air-Conditioning include emissions from the “First-Fill” in three Czech automobile factories and from servicing old equipment. This fact is also supported by the information on disposed refrigerants (Řeháček, 2015). The contribution of this category to total actual 2.F emissions was 27.87% in 2014. It can be anticipated that emissions from this category will increase in the future.

Emissions from other subcategories are included in the above-mentioned two categories due to lack of detailed information. Wholesale distributors supply F-gases to consumers, which use them across multiple categories. Unfortunately, wholesale distributors and even consumers do not provide exact information about distribution of F-gases into detailed categories according to their usage. The methodology used in these calculations underestimates the real emissions, as the information about marketed products containing F-gases (cars, air containers etc.) is not taken into account. Marketed products could be imported already filled up, partly filled or empty. Account is taken only of bulk F-gases. Measures are in progress to obtain the relevant data to split the emission categories..

Tab. 4-17 Parameters for use in slightly modified eq. 7.3 IPCC 2006 Gl. (IPCC, 2006)

Sub-application	Lifetimes (years)	Emission Factors (% of initial charge/year)		End-of-Life Emission (%)	
Factor in Equation	D	k	X	ηrec,d	p
		Initial Emission	Operation Emission	Recovery Efficiency	Initial Charge Remaining
Commercial Refrigeration	14.493	0.816	8.854	75.224	73.881
Mobile Refrigeration	9.429	0.348	15.571	60.476	42.619

Parameters for assessment following the 2006 IPCC methodology were adjusted to fit the level of aggregation. Methodology implementation has been thoroughly revised also incorporating emissions from decommissioning of refrigeration and air-conditioning appliances.

Emissions from decommissioning are calculated using Gaussian distribution model with mean at lifetime expectancy (see Tab. 4-17 above). The model takes into account different approach for serviced equipment and newly filled equipment, assuming only half life-expectancy for the serviced equipment, resp. the amount of service-filled gas.

The coolant media type used for the purpose of mobile air-conditioning is HFC-134a and the main type used for stationary air conditioning/refrigeration is R-410, a mixture of HFC-32 and HFC-125 in a ratio of 1:1. Other types of HFCs like HFC-23, HFC-32 and HFC-245fa (in 2.F.1.a Commercial Refrigeration) are used in small amounts in refrigeration mixtures as additive for adjustment of properties of mixtures of refrigerants.

In 2014 no significant changes occurred in the collection and treatment policies of discarded refrigeration appliances. Only two companies in Czech Republic are dealing with regeneration of HFC coolants.

They used privately constructed distilling machinery to process app. 5 tonnes of HFC-134a contaminated with mineral oil fractions. The HFC was collected and stored during previous years. Emissions from this process are not included in the inventory.

Most of the discarded refrigeration appliances contained old refrigerant's media - CFC-12 and HCFC-22 and old insulating materials - CFC-11. Appliances containing HFCs are still being disposed in negligible amounts, considering their 6-30 year life cycle (IPCC 2006 Gl., Volume 3, Chapter 7, table 7.9.) which depends on the type of device. According to ISPOP database in the Czech Republic were eliminated by ecological burning or regenerated 8.38 t of HFC-134a, 8.51 t of HFC-125, 2.14 t of HFC-143a, 6.72 t of HFC-32 and 0.51 t of SF_6. However in the next 5 years we can expect an increase in appliances disposal with a lifetime of about 20 years such as industrial refrigeration, residential and commercial air-conditioning etc.

A mixture of retrieved cooling media is being incinerated in specialized facilities. In one case, the retrieved mixture of ODS is exported as a raw material for a different industrial processes than air-conditioning or refrigeration. A very small amount of coolant medium (R 410) is exported for purposes of regeneration, where this amount depends on claims in the automobile market and remains at a level of in 0-3 t p.a.

4.7.2.2 Foam Blowing Agents (CRF 2.F.2)

F-gases are used in the Czech Republic only for producing hard foam. Solely HFC-143a is used regularly for foam blowing. HFC-227ea and HFC-245fa were used occasionally in previous years for testing purposes. Use of HFC for foam blowing was not reported in 2014. Due to high costs, HFCs are being replaced by other hydrocarbons.

Emissions from this category are calculated by default methodology and EF described in IPCC, 2006 equation 7.7 for foam blowing. The contribution of foam blowing to total emissions of 2.F category equals to 0.09% in 2014. Trend of F-gases emissions from Foam Blowing Agents is illustrated on Fig. 4-8.

4.7.2.3 Fire Protection (CRF 2.F.3)

Emissions from this category are calculated on the basis of IPCC 2006 Gl., equation 7.17. Calculations are based on data concerning production of new equipment and servicing the old equipment. The share of this category in the total actual emissions from 2.F was 0.74% in 2014. Trend of F-gases emissions from Fire Protection is illustrated on Fig. 4-8.

It was revealed in consultations with servicing companies that first-fill leakages are very low and remain below 2% of the total emissions. Operational leakages are virtually non-existent and depend solely upon activation of fire alarms.

In the equipment servicing process, the original halons are sucked out and usually re-used again. The halons are recycled either with simple filtration or distillation. Re-use of original media without any treatment may also occur. Old types of halons (prohibited in the years before 2000) can no longer be manufactured but some of the mixtures can be reused after regeneration. A major part of new equipment employs HFC-227ea, while some installations are filled with HFC-236fa. Due to reuse of regenerated old halon mixtures, HFCs are being introduced rather slowly.

4.7.2.4 Aerosols (Propellants and Solvents) (CRF 2.F.4)

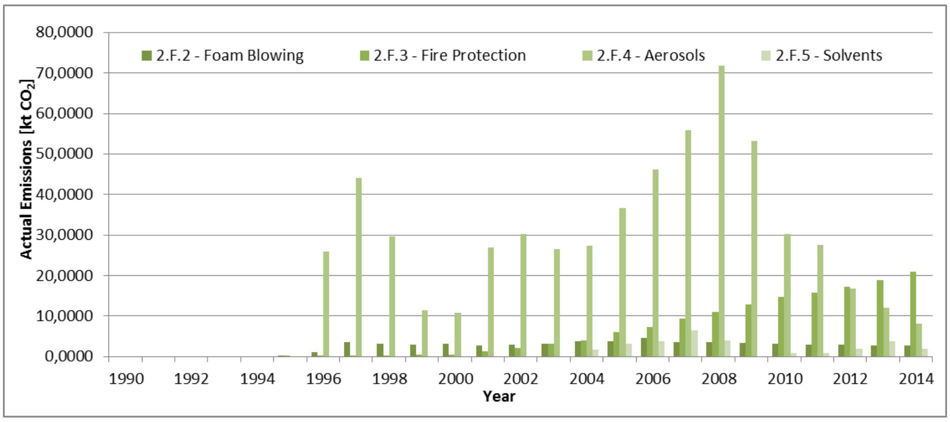


Fig. 4-17 Trend of F-gases actual Emissions for Foam Blowing Agents, Fire Protection, Aerosols and Solvents [kt CO_2 eq]

Emissions from this category are based on IPCC, 2006, equation 7.6; EF equals to 50% (default). A small amount of F-gases used as solvents was reported in the Czech Republic in 2014. The contribution of this category to the total actual 2.F emissions equals to 0.29% in 2014. Trend of F-gases emissions from

Aerosols is illustrated on Fig. 4-17.

In this year consumption of HFC-134a, used like propellant for aerosols decreased. F-gases as propellants for aerosols are currently being replaced by cheaper propellants, specifically dimethyl ether and other hydrocarbons (butane, isobutane and propane).

4.7.2.5 Solvents (Non-Aerosol) (CRF 2.F.5)

Emissions from this category are based on IPCC, 2006, equation 7.5; EF equals to 50% (default). Use of HFC for Solvents was not reported in the Czech Republic in 2014. The contribution of this category to the total actual 2.F emissions equals to 0.07% in 2014. Trend of F-gases emissions from Solvents is illustrated on Fig. 4-8.

4.7.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006, volume 1, Chapter 3, Uncertainties). Improvement of uncertainty estimation is in progress.

4.7.4 Source-specific QA/QC and verification

Verification has been performed by comparison of data received from the customs authorities, from submitted questionnaires and from reports to MoE by significant importers and/or exporters. The methodology and calculations were performed twice independently and were compared. This comparison indicated few errors, which had been corrected.

4.7.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

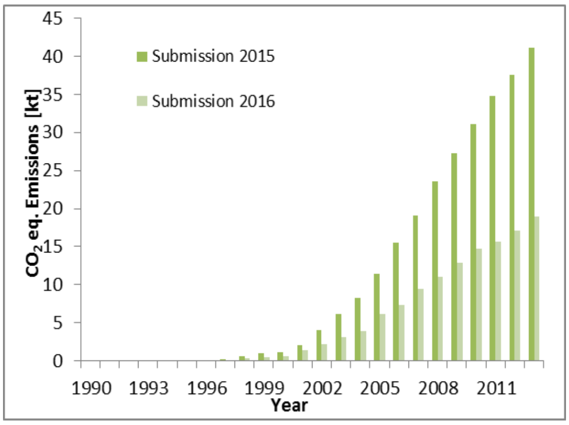
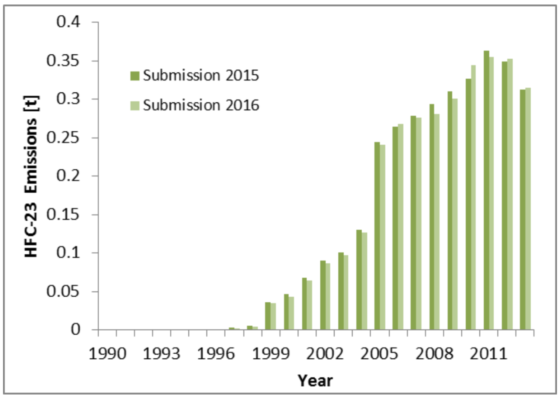


Fig. 4-18 Recalculation for 2.F.3 category - Fire protect



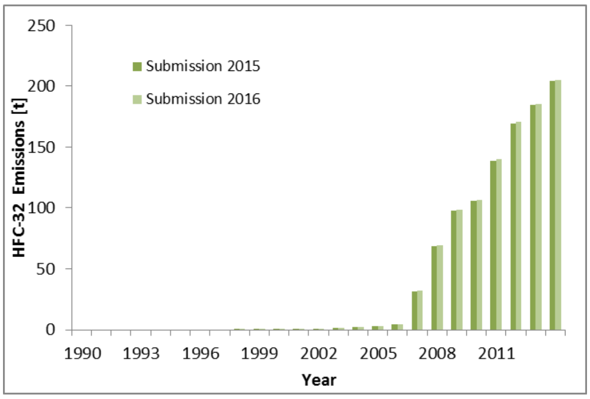
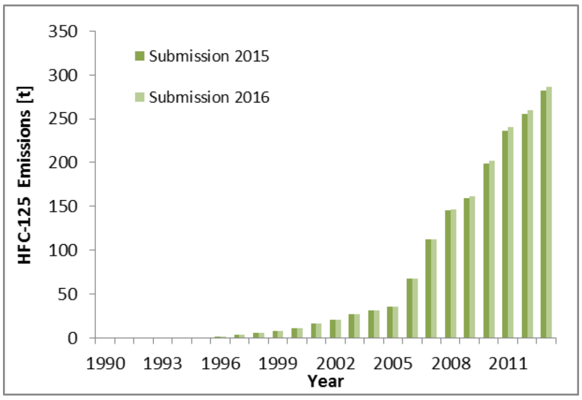


Fig. 4-19 Recalculation for 2.F.1 category - HFC 23 (left) and HFC 32 (right)



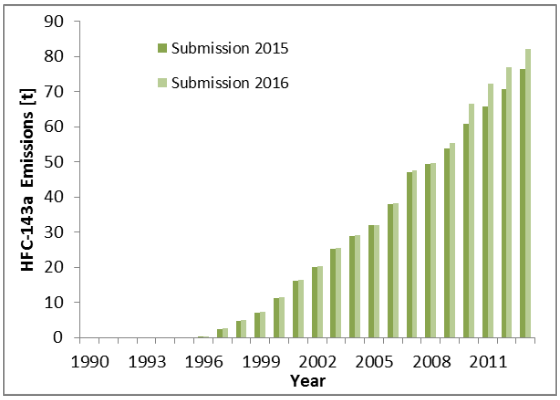


Fig. 4-20 Recalculation for 2.F.1 category - 125 (left) and HFC 143a (right)

This subsector has undergone several recalculations because of the acquisition of new, more reliable data. Historical data has been revaluated on the basis of consultations with external experts. Based on the acquisition of more reliable data, the following recalculations were made: relocation of HFC-23 (Fig 4-19), HFC-32 (Fig 4-19), HFC-143a (Fig 4-20) and HFC-125 (Fig 4-20) from 2.F.1.e (Mobile Air conditioning) to 2.F.1.a (Commercial refrigeration) and, further, the error classification of HFC-245ca was corrected to HFC-245fa. These recalculations were consulted with and verified by the independent F-gas expert.

Furthermore, subcategory 2.F.3 Fire Protection was recalculated by changing the life factor and lifetime according to IPCC 2006 Gl (Fig. 4-14). The subcategory 2.F.5 Solvents (gas HFC-245fa) was recalculated on the basis of new, more reliable data.

4.7.6 Source-specific planned improvements, including tracking of those identified in the review process

Accounting for F-gases contained in products (cars, air containers, etc.) is still being developed and its inclusion is planned for future submissions. Ministry of environment was requested for new source of data for F-gases (according to REGULATION (EU) No 517/2014 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014). So far the inventory team did not receive any information or data from Ministry of environment.

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

4.8.1 Electrical Equipment (2.G.1)

4.8.1.1 Source category description

This category includes SF_6 used like insulation in electrical equipment. Basic data about the new equipment and services was obtained from questionnaires, conducted by Řeháček, 2015. SF_6 for use in electrical equipment is mainly imported as part of the equipment, which is filled below operational amount. First servicing could be then considered as "first fill". Bulk imports are mostly being transferred for the purpose of operational stock-in-trade.

Emissions of SF_6 keeps very steady trend in the whole time series, thanks to their irreplaceable role in electrical equipment insulation. High price of SF_6 on the market prevents its expansion in the fields of other possible use.

SF_6 is still used in older types of heavy current electrical engineering devices. Significant energy companies are the main contributors to the SF_6 emissions. The reason for frequent use of SF_6 is long lifetime of installed devices with this charge. However there is no detailed information about number of devices with SF_6.

4.8.1.2 Methodological issues

Emissions from this category are calculated in line with IPCC 2006 Gl., specifically Equation 8.1, which is called the Tier 1 method. Default emission factors for Sealed Pressure Electrical Equipment were chosen from IPCC, 2006, volume 3, part 2 Other Product And Manufacture Used, table 8.3.

Operational leakage is not measured (legislation does not force operators to do so) but operators usually distinguish between amount of SF_6 used for servicing or filling to new equipment. According to consultations with the main operator in the country, the leakage is virtually non-existent and depends solely on accidents; leakage usually remains below 100 kg p.a. in total. Such a low amount of SF_6 does not even require the operator to report SF_6 usage in ISPOP.

SF_6 for use in electrical equipment is mainly imported as the part of the equipment which is filled below the operational amount. First servicing is then considered as "first fill". Bulk imports are mostly imported for the purpose of operational stock-in-trade.

4.8.1.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

4.8.1.4 Source -specific QA/QC and verification

Validation was performed by comparing the data obtained from the customs authorities, questionnaires and reports from Ministry of the Environment.

4.8.1.5 Source -specific recalculations, including changes made in response to the review process and impact on emission trend

A research of data composition in the subsector 2.G.1 Electrical Equipment was conducted. Results of the research showed, that the emissions factor for HV switchgear (Table 8.3, 2006 IPCC Gl., Vol. 3-2) is more accurate for condition of the Czech Republic. Thus recalculation using emission factor for HV was performed in this submission. Difference between last and this submission shows Fig. 4-21.

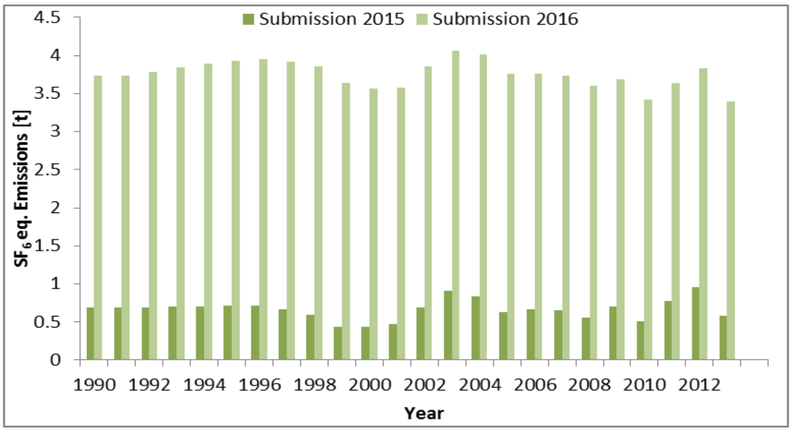


Fig. 4-21 Recalculation in 2.G.1 category - Electrical Equipment

4.8.1.6 Source -specific planned improvements, including tracking of those identified in the review process

Planned improvement for this category is to contact industry facilities which use SF_6 for detailed information about stocks, emissions and division between HV and MV equipment.

4.8.2 SF_6 and PFCs from Other Product Use (CRF 2.G.2)

4.8.2.1 Source category description

This category includes estimates emissions from double-glazed sound-proof windows (CRF - 2.G.2.c). In the Czech Republic for several years SF_6 for manufacturing sound-proof windows is not used. Lifetime of windows filled with SF_6 is assumed to be 25 years. SF_6 was replaced by nitrogen and argon. Emissions occur only from stocks, which can be in the current situation difficult to estimate.

4.8.2.2 Methodological issues

Emissions from this category (Sound-proof glazing) are calculated in line with IPCC 2006 Gl., specifically Equation 8.20, 8.21 and 8.22.

4.8.2.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

4.8.2.4 Source-specific QA/QC and verification

Validation was performed by comparing the data obtained from the customs authorities, questionnaires and reports from Ministry of the Environment.

4.8.2.5 Source-specific recalculations, including changes made in response to the review process

In this year no recalculations in the whole sector were performed.

4.8.2.6 Source-specific planned improvements, including those in response to the review process

No improvements are currently planned in this category in next submission.

4.8.3 N_2O from Product Uses (CRF 2.G.3)

4.8.3.1 Source category description

This category (2.G.3) includes N_2O emissions from the use of this substance in the food industry (aerosol cans) and in health care (anaesthesia).

4.8.3.2 Methodological issues

The calculation of emissions from this category, are based on IPCC, 2006, Volume 3 Chapter 8 equation 8.24. These not very significant emissions corresponding to 0.75 kt N_2O were derived from production in the Czech Republic (0.6 kt N_2O) and from import of N_2O (0.15 kt N_2O), see (Markvart and Bernauer, 2010-2013 and Bernauer and Markvart 2014-2015).

So far, in the Czech Republic, no relevant data have been available to distinguish between N_2O used in anaesthesia and for aerosol cans. Therefore, the existing split (50% for anaesthesia) was based only on a rough estimate.

4.8.3.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

Uncertainties for activity data in this category at the level of 50% were estimated. No uncertainty was determined for the emission factor since we assumed that all the gas is emitted (the emission factor is equal 1 t/t N_2O). Overall uncertainty data are given in Chapter 1.7.

4.8.3.4 Source-specific QA/QC and verification

The sector-specific QA/QC plan follows from the overall plan described in Chapter 1. Attention is focused on identifying gaps and imperfections using the reporting software (CRF Reporter), specifically by observing trends in figures and by checking IEFs.

According to the QA/QC plan, data and calculations are provided by the external consultants (M. Markvart and B. Bernauer) and are checked by the experts from CHMI and vice versa.

4.8.3.5 Source-specific recalculations, including changes made in response to the review process

In this year, no recalculations were performed in this sector.

4.8.3.6 Source-specific planned improvements, including those in response to the review process

No improvements are currently planned in this category in next submission.

4.8.4 Other (CRF 2.G.4)

4.8.4.1 Source category description

This category includes estimated emissions from Laboratory (experimental) use. This category was included in the 2006 submission for the first time and encompasses emissions of SF_6 from laboratory use. Emissions of F-gases were not identified in this category in 2014.

4.8.4.2 Methodological issues

Data were obtained from the customs authorities and sectoral expert Ing. Řeháček.

4.8.4.3 Uncertainties and time-series consistency

The uncertainty estimates were based on expert judgment (see Guidelines IPCC, 2006 Volume 1 Chapter 3 Uncertainties). Improvement of uncertainty estimation is in progress.

4.8.4.4 Source-specific QA/QC and verification

Validation was performed by comparing the data obtained from the customs authorities, questionnaires and reports from Ministry of the Environment.

4.8.4.5 *Source-specific recalculations, including changes made in response to the review process*

In the subcategory 2.G.4 Laboratory (Experimental) use recalculation for 2004-2006 were conducted using assumption of covering more than one year, since emissions are assumed to be continuous over the year (Eq. 8.23, 2006 IPCC Gl., Vol. 3-2). Impact of recalculation is displayed in Fig. 4-22.

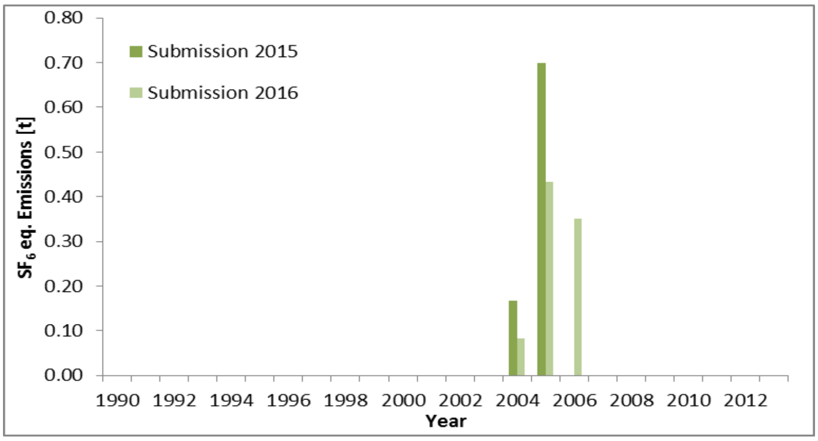


Fig. 4-22 Recalculation in 2.G.1 category - Electrical Equipment

4.8.4.6 *Source-specific planned improvements, including those in response to the review process*

No improvements are currently planned in this category in next submission.

4.9 Acknowledgement

The authors would like to thank representatives from the Czech Ministry of the Environment, Department of Climate Change, Unit of Emission Trading for providing EU ETS. However, these data are still not available for the complete time-series.

The authors would also like to thank representatives of companies that willingly respond to our surveys and therefore help to bring to life these emission estimates.

5 Agriculture (CRF Sector 3)

5.1 Overview of sector

Agricultural greenhouse gas emissions under Czech national conditions consist mainly of emissions from enteric fermentation (CH_4 emissions only), manure management (CH_4 and N_2O emissions), agricultural soils (N_2O emissions only), urea application and liming (CO_2 emissions only). The other IPCC subcategories – rice cultivation, prescribed burning of savannas, field burning of agricultural residues and “other” – do not occur in the Czech Republic.

Methane emissions are derived from animal breeding. These emissions originated primarily from enteric fermentation (digestive processes), which is manifested most for ungulate animals (in this country mostly cattle). Other emissions are derived from fertilizer management, where methane is formed under anaerobic conditions (with simultaneous formation of ammonia which, however, is not monitored in the framework of greenhouse gas inventories).

Nitrous oxide emissions are formed mainly by nitrification-denitrification processes in soils. The anthropogenic contribution that is determined in the national inventory of greenhouse gases is caused by nitrogenous substances derived from inorganic nitrogen-containing fertilizers, manure from animal breeding and nitrogen contained in parts of agricultural crops that are returned to the soil (for example, in the form of straw together with manure, or that are ploughed into the soil). In addition, emissions are also included from stables and fertilizer management and indirect emissions derived from atmospheric deposition and from nitrogenous substances flushed into water courses and reservoirs.

Carbon oxide emissions are derived from utilizing of non-organic fertilization on agricultural soils, mainly based on industrial produced urea and limestone application on the soils.

5.1.1 Key categories

For Agriculture, six categories of sources were evaluated by analysis decribed in IPCC (2006) as key categories. An overview of sources, including their contribution to aggregate emissions, is given in Tab. 5-1.

Tab. 5-1 Overview of significant categories in this sector (2014)

Category	Gas	Character of category	% of total GHG*
3.A Enteric Fermentation	CH_4	LA, TA	2.28
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	LA, TA	1.94
3.B Manure Management	N_2O	LA, TA	1.06
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	LA	0.63
3.B Manure Management	CH_4	LA, TA	0.62
3.G Liming	CO_2	TA	0.12

** assessed without considering LULUCF*
KC: key category, LA, LA: identified by level assessment with and without considering LULUCF, respectively*
TA, TA: identified by trend assessment with and without considering LULUCF, respectively*

5.1.2 Quantitative overview

Agriculture is the third largest sector in the Czech Republic producing 7.15% of total GHG emissions incl. LULUCF (6.72% excl. LULUCF) in 2014 with 8 287 kt CO_2 eq.; 38.4% of emissions came from Agricultural Soils, 34.0% from Enteric Fermentation and 25.1% from Manure Management. Carbon dioxide emissions from liming and urea application on managed soils contribute 2.5% towards total 2014 agricultural emissions. During the 1990 – 2014 period, emissions from Agriculture decreased by more than 53%. The quantitative overview and emission trends in the reported period are provided in Fig.5.1 and Tab. 5-2.

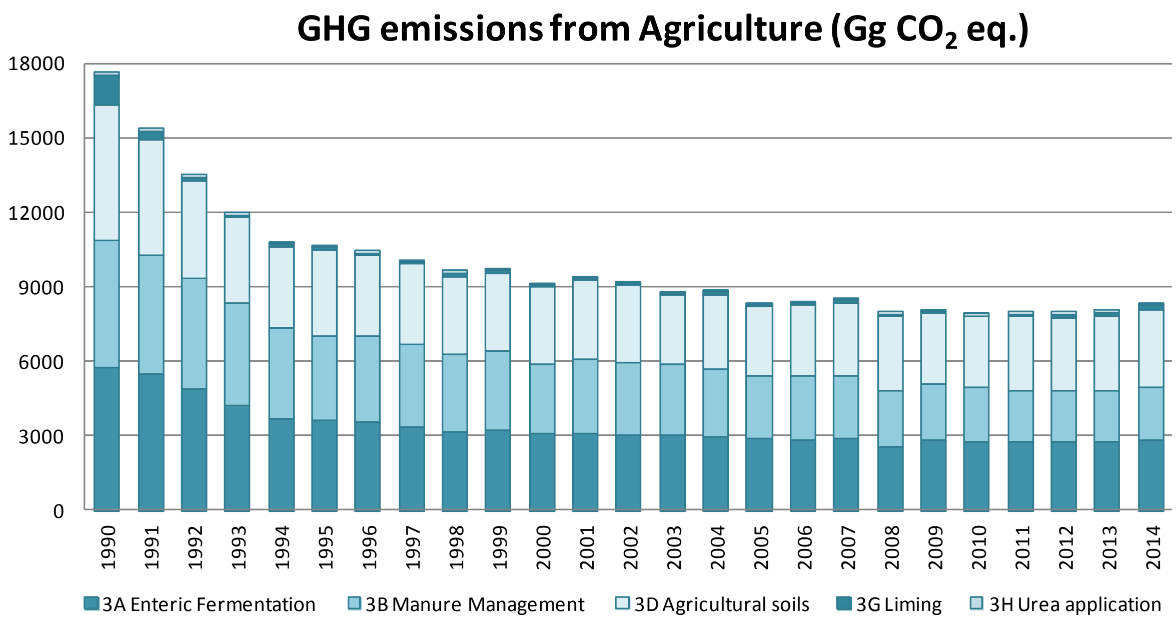


Fig. 5-1 The emission trend in agricultural sector during reporting period 1990-2014 (in kt CO_2 eq.)

Tab. 5-2 Emissions of Agriculture in period 1990-2014 (sorted by categories)

Year	TOTAL	Enteric Fermentation (3.A)	Manure Management (3.B)	Managed soils (3.D)	Liming (3.G)	Urea Application (3.H)
	Unit [kt CO_2 eq.]					
1990	17616	5755	5082	5493	1178	109
1991	15380	5430	4843	4662	313	132
1992	13487	4862	4481	3927	108	109
1993	11971	4211	4098	3465	103	93
1994	10808	3688	3613	3313	103	91
1995	10673	3588	3400	3465	110	109
1996	10444	3553	3424	3254	112	100
1997	10045	3319	3309	3257	92	67
1998	9648	3106	3182	3127	90	143
1999	9711	3175	3220	3142	87	88
2000	9378	3048	3058	3111	112	48
2001	9414	3071	2968	3193	105	77
2002	9215	3005	2934	3113	99	64
2003	8786	2972	2870	2805	79	61
2004	8830	2906	2744	3034	76	70
2005	8335	2848	2522	2827	64	74
2006	8419	2807	2584	2868	78	83
2007	8545	2837	2560	2947	80	122
2008	8369	2868	2321	2984	95	100

Year	TOTAL	Enteric Fermentation (3.A)	Manure Management (3.B)	Managed soils (3.D)	Liming (3.G)	Urea Application (3.H)
	Unit [kt CO_2 eq.]					
2009	8065	2800	2238	2878	64	85
2010	7933	2720	2200	2841	61	111
2011	7986	2726	2102	2967	80	111
2012	8002	2759	2048	2944	116	136
2013	8041	2759	2010	3011	135	126
2014	8287	2817	2080	3182	150	57

The trend series are consistent both for methane and for nitrous oxide. For methane, the decrease in emissions for enteric fermentation since 1990 is connected with the decrease in the numbers of animals while the decrease in emissions derived from manure is not as great, as there has been a smaller decrease in the number of head of swine. It would seem that conditions have partly stabilized somewhat in agriculture since 1994.

An overview of former recalculations is given in Chapter 10. The Czech Republic has made a number of improvements in its 2016 annual submission. The Czech Republic has also ensured that this submission is in accordance with the IPCC 2006 Guidelines. According to recommendation and requests of ERT review these changes were implemented to the Czech emission inventory:

- The emission factors for estimates of methane emissions from Enteric Fermentation from cattle (dairy and non-dairy) were recalculated following revision of the coefficient for calculating the net energy for maintenance (Cfi) and cattle methane conversion factor (Ym). A cattle methane conversion factor Ym equal to 0.065 was applied to the estimates in Table 10.12 (2006 Gl. IPCC) and coefficients Cfi for dairy and non-dairy cattle were taken from Table 10.4 (2006 Gl. IPCC). The mentioned changes generated new Gross Energy values (GE) and updated emission factors for estimation of methane emissions from Enteric Fermentation.
- The emission factors for estimation of CH_4 emissions for the cattle category of Manure Management were recalculated following the adoption of Cfi and Ym parameters in accordance with 2006 Gl. IPCC. CH_4 for manure management for pigs was based on recalculation of the CH_4 emission from pig manure, according to the 2006 Gl. IPCC, to better fit the actual manure handling conditions in the Czech Republic. Instead of 3 kg/head/yr, twice this value, 6 kg/head/yr, was used. Manure management CH_4 emission factors from Table 10A-9 for goats, horses and poultry were employed in the inventory. The default value for poultry was adjusted to Czech conditions.
- As a result of these changes, the Nex values for the cattle category were also updated. As a result of the application of the national Typical Animal Mass (TAM) value for other than cattle categories (pig, sheep, goats, horses, poultry), the country-specific Nitrogen Excretion values (Nex) were obtained using by Equation 10.30 (2006 Gl. IPCC).
- N_2O emissions from Manure applied to soils and Pasture, Range and Paddock were recalculated following revision of the input parameters for Livestock. Because some outputs from the Manure Management category correspond to the inputs for estimates of nitrous oxide emissions from soils, then updating of the Manure Management outputs resulted in updating of the emissions from soils. The changes in direct emissions resulted in changes in indirect emissions, so the indirect N_2O emissions from soils were also recalculated.
- The CO_2 emissions from Urea application in managed agricultural soils were recalculated following revision of the activity data. The statistical production data were replaced by more precise data corresponding to the real consumption by the Ministry of Agriculture (MA 2016, pers. communication).

These improvements and methodological changes have resulted in an increase in agricultural emissions in the 2014 vs. 2013 inventory. A detailed description of GHG emission estimation in the Czech Republic is presented in the following chapters.

5.1.3 Overview of source specific QA/QC and verification

Following the recommendation of the latest in-country review, a sector-specific QA/QC plan was formulated, tightly linked to the corresponding QA/QC plan of the National Inventory System, chapter 1.5. The plan describes the key procedures of inventory compilation, provides a table of personal responsibilities and a timetable of sector-specific QA/QC procedures. This plan consolidates the quality assurance procedures and facilitates effective quality control of the Agriculture inventory. The Institute of Forest Ecosystem Research (IFER) is the sector-solving institution for this category.

The agricultural greenhouse gas inventory is compiled by an experienced expert from the IFER, including performance of self-control. Czech University of Life Sciences, Institute of Animal Science Prague, Research Institute for Cattle Breeding and Research Institute of Agricultural Engineering are other institutes contributing information used in the sector of Agriculture. Slovak agricultural experts (SHMI) also participate in debates on the inventory improvements.

The potential errors and inconsistencies are documented and corrections are made if necessary. In addition to the official review process, emission inventory methods and results are internally reviewed by the technical experts involved in the emission inventory of the Agriculture and LULUCF sectors. To comply with QA/QC, is necessary to check:

- The inclusion of all activity data for animal categories, annual crop production, amount of synthetic fertilizers, sewage sludge, liming and urea applied to managed soils (Czech official statistics, urea production data)
- The consistency of time-series activity data and emission factors
- The update of national zoo-technical data
- All the emission factors and used parameters/fractions

QA/QC includes checking of activity data, emission factors and methods employed. All the differences are discussed and, if necessary, also corrected. The procedure of inventory compiling is initiated by IFER, where all the necessary data, obtained from the Czech Statistical Office (CzSO), are inserted into the excel spreadsheets. The excel files are verified by other IFER experts. Some more specific parameters, not available from CzSO, are required to estimate the country-specific emission factors for cattle (Tier 2). The zoo-technical national data (esp. cattle breeding) are supplied by experts from agricultural institute (see above). The appropriate values in the calculation spreadsheets are updated at IFER, replacing the older values. The verified data are transferred to the CRF Reporter, where the data are again technically verified. The completeness check of CRF tables was performed for final time-series approval.

A responsible person (IFER expert) fills in QA/QC forms, including information from checking and verifying activity data, CRF data and NIR content separately for the reported emission inventory categories. The QA/QC forms are archived in IFER and CHMI (ftp server). All the information used for the inventory report is archived by the author and by the NIS coordinator. Hence, all the background data and calculations are verifiable.

At the beginning of July 2015, a peer-review with colleagues from Slovak national emission team took place in Bratislava focusing on improvement plans of GHG national inventories. During the 2 days-session several key issues were discussed to understand of different or similar approaches in the national emission inventory assessments used by Czech or Slovak agricultural experts.

5.2 Livestock (CRF 3.1)

The methods for estimating CH_4 and N_2O emissions from livestock require definitions of livestock sub-categories, annual populations (see Tab. 5-3) and, for higher Tier 2 methods (cattle), also feed intake and other characterization. A coordinated livestock characterization was used to ensure consistency across the following source categories for the whole emission inventory.

Tab. 5-3 Animal population in the period 1990-2014 (heads)

	1990	1991	1992	1993	1994	1995
Cattle	3 506 222	3 359 976	2 949 574	2 511 737	2 161 438	2 029 827
Pigs	4 789 898	4 569 304	4 609 149	4 598 821	4 070 898	3 866 568
Sheep	429 714	429 106	342 069	254 301	196 030	165 345
Poultry	31 981 100	33 278 468	30 756 308	28 219 580	24 974 149	26 688 376

	1996	1997	1998	1999	2000	2001
Cattle	1 988 810	1 865 902	1 700 789	1 657 337	1 573 530	1 582 285
Pigs	4 016 246	4 079 590	4 012 943	4 000 720	3 687 967	3 469 802
Sheep	134 009	120 921	93 557	86 047	84 108	87 539
Poultry	27 875 356	27 572 714	29 035 455	30 222 187	30 784 432	28 864 561

	2002	2003	2004	2005[1)]	2006	2007
Cattle	1 520 136	1 473 828	1 428 329	1 397 308	1 373 645	1 391 393
Pigs	3 440 925	3 362 801	3 126 539	2 876 834	2 840 375	2 830 415
Sheep	96 286	103 129	115 852	140 197	148 412	168 910
Poultry	29 946 846	26 873 408	25 493 559	25 372 333	25 736 003	24 592 085

	2008	2009	2010	2011	2012	2013
Cattle	1 401 607	1 363 213	1 349 286	1 343 686	1 353 685	1 352 822
Pigs	2 432 984	1 971 417	1 909 232	1 749 092	1 578 827	1 586 627
Sheep	183 618	183 084	196 913	209 052	221 014	220 521
Poultry	27 316 866	26 490 848	24 838 435	21 250 147	20 691 308	23 265 358

	2014					
Cattle	1 373 560					
Pigs	1 6170 61					
Sheep	225 397					
Poultry	21 463 815					

5.2.1 Enteric fermentation (CRF 3.A)

5.2.1.1 Source category description

This chapter describes estimation of CH_4 emissions from Enteric Fermentation. In 2014, 73% of agricultural CH_4 emissions arose from this source category. This category includes emissions from cattle (dairy and non-dairy), swine, sheep, horses and goats. Camels, llamas, mules and asses do not occur in the Czech Republic. A few of buffaloes are kept in several private farmers (as a private zoo). Enteric fermentation emissions from poultry have not been estimated, the IPCC Guidelines do not provide a default emission factor for this animal category.

5.2.1.2 Methodological issues

Emissions from enteric fermentation of domestic livestock have been calculated by using Tier 1 and Tier 2 (cattle category) methodologies presented in the 2006 IPCC Guidelines, that are linked to the previous methodologies IPCC (1997 and 2000). Methane emissions for cattle, which are a dominant source in this category, have been calculated using Tier 2 method, while for other livestock Tier 1 method was used. The contribution of emissions from livestock other than cattle to the total emissions from enteric fermentation is not significant.

Enteric fermentation of cattle

As the most important output of the national study (Kolar, Havlikova and Fott, 2004), a system of calculation spreadsheets have been developed and used for all the relevant calculations of CH_4 emissions.

The emission factor for methane from fermentation (EF) in kg/head p.a. is proportional to the daily food intake and the conversion factor. It thus holds that

$$EF_i = GE \cdot \frac{365}{55.65} \cdot Y$$

where the "daily food intake" (GE in MJ/day) is taken as the mean feed ration for the given type of cattle (there are several subcategories of cattle) and Y is the conversion factor, which is considered to be 0.065 for cattle (see Table 10.12, Volume 4, IPCC 2006). Coefficient 55.65 has dimensions of MJ/kg CH_4.

In principle, this equation should be solved for each cattle subcategory, denoted by index i. The Czech Statistical Office, see Statistical Yearbooks (CzSO, 1990–2014), provides following categorization of cattle:

- Calves younger than 6 months[1] of age (male and female)
- Young bulls and heifers (6-12 months of age[2])
- Bulls and bullocks (1 – 2 years, over 2 years)
- Heifers (1 – 2 years, over 2 years)
- Mature cows (dairy and suckler)

More disaggregated sub-categories given above in parenthesis are given in the study by external agricultural consultants of CHMI (Hons and Mudrik, 2003).

In the calculation, it is also very important to distinguish between dairy and suckler cows, where the fraction of suckler cows (suckler/all cows) gradually increased in the 1990-2014 time period. Based on the ERT recommendation (2011) the sub-category "Suckler cows" was reallocated from Dairy cattle to Non-dairy cattle.

According to the IPCC methodology, Tier 2 (IPCC 2006, 2000 and 1997), the "daily food intake" for each subcategory of cattle is not measured directly, but is calculated from national zoo-technical inputs, mainly weight, weight gain (for growing animals), daily milk production including the percentage of fat (for cows) and the feeding situation (stall, pasture). The national zoo-technical inputs (noted above) were updated by expert from the Czech University of Agriculture in Prague in 2006 and 2011. Examples of input data used (Hons and Mudřík, 2003, Mudřík and Havránek, 2006, Kvapilík J. 2010 and 2011 –

[1] Since 2009 the age limit for "Calves" shifted up to 8 months.
[2] Since 2009 the age limit for "Young bulls and heifers" shifted up to 8 -12 months.

pers.com.) are given below, Tab. 5-4 (incorrect data for *Bulls 6-12 months* was corrected) and Tab 5-5. The numbers of grazing days for individual cattle categories are presented in the Tab. 5-6.

Tab. 5-4 Weights of individual categories of cattle, 1990–2014, in kg

Categories of cattle	1990 – 94	1995 – 98	1999 – 04	2005 – 09	2010 - now
Mature cows (dairy and suckler)	520	540	580	585	590
Heifers > 2 years	485	490	505	510	515
Bulls and bullocks > 2 years	750	780	820	840	850
Heifers 1-2 years	380	385	395	395	390
Bulls 1-2 years	490	510	530	540	560
Heifers 6-12 months	275	280	285	285	290*
Bulls 6-12 months	325	330	335	340	350*
Calves to 6 months	128	132	133	135	135*

*Note: * Since 2009 the age limit for "Calves" shifted up to 8 months.*

Tab. 5-5 Feeding situation, 1990–2014, in% of pasture, otherwise stall is considered

Categories of cattle	1990 – 94	1995 – 98	1999 – 04	2005 – 09	2010 - now
Dairy cows	10	20	20	22	15
Suckler cows	10	20	20	50	95
Heifers > 2 years	30	30	30	35	50
Bulls > 2 years.	30	40	40	40	25
Heifers 1-2 years	30	40	40	40	50
Bulls 1-2 years	30	40	40	40	25
Heifers 6-12 months	30	40	40	40	50*
Bulls 6-12 months	30	40	40	40	50*

*Note: * Since 2009 the age limit for "Calves" shifted up to 8 months.*

Tab. 5-6 Grazing days for individual cattle categories

Categories of cattle	1990 – 94	1995 – 98	1999 – 04	2005 – 09	2010 - now
Dairy cows	18	20	36	40	27
Suckler cows	18	20	36	90	171
Heifers > 2 years	54	54	54	63	90
Bulls > 2 years.	54	72	72	72	45
Heifers 1-2 years	54	72	72	72	90
Bulls 1-2 years	54	72	72	72	45
Heifers 6-12 months	54	72	72	72	90*
Bulls 6-12 months	54	72	72	72	90*

*Note: * Since 2009 the age limit for "Calves" shifted up to 8 months.*

Percentages of pasture are related only to the summer part of the year (180 days), while only the stall type is used in the rest of year. The daily milk production statistics (Tab. 5-7), in which only milk from dairy cows is considered, increased to 21.11 liters/day/head in 2014, with an average fat content of 3.90%. A relevant daily milk production of non-dairy cows is 3.5 l/day/head. The activity data of milk production comes from the official statistics (CzSO) and these are verified in Yearbook of cattle in Czech Republic (annual report).

As the official statistics, specifically from CzSO, provide population values for cows and other cattle, the resulting EFs in the CRF Tables are defined for the categories of "Dairy cows" and "Non-dairy cattle". The numbers of animal population are based on surveys of livestock (up to 1991 as at 1.1., from 1992 to 2002 as at 1.3., since 2003 as at 1.4.).

The country-specific parameter DE (digestibility, in %) for cattle was estimated based on existing publications. Considering the individual OMD (organic matter digestibility) values for the most common feed (e.g. corn silage, hay and straw, green fodder – alfalfa and clover, etc.) the average digestibility for cattle was estimated. The estimated average digestibility corresponds to approximately 70% (Koukolová and Homolka 2008 and 2010, Tománková and Homolka 2010, Jančík et al. 2010, Petrikovič et al. 2000, Petrikovič and Sommer 2002, Sommer 1994, Zeman et. al. 2006, Třináctý 2009, Čermák et al. 2008). Dr. Pozdíšek (expert from the Research Institute for Cattle Breeding, Ltd., pers. com.) determined the conservative average digestibility values for 3 basic cattle sub-categories. These digestibility values were employed for the emission estimation:

- Dairy cattle DE = 67%
- Suckler cows DE = 62%
- Other cattle DE = 65%

According to requests by Initial checks the coefficients (Cfi) for calculating Net energy for maintenance (NEM) of cattle were updated based on the default values in the Table 10.4, Volume 4 of 2006 Gl.

Details of the calculation are given in the above-mentioned study (Kolar, Havlikova and Fott, 2004) and the results are illustrated in Tab. 5-8. It is obvious that EFs have increased slightly since 1990 because of the increasing weight and milk production for cows and because of the increasing weight and weight gain for other cattle. On the other hand, CH_4 emission from enteric fermentation of cattle dropped during the 1990-2014 period to about one half of the former values due to the rapid decreases in the numbers of animals kept.

Tab. 5-7 Milk production of dairy cows and fat content (1990–2014)

	Dairy cows	Daily production	Fat content
	[thousands]	[liters/day head]	[%]
1990	1206	10.67	4.03
1991	1165	9.63	4.09
1992	1006	10.13	4.07
1993	902	10.18	4.10
1994	796	10.79	4.04
1995	732	11.34	4.02
1996	713	11.69	4.08
1997	656	11.29	4.02
1998	598	12.44	4.05
1999	583	12.85	4.03
2000	548	13.55	4.00
2001	529	14.00	4.03
2002	496	15.08	3.98
2003	490	15.77	3.98
2004	476	16.41	3.98
2005	438	17.13	3.90
2006	424	17.45	3.90
2007	410	17.94	3.88
2008	406	18.51	3.86
2009	400	18.82	3.85
2010	384	18.91	3.86
2011	374	19.53	3.88
2012	373	20.31	3.85
2013	367	20.39	3.88
2014	373	21.11	3.90

Tab. 5-8 Methane emissions from enteric fermentation, cattle (Tier 2, 1990–2014)

	Dairy cows [thous.]	Other cattle [thous.]	EF. cows [kg CH_4/hd]	EF. other [kg CH_4/hd]	Em. cows [kt CH_4]	Em. other [kt CH_4]	Emissions [kt CH_4]
1990	1206	2300	96.68	44.47	116.61	102.27	218.88
1991	1165	2195	93.06	44.57	108.45	97.81	206.26
1992	1006	1943	94.85	45.69	95.44	88.78	184.23
1993	902	1609	95.17	45.40	85.88	73.06	158.95
1994	796	1366	97.17	45.38	77.32	61.97	139.29
1995	732	1298	101.21	47.59	74.11	61.75	135.86
1996	713	1275	102.83	47.92	73.37	61.11	134.48
1997	656	1210	100.99	48.65	66.28	58.84	125.13
1998	598	1103	105.53	48.80	63.09	53.82	116.91
1999	583	1074	110.16	51.65	64.23	55.49	119.72
2000	548	1026	112.61	52.11	61.69	53.45	115.14
2001	529	1053	114.51	52.92	60.62	55.72	116.34
2002	496	1024	118.21	53.88	58.67	55.17	113.84
2003	490	984	120.81	54.23	59.23	53.34	112.57
2004	476	952	123.20	54.15	58.63	51.58	110.21
2005	438	960	125.72	55.25	55.04	53.01	108.06
2006	424	950	126.91	55.30	53.81	52.52	106.33
2007	410	981	128.55	55.66	52.75	54.60	107.35
2008	406	996	130.48	56.36	52.91	56.13	109.05
2009	400	964	131.53	56.48	52.55	54.43	106.98
2010	384	966	132.02	54.96	50.63	53.08	103.71
2011	374	970	134.49	55.46	50.28	53.79	104.07
2012	373	981	137.08	55.42	51.15	54.34	105.49
2013	367	985	137.67	55.70	50.57	54.89	105.46
2014	373	1001	140.54	55.33	52.37	55.38	107.75

Enteric fermentation of other livestock

Compared to the cattle, the contribution of other farm animals to the whole CH_4 emissions from enteric fermentation is much smaller, only about 5.4%. Therefore, CH_4 emissions from enteric fermentation of other farm animals (other than cattle) are estimated using Tier 1 approach. Because of some features of keeping livestock in the Czech Republic that are similar to the neighbouring countries of Germany and Austria, default EFs for Tier 1 approaches recommended for Western Europe were employed. The obsolete national approach used in the past, which was found not to be comparable with other European countries (Dolejš, 1994 and Jelínek et.al., 1996), was definitively abandoned. The estimated values are presented for the whole period since 1990.

<u>Sheep, goats, swine and horses</u>

The Czech Statistical Office (CzSO) publishes data on the number of goats, sheep, swine, horses and poultry annually in the Statistical Yearbooks (1990-2014).

Considering the rather small numbers in these animal categories, default coefficients from the IPCC method have been used for estimating methane emissions: 8 kg of methane annually per head for sheep, 5 kg of methane for goats, 1.5 kg of methane for swine and 18 kg of methane for horses.

<u>Poultry</u>

IPCC guidelines do not define or require estimates of quantities of methane from enteric fermentation.

5.2.1.3 Uncertainty and time-series consistency

As mentioned above, methane emissions from the breeding of farm animals are caused both by enteric fermentation and also by the decomposition of animal excrements (manure). Determination of these emissions was prepared at the level of both Tier 1 and Tier 2. As enteric fermentation is considered according to Tab. 5-1 to constitute a key source, preference should be given to determination in Tier 2.

For quite a long time, calculations were based on historical studies (Dolejš, 1994) and (Jelínek et al, 1996). In principle, emissions from animal excrements could be calculated according to Tier 1 (this is not a key source); however, because of tradition and for consistency of the time series, the final values were also calculated according to Tier 2 using the emission factors from above-mentioned studies (Dolejš, 1994; Jelínek et al, 1996). An approach based on historical studies was indicated to be obsolete in many reviews organized by UNFCCC. Moreover, IEFs (implied emission factors) were mostly found as outliers: especially EFs for enteric fermentation in cattle seemed to be substantially underestimated. Details of the historical approach are given in former NIRs (submitted before 2006).

The Czech team accepted critical remarks put forth by the International Expert Review Teams (ERT) and prepared a new concept for calculation of CH_4 emissions. This concept, in accordance with the plan for implementing Good Practice, is based on the following decisions:

1) Emissions of methane from enteric fermentation of livestock (a key source) come predominantly from cattle. Therefore Tier 2, as described in Good Practice (Good Practice Guidance, 2000) is applied only to cattle.
2) CH_4 emissions from enteric fermentations of other farm animals are estimated by Tier 1 approach. Because of some features of keeping livestock in the Czech Republic that are similar to the neighboring countries of Germany and Austria, default EFs for Tier 1 approaches recommended for Western Europe were employed.

Increased attention was firstly paid to enteric fermentation. It was stated that cooperation with specialized agricultural experts is crucial to obtain new consistent and comparable data of suitable quality. The relevant nationally specific data, milk production, weight, weight gain for growing animals, type of stabling, etc. were collected by our external experts (Hons and Mudrik, 2003). Moreover, statistical data for sufficiently detailed classification of cattle, which are available in the Czech Republic, were also collected at the same time. Calculation of enteric fermentation of cattle using Tier 2 approach was described in a study (Kolar, Havlikova and Fott, 2004) for the whole time series since 1990 using the above-mentioned country-specific data. The necessary QA/QC procedures were performed in cooperation with experts from IFER. The nationally specific data like weight of individual categories of cattle, weight gains of these categories and recent feeding situation were revised in 2006. The new values were estimated in a similar way by our external experts (Mudrik and Havranek, 2006) for the next period.

The national zoo-technical inputs (mainly weight, weight gain, daily milk production including the percentage of fat and the feeding situation) were updated in this submission in conjunction with an expert from the Research Institute of Animal Production. Also in this submission, the sub-category "Suckler cows" was reallocated from “Dairy cattle” to “Non-dairy cattle”; more accurate cattle population data were used. Additionally, the new digestibility values (DE) were employed for cattle (detailed in Chapter 6.2.2.1), affecting the implied emission factors for cattle categories. These changes in the activity data and input parameters resulted in changes in emissions for the entire reporting period.

Uncertainty estimates are based on expert judgment. The uncertainty in the activity data equals to 5%. The uncertainty in the emission factor equals to 20%. The combined uncertainty, calculated according to IPCC Tier 1 methodology, equals to 20.6%.

5.2.1.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in section 5.1.3.

5.2.1.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

The emission factors for estimation of methane emissions from Enteric Fermentation by cattle (dairy and non-dairy) were recalculated following revision of the coefficient for calculating **the** net energy for maintenance (Cfi) and cattle methane conversion factor (Ym). These new default parameters were employed according to the 2006 IPCC Guidelines for the entire period. A cattle methane conversion factor Ym equal to 0.065 was applied to the estimates in Table 10.12 (2006 Gl. IPCC) and coefficients Cfi for dairy and non-dairy cattle were employed from Table 10.4 (2006 Gl. IPCC). The mentioned changes generated new Gross Energy values (GE) and updated emission factors for estimation of methane emissions from Enteric Fermentation.

5.2.1.6 Source-specific planned improvements, including tracking of those identified in the review process

The analysis of uncertainties is currently in progress.

5.2.2 Manure management (CRF 3.B)

This chapter describes the estimation of CH_4 (37%) and direct (43%) and indirect (20%) N_2O emissions coming from animal manure management. Total emissions coming from Manure Management (CH_4 and N_2O) are 2080 kt CO_2 eq. in 2014. For detailed information see Tab. 5-9.

The good agricultural practices were developed based on agricultural policies and structures that support the trends in animal waste management system allocation. These practices aim to use techniques to reduce emissions, protecting the environment while incurring the low costs. Among these procedures are included inexpensive and austerity measures, such as the incorporation of relevant proteins in livestock feed, regular cleaning of the stables or proper timing of manure applications to agricultural land in the period when plants absorb the maximum amount of nutrients. Such measures may also involve complicated procedures, such as using low-emission techniques for application and storage of manure, livestock housing.

5.2.2.1 Source category description

During period 1990-2014 the emissions from Manure Management decreased by 60%. The emissions from cattle and swine dominate this trend. The reduction in the cattle population is partly counterbalanced by an increase in cow efficiency (increasing gross energy intake and milk production).

This emission source covers manure management of domestic livestock. Both nitrous oxide (N_2O) and methane (CH_4) emissions from manure management of livestock (cattle, swine, sheep, horses, goats and poultry) are reported. The animal waste management systems (AWMS) are distinguished for N_2O emission estimations: liquid system, daily spread, solid storage & dry lot and other manure management systems. Nitrous oxide is produced by the combined nitrification-denitrification processes occurring in the manure. Methane is produced in manure during decomposition of organic material by anaerobic and facultative bacteria under anaerobic conditions. The amount of emissions is dependent on the amount of organic material in the manure and climatic conditions.

Tab. 5-9 List of emissions from Manure Management during 1990-2014 (in kt CO_2 eq.)

	TOTAL	CH_4 emissions	N_2O emissions	
			Direct	Indirect
1990	5082	1772	2251	1058
1991	4843	1690	2143	1010
1992	4481	1581	1956	944
1993	4098	1462	1763	873
1994	3613	1280	1563	769
1995	3400	1218	1458	723
1996	3424	1180	1513	730
1997	3309	1130	1470	710
1998	3182	1098	1400	684
1999	3220	1114	1415	690
2000	3058	1086	1320	653
2001	2968	1072	1270	626
2002	2934	1099	1217	618
2003	2870	1099	1166	605
2004	2744	1047	1120	576
2005	2522	1003	1027	492
2006	2584	992	1054	538
2007	2560	985	1043	533
2008	2321	937	938	446
2009	2238	847	937	453
2010	2200	816	933	451
2011	2102	776	898	428
2012	2048	751	883	413
2013	2010	763	887	359
2014	2080	768	893	419

5.2.2.2 Methodological issues

Methane emissions (CRF 3.B.1)

CH_4 emissions from manure management were identified as a *key source* only by trend assessment (TA). The estimation of methane emissions from Manure Management is provided of cattle by Tier 2. This category of emissions was identified based on analysis of National Inventory System (NIS) as a key category by trend (see Tab. 5-1).

Cattle category

The activity data as cattle population distributed by age comes from the Czech statistical office (CzSO). This is a consistent time series of number of animals during entire reported period (1990-2014). Gross energy (GE) values are estimated based on the national study Kolář *et al*. (2004). These GE parameters are reported in CRF as a country-specific data for the entire reported period (Tab. 5-10).

Tab. 5-10 Gross Energy (GE, MJ/head/day) of cattle in period 1990-2014

	1990	1995	2000	2005	2010	2011	2012	2013	2014
Dairy cows	226.8	237.4	264.1	294.9	309.7	315.5	321.5	322.9	329.7
Other cattle	104.3	111.6	122.2	129.6	128.9	130.1	130.0	130.6	129.8

The current updated data of AWMS distribution were applied for emission estimation. The other specific parameters for estimation of emission factors for cattle were obtained (Bo, MCF) from Dämmgen *et al.* (2012). The specific parameters recommended for use by study in neighbouring states (Dämmgen *et al.* 2012) are comparable to the default values (2006 IPCC Guidelines) and corresponds to Czech climate conditions. The parameters recommended in Dämmgen *et al.* (2012) were utilized for the emission estimation (Tab. 5-11). The VS parameters calculated based on B_0, ASH and MCF values by Dämmgen *et al.* (2012) and EF for estimation of methane emissions are presented in Table 5-12.

Tab. 5-11 List of parameters for methane emission factor estimation in Manure Management in Czech conditions

Parameters	Dairy cows	Other cattle
B_o	0.24	0.17
ASH	8%	
MCF values:		
Liquid system	17%	
Daily spread	0.1%	
Solid storage and dry lot	2%	
Pasture range and paddock	1%	

Tab. 5-12 Parameter VS, EF (kg CH_4/h/yr) and methane emissions from Manure Management in period 1990-2014

	Dairy cows		Other cattle	
	VS	EF	VS	EF
1990	4.29	14.27	2.40	8.39
1991	4.13	13.74	2.38	8.33
1992	4.21	14.00	2.35	8.27
1993	4.22	14.05	2.34	8.23
1994	4.31	14.00	2.34	8.24
1995	4.47	13.90	2.44	8.21
1996	4.54	10.76	2.45	8.28
1997	4.46	8.69	2.47	8.43
1998	4.66	9.07	2.48	8.48
1999	4.86	9.61	2.62	9.01
2000	4.97	11.99	2.64	9.13
2001	5.05	12.34	2.67	9.96
2002	5.21	15.38	2.72	10.20
2003	5.32	18.31	2.73	10.29
2004	5.43	18.67	2.73	10.27
2005	5.53	18.86	2.79	10.56
2006	5.58	19.03	2.79	10.59
2007	5.65	19.28	2.80	10.36
2008	5.74	19.56	2.82	10.19
2009	5.78	19.71	2.83	9.88
2010	5.82	20.48	2.80	9.27
2011	5.93	20.86	2.82	9.25
2012	6.04	21.25	2.82	9.15
2013	6.06	21.34	2.83	9.18
2014	6.19	21.78	2.82	9.09

The equations for determination of emission factors and estimation of methane emissions were taken from the IPCC (2006).

1. To estimate the methane emissions the Eq. 10.22 (2006 IPCC, p. 10.37) was used:

$$CH_{4\ emissions}\left[\frac{kt}{year}\right] = \sum\left(\frac{EF \cdot cattle\ population}{10^6}\left[\frac{kg}{kt}\right]\right)$$

2. To estimate the VS parameter the Eq. 10.24 (2006 IPCC, p. 10.42) was utilized:

$$VS = GE \cdot \left[\frac{1-DE}{100} + (UE \cdot GE)\right] \cdot \frac{1-ASH}{18.45}$$

3. The estimation of methane emission factors by Eq. 10.23 (2006 IPCC, p. 10.41) was done:

$$EF = VS \cdot 365 \cdot B_o \cdot 0.67 \cdot \sum (MCF \cdot MS)$$

Other livestock category

The emissions from farm animals other than cattle are estimated by the Tier 1 approach. Default EFs for Western Europe were employed for similar reasons as in the previous paragraph (Tab. 5-13). In relation to the decreasing trend in the animal population (especially cattle and swine) the emissions from *Manure Management* rapidly declined during 1990 – 2003.

Tab. 5-13 Default emission factors used to estimate CH_4 emissions from Manure Management

Livestock type	EF (kg/head/yr)
Sheep	0.19
Goats	0.13
Horses	1.56
Swine	6.00
Poultry*	0.173

** Emission factor for poultry was assessed as a weighted average of two default EFs for different breeding system (13% wet and 87% dry systems; 0.173 = 1.13 x 0.13 + 0.03 x 0.87).*

Nitrous oxide emissions (CRF 3.B.2)

N_2O emissions from manure management were identified as a key source; Tier 2 methodology is used for emission estimation for the cattle category (Tier 2 for other animals). Emissions are calculated on the basis of N excretion per animal and animal waste management system. Following the guidelines, all emissions of N_2O taking place before the manure is applied to soils are reported under Manure Management. The IPCC Guidelines method for estimating N_2O emissions from manure management entails multiplying the total amount of N excretion (from all animal species/categories) in each type of manure management system by an emission factor for that type of manure management system.

Input data consists in the mass fraction Xi,j of animal excrement in animal category i (i = dairy cows, other cattle, pigs, …) for various types of excrement management (AWMS - Animal Waste Management System) j (j = anaerobic lagoons, liquid manure, solid manure, pasturage, daily spreading in fields, other). Here, it holds that Xi, 1 + Xi, 2 + ... + Xi, 6 = 1. For Tier 1, gives only the values of matrix X for typical means of management of animal excrement in Eastern and Western Europe. AWMS parameters presented in the IPCC methodology (IPCC, 2006) were determined for the Czech conditions. The Czech specific AWMS parameters are distributed to dairy and non-dairy cattle categories (Tab. 5-15).

The capacity of manure storage corresponds to the actual production for 6 months. This does not apply to the storage of solid manure on agricultural land prior to use. Solid manure may be stored on agricultural land for a maximum period of 24 months (Decree No. 274/1998 Coll.). If the company is active in vulnerable areas, solid storage is permitted on agricultural land for a maximum period of 12 months (Regulation 103/2003 Coll.). The company/owner can store manure for fertilizer again on the same agricultural land four years after soil cultivation of the agricultural land. Liquid manure is to be stored in leak-proof tanks or scrub areas in stables. Reservoirs and tanks or areas in the stables match the capacity of at least four months estimated production of liquid manure or share a minimum of three months estimated production of liquid manure and dung, depending on the climatic conditions of the region.

In response to the list of potential problems and further questions raised by ERT, the Czech Republic revised the Nex values for dairy and non-dairy cattle (see Tab. 5-14) and changed the distribution ratio of manure per AWMS (see Tab. 5-15) according to the national conditions based on expert judgment (Hons and Mudřík 2004 and Kvapilík J. 2010 and 2011 – pers.com.).

The IPCC default nitrogen rates and nitrogen excretion (Nex) values and distribution of AWMS systems for other animal categories (excl. cattle) are presented in Tab. 5-16. The emissions are then summed over all the manure management systems. The manure production data for individual AWMS are reported in Tab. 5-17.

Tab. 5-14 Czech national Nex (nitrogen excretion) values used to estimate N_2O emissions from Manure Management

	Nitrogen excretion (Nex)	
	Dairy cows	Non-dairy cattle (AVG value)
	[kg/head/year]	
1990	112.34	61.53
1991	109.46	61.58
1992	110.91	62.65
1993	111.26	62.23
1994	112.78	62.18
1995	116.63	64.47
1996	118.15	64.82
1997	116.45	65.58
1998	120.34	65.78
1999	125.90	68.84
2000	127.86	69.39
2001	129.55	70.31
2002	132.45	71.37
2003	134.62	71.81
2004	136.61	71.69
2005	138.51	73.21
2006	139.49	73.25
2007	140.76	73.36
2008	142.26	73.96
2009	143.08	74.41
2010	144.02	73.26
2011	145.27	73.72
2012	147.21	73.62
2013	147.50	73.89
2014	149.69	73.58

Tab. 5-15 Czech national distribution of AWMS systems for cattle category only

Dairy cows	Fraction of Manure Nitrogen per AWMS (in%)			
	Liquid	Daily spread	Solid	PRP
1990	25	2	68	5
1995	23	1	66	10
2000	15	1	74	10
2005	26	1	62	11
2010 - now	27	1	65	7
Non-dairy cattle (AVG)	**Liquid**	**Daily spread**	**Solid**	**PRP**
1990	45	1	42	12
1995	43	1	39	17
2000	44	1	38	17
2005	49	1	34	16
2006	49	1	34	16
2007	48	1	33	18
2008	47	1	32	20
2009	45	1	32	22
2010	43	1	32	24
2011 - now	42	1	32	25

Tab. 5-16 IPCC default nitrogen excretion (Nex) and distribution of AWMS systems for other animal categories

Livestock type	Nex (kg/head/yr)	Type of AWMS				
		Liquid	Daily spread	Solid	PRP	Other
		Fraction of Manure Nitrogen per AWMS (in%)				
Sheep	20	0	0	2	87	11
Swine	20	76	0	23	0	1
Poultry	0.6	13	0	1	2	84
Horses	25	0	0	0	96	4
Goats	25	0	0	0	96	4

Tab. 5-17 Manure production distributed by individual AWMS in 2014

AWMS	Nitrogen Production in Manure (kg N/yr)
Liquid systems	80 600 562
Solid storage & drylot	69 342 398
Other	11 713 109
Daily spread	1 184 783
Pasture range and paddock (PRP)	26 831 519
Total	**189 672 372**

Emission factors

To estimate N_2O emissions from manure management, the default emission factors for the different animal waste management systems were taken from the Table 10.21 (2006 IPCC), see Tab. 5-18.

Tab. 5-18 IPCC default emission factors of animal waste per different AWMS

AWMS	Emission Factor (EF3) (kg N_2O-N per kg N excreted)
Liquid	0.005
Solid Storage	0.02
Other Systems	0.01

Indirect Emissions from Manure Management (CRF 3.B.2.5)

Indirect emissions result from volatile nitrogen losses that occur primarily in the forms of ammonia and NOx. The fraction of excreted organic nitrogen that is mineralized to ammonia nitrogen during manure collection and storage depends primarily on time and, to a lesser degree, temperature. Simple forms of organic nitrogen such as urea (mammals) and uric acid (poultry) are rapidly mineralized to ammonia nitrogen, which is highly volatile and easily diffused into the surrounding air. Nitrogen losses begin at the point of excretion in buildings and other animal production areas and continue through on-site management in storage and treatment systems (i.e., MMS – manure management systems). Nitrogen is also lost through runoff and leaching into soils from solid storage of manure in outdoor areas, in feedlots and where animals graze in pastures.

Tier 1 calculation of N volatilization in the form of NH_3 and NO_x from MMS is based on multiplication of the amount of nitrogen excreted (from all livestock categories) and managed in each MMS by a fraction of volatilized nitrogen (Eq. 10.26). N losses are then summed over all the MMS´s. The Tier 1 method is applied using default nitrogen excretion data, default MMS data (Annex 10A.2, Tables 10A-4 to 10A-8) and default fractions of N losses from MMS due to volatilization (Table 10.22). In order to estimate indirect N_2O emissions from Manure Management, two fractions of nitrogen losses (due to volatilization and leaching/runoff) and two default indirect N_2O emissions factors associated with these losses (EF_4 and EF_5) were employed (Table 11.3, IPCC 2006 Guidelines). Default values for volatilization N losses are presented in Table 10.22. The fraction of manure nitrogen that leaches from manure management systems ($Frac_{leachMS}$ =30%) is highly uncertain. The sum of indirect emissions from Manure Management is presented in the last column of Tab. 5-9.

5.2.2.3 Uncertainty and time-series consistency

As mentioned above, methane emissions from the breeding of farm animals are caused both by enteric fermentation and also by the decomposition of animal excrements (manure). Determination of the latter was prepared at the level of Tier 1, excluding the cattle, where the emissions are calculated by Tier 2 since submission 2012.

The Czech team accepted critical remarks put forth by the International Expert Review Teams (ERT). A concept, in accordance with the plan for implementing Good Practice, is based on decision, that CH_4 emissions from manure management for all farm animals are estimated by Tier 1 approach. For similar reasons as in the previous paragraphs, the default emission factors for Western Europe were employed.

On the basis of the recommendations of the ERT 2009, the estimation of manure management N_2O emissions from horses and goats is reported as two individual groups of animals (category Other livestock was regrouped to two categories), applying the IPCC Tier 1 method and the IPCC default values. The total emissions from the category "N_2O emissions from Manure Management" were not affected.

According to the recommendations of ERT 2011 (ARR), the recalculation of emissions from Manure Management was performed using new national parameters: feed consumption, nitrogen feed intake and protein content of milk and feed (revised Nex value). In addition, the values of digestible energy expressed as a percentage of gross energy (DE) for cattle were revised (the default values were substituted by national values). Further national data on the distribution of manure management practices across AWMS were collected and updated (Kvapilík J. 2010 and 2011– pers.com.).

According to the previous reiterated ERT recommendation (ARR 2011), the Czech Republic recalculated the methane emissions from Manure Management of cattle. In line with the IPCC a higher-tier method to estimate the CH_4 emissions from Manure Management (cattle only) was implemented in 2014 submission. The aim of the recalculation was to review the estimation of methane emissions from Manure Management of cattle by Tier 2. The recalculation of methane emissions from manure management of cattle resulted in an increase in emissions from cattle category approx. 12% in 1990, resp. 42% in 2011. Total methane emissions from Manure Management increased after recalculation by 7% in 1990, resp. by 26% in 2011 (Tab. 5-12). The study Exnerova (2013, in Czech) describing a new method was elaborated.

Application of the higher-tier method to methane emission estimation in 2014 submission has the effect of reducing the uncertainties of this sub-category.

On the basis of the recommendations of the ERT 2011, based on new zoo-technical data and updated country-specific parameters and activity data the emissions from Manure management for dairy and non-dairy cattle categories were calculated by Tier 2 method over the entire 1990-2011 reporting period. The estimation of N_2O emissions from Manure management was performed using the revised Nex values for dairy and non-dairy cattle with the updated parameters (feed consumption, nitrogen feed intake and protein content of milk, to estimate the amount of N retained in milk). Equations 10.32 and 10.33 (2006 IPCC) were used to revise Nex and to calculate the variables for nitrogen intake and nitrogen retained (milk production and growth). The results served as an input for Eq. 10.31. The parameters for estimation of the revised Nex for cattle were collected from literature and from personal communications with agricultural experts. The protein content in milk was determined to 3.3% (Poustka 2007, Ingr 2003 and Turek 2000) and protein content in feed (in dry matter) to 18% (Zeman - Czech feed standards 12-21%, Central Institute for Supervising and Testing in Agriculture 18%, Karabcová pers. commun. 16-18%). The country-specific redistribution of manure management practices across AWMS for cattle (Tab. 5-15) was taken from Hons and Mudrik (2004) for the 1990-1999 period and updated data from Kvapilík J. (2010 and 2011– pers.com.) was used for the 2000-2011 period. Dr. Kvapilik (author of the Annual report of Czech cattle breeding of the Institute of Animal Science in Prague) also provided national data on grazing animals (cattle feed situation, see Tab. 5-5 and Tab. 5-6).

Application of the higher-tier method to methane emission estimation in 2014 submission has the effect of reducing the uncertainties of this sub-category.

Uncertainty estimates are based on expert judgment. The uncertainty in the activity data equals to 5%. The uncertainty in the emission factor for estimation of CH_4 emissions equals to 20%; for estimation of N_2O emissions, this value equals to 30%. The combined uncertainty for CH_4 emissions equals to 20.6% and that for N_2O emissions equals to 30.41%.

5.2.2.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in section 5.1.3.

5.2.2.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

The emission factors for estimation of CH_4 emissions for the cattle category for Manure Management were recalculated following the adoption of Cfi and Ym parameters in accordance with 2006 Gl. IPCC. CH_4 for manure management for pigs was based on recalculation of the CH_4 emissions from pig manure, according to the 2006 Gl. IPCC, to better fit the actual manure handling conditions in the Czech Republic. Instead of 3 kg/head/yr, twice the value, 6 kg/head/yr was used. Manure management CH_4 emission factors from Table 10A-9 for goats, horses and poultry were employed in the inventory. The default value for poultry (weighted average of types of breeding) was adjusted to the Czech conditions. As a result of these changes, the Nex values for cattle category were updated also. As a result of application of the national Typical Animal Mass (TAM) for other than cattle categories (pig, sheep, goats, horses, poultry), the country-specific Nitrogen Excretion values (Nex) for the mentioned animals for the whole entire period were determined using Equation 10.30 (2006 Gl. IPCC).

5.2.2.6 Source-specific planned improvements, including tracking of those identified in the review process

According to recommendation of ERT a revision of the estimated N excretion rate for goats would be solved in the future. The analysis of uncertainties is in progress.

5.3 Rice cultivation (CRF 3.C)

At present, no commercial rice cultivation is being carried out in the Czech Republic. The “NO” notation key is reported in the CRF tables.

5.4 Agricultural soils (CRF 3.D)

5.4.1 Source category description

This source category includes direct and indirect nitrous oxide emissions from agricultural soils. Both of these categories (direct and indirect) are key sources of N_2O soil emissions (Tab. 5-1). Nitrous oxide is produced in agricultural soil as a result of microbial nitrification-denitrification processes. The processes are influenced by chemical and physical characteristics (availability of mineral N substrates and carbon, soil moisture, temperature and pH). Thus, addition of mineral nitrogen in the form of synthetic fertilizers, animal manure applied to soils, crop residue/renewal and sewage sludge enhance the formation of nitrous oxide emissions.

Nitrous oxide emissions from agricultural managed soils include these subcategories:

- The direct emissions (synthetic fertilizers, animal manure applied to soils, crop forage residues/renewal and sewage sludge)
- The emissions from pasture manure (PRP)
- The indirect emissions (atmospheric deposition and nitrogenous substances flushed into water courses and reservoirs -leaching)

In 2014, 71% of total N_2O emissions from Agriculture originated from Agricultural Soils, while the rest originated from Manure Management (29%). The trend in N_2O emissions from this category is during reporting period 1990-2014 decreasing. Tab. 5-19 presents the N_2O emissions of Agricultural soils by the individual sub-categories.

Tab. 5-19 N_2O emissions come from Agricultural Soils in period 1990-2014 in kt N_2O

Year	Total emissions	Direct emissions				Pasture Manure	Indirect emissions	
		a	b	c	d		Atmosph. deposition	Leaching
1990	18.43	5.91	3.80	2.78	--	0.90	2.02	3.01
1991	15.64	4.21	3.63	2.65	--	0.87	1.77	2.52
1992	13.18	3.20	3.36	2.14	--	0.77	1.56	2.15
1993	11.63	2.55	3.04	2.16	--	0.64	1.37	1.86
1994	11.12	2.87	2.66	1.97	--	0.55	1.28	1.79
1995	11.63	3.24	2.50	1.98	--	0.77	1.28	1.85
1996	10.92	2.69	2.52	2.01	--	0.75	1.23	1.72
1997	10.93	2.91	2.44	1.91	--	0.71	1.22	1.74
1998	10.49	2.87	2.34	1.77	--	0.65	1.18	1.68
1999	10.54	2.83	2.37	1.81	--	0.66	1.18	1.69
2000	10.44	3.01	2.26	1.69	--	0.64	1.16	1.68

Year	Total emissions	Direct emissions				Pasture Manure	Indirect emissions	
		a	b	c	d		Atmosph. deposition	Leaching
2001	10.71	3.19	2.22	1.78	--	0.65	1.16	1.71
2002	10.45	3.21	2.19	1.55	0.01	0.63	1.15	1.70
2003	9.41	2.71	2.14	1.31	0.02	0.61	1.08	1.55
2004	10.18	3.06	2.05	1.77	0.02	0.60	1.08	1.60
2005	9.49	2.92	1.84	1.63	0.02	0.62	0.99	1.48
2006	9.62	3.04	1.94	1.40	0.03	0.61	1.04	1.55
2007	9.89	3.16	1.93	1.45	0.03	0.67	1.06	1.59
2008	10.01	3.36	1.72	1.60	0.03	0.75	1.01	1.55
2009	9.66	3.14	1.71	1.53	0.02	0.77	0.98	1.50
2010	9.53	3.20	1.67	1.40	0.04	0.75	0.98	1.50
2011	9.96	3.37	1.60	1.67	0.04	0.77	0.98	1.52
2012	9.88	3.51	1.57	1.44	0.03	0.80	0.98	1.55
2013	10.11	3.69	1.41	1.55	0.03	0.81	1.01	1.60
2014	10.68	3.79	1.63	1.83	0.03	0.77	1.02	1.62

Note: a, b, c, d = individual sources of direct emissions; (a) Synthetic fertilizers, (b) Animal manure applied to soils, (c) Crops (fixing and residues) and (d) Sewage sludge

5.4.2 Methodological issues

Although agricultural soils are key source, emissions of N_2O are estimated and analyzed using Tier 1 approach of the IPCC methodology (2006 IPCC). A set of interconnected spreadsheets in MS Excel has been used for the relevant calculations for several years. The emissions from nitrogen excreted to pasture range and paddocks by animals are reported under animal production in CRF table. The nitrogen from manure that is spread daily is consistently included in the manure nitrogen applied to soils.

5.4.2.1 Activity data

The standard calculation of Tier 1 required the following input information based on Statistical Yearbooks of the Czech Republic (Statistical Yearbooks, 1990-2014):

- An amount of nitrogen applied in the form of industrial nitrogen fertilizers (CzSO data);
- A farm animal population data (CzSO data presented in Tab. 5-3);
- An annual yields (i.e. harvests, see Tab. 5-20)
- A manure production during grazing of animals (PRP category, see Tab. 5-17).
- An annual sewage sludge directly applied to the agricultural soils

Tab. 5-20 Annual yield of agricultural products (t/ha)

	Grains	Pulses	Potatoes	Sugar beets	Fodder	Soya beans
1990	5.42	2.68	16.00	33.89	6.77	3.67
1991	4.84	2.74	17.95	33.73	7.43	10.67
1992	4.14	2.22	17.78	31.11	5.67	6.17
1993	4.03	2.42	22.83	40.19	6.55	1.12
1994	4.08	2.26	16.03	35.53	5.74	1.02
1995	4.17	2.38	17.04	39.63	6.13	1.29
1996	4.19	2.40	20.80	41.45	6.27	1.42
1997	4.12	2.01	19.24	39.39	6.16	1.37
1998	3.97	2.29	21.08	40.71	5.97	1.25
1999	4.37	2.55	19.67	45.55	5.74	1.53
2000	3.92	2.09	21.32	45.62	5.60	1.25
2001	4.51	2.38	20.82	45.33	5.79	1.59
2002	4.33	1.91	23.51	49.45	6.21	2.13

	Grains	Pulses	Potatoes	Sugar beets	Fodder	Soya beans
2003	3.97	1.98	18.97	45.20	4.91	1.55
2004	5.47	3.11	23.96	50.35	6.06	1.43
2005	4.81	2.44	28.08	53.31	6.20	2.04
2006	4.18	2.24	23.05	51.48	6.08	1.85
2007	4.58	2.13	25.71	53.25	5.98	1.75
2008	5.39	2.15	25.83	57.26	6.39	2.17
2009	5.13	2.14	26.19	57.91	6.57	2.26
2010	4.71	1.86	24.56	54.36	6.05	1.69
2011	5.64	2.85	30.45	66.84	7.01	2.36
2012	4.57	1.94	27.98	63.26	6.75	2.29
2013	5.26	2.14	23.12	60.00	6.55	2.07
2014	6.23	2.67	29.07	70.28	7.59	2.28

5.4.2.2 Direct emissions from managed soils (CRF 3.D.1)

Synthetic N fertilizers (CRF 3.D.1.1)

The application of agricultural fertilizers was formerly intensive in the Czech Republic, but decreased radically during the 1990s. The amount of nitrogen fertilizers applied in 1990 equalled over 418 kt, which had decreased to 261 kt by 2014. This corresponds to the trend reported for use of fertilizers, which decreased substantially in the early 1990s (Sálusová et al., 2006).

Organic N applied as fertilizer (animal manure, sewage sludge) (CRF 3.D.1.2)

The amount of organic N inputs applied to soils was calculated using Equation 11.3 (2006 IPCC Guidelines). This includes applied animal manure, sewage sludge and compost applied to soils. In order to estimate the amount of animal manure nitrogen that is directly applied to soils or used in feed, fuel or for construction purposes, it is necessary to reduce the total amount of nitrogen excreted by animals in managed systems by the losses of N through volatilisation, conversion to N_2O and losses through leaching and runoff. To coordinate with reporting for N_2O emissions from managed soils, Eq. 10.34 and the default values for nitrogen loss from Table 10.22 (2006 IPCC) were used to estimate the amount of animal manure nitrogen that is directly applied to soils.

A newly reported sub-category includes the emissions generated by direct application of sewage sludge to agricultural soils. The verifiable activity data from CzSO in tonnes of dry mass have been available since 2002. The national specific value of nitrogen content of 3.7% (Černý *et al.* 2009) and default emission factor (EF_1, see Table 11.1., 2006 IPCC Guidelines) were utilized to estimate the emissions from sewage sludge.

Urine and dung N deposited on pasture by grazing animals (PRP) (CRF 3.D.1.3)

The annual amount of N deposited on pasture, range and paddock soils by grazing animals was estimated using Eq. 11.5 from the number of animals of each livestock species, the annual average amount of N excreted by each livestock species and the fraction of this N deposited on pasture, range and paddock soils by each livestock species. The data needed for this estimation can be obtained from PRP (cattle, swine and poultry) in the livestock category. The default emission factors (Tab. 5-21) are used to estimate emissions from different animal categories.

Tab. 5-21 IPCC default emission factors of animal waste for PRP

	EF_3 (kg N_2O-N per kg N excreted)
PRP (cattle, swine, poultry)	0.02
PRP (cattle, swine, poultry)	0.01

The fraction of livestock N excreted and deposited onto soil during grazing (FracGRAZ) varied from 0.075 in 1990 to 0.141 in 2014.

N-crop residues (CRF 3.D.1.4)

This category includes the amount of N in crop residues (above-ground and below-ground), including N-fixing crops, returned to soils annually. It also includes the N from N-fixing and non-N-fixing forages mineralised during forage or pasture renewal. This is estimated from crop yield statistics (CzSO) and default factors for above-/below-ground residues: yield ratios and residual N contents (see Tab. 5-22).

Tab. 5-22 Data from Table 11.2 (2006 IPCC)

	Grains	Pulses	Potatoes	Sugar beets	Fodder	Soya beans
Dry mater	0.88	0.91	0.22	0.22	---	0.91
R_{AG}	calc	calc	calc	calc	calc	calc
AG_{DM}	calc	calc	calc	calc	calc	calc
FR_{remove}	0.5	0.5	0.5	0.5	0.5	0.5
N_{AG}	0.006	0.008	0.019	0.019	0.027	0.008
R_{BG}-BIO	0.22	0.19	0.2	0.2	0.4	0.19
N_{BG}	0.009	0.008	0.014	0.014	0.022	0.008

Note: The parameters R_{AG} and AG_{DM} are calculated by using Eq. 11.6 (2006 IPCC Guidelines), and adequate parameters.

Since different crop types vary in residue, yield ratios, renewal time and nitrogen contents, separate calculations are performed for major crop types and then nitrogen values for all crop types are summed up. Crops are segregated into: 1) non-N-fixing grain crops, 2) N-fixing grains and pulses, 3) potatoes, 4) sugar beets, 5) N-fixing forage crops (alfalfa, clover) and 6) soya. Eq. 11.6 is used to estimate N from crop residues and forage/pasture renewal for a Tier 1 approach.

Data on crop yield statistics (yields and area harvested, by crop) was obtained from national sources (CzSO). Since yield statistics for many crops are reported as field-dry or fresh weight, a correction factor was applied to estimate dry matter yields where appropriate (Eq. 11.7). The default values for dry matter content from Table 11.2 were employed. Only forage production activity data are presented as a dry matter in CzSO statistics.

The emission factors used for calculation of direct N_2O emissions are shown in Tab. 5-23. The default fraction values used to estimate N_2O emissions are presented in Tab. 5-24. The value of EF_1 has been changed from 1.25% to 1% compared to the 1996 IPCC Guidelines, as a result of new analyses of the available experimental data (Bouwman et al., 2002a,b; Stehfest and Bouwman, 2006; Novoa and Tejeda, 2006 in press).

Tab. 5-23 IPCC default parameters/fractions used for the direct emissions

Parameters/Fractions	Default values
$Frac_{GASM}$	0.20
$Frac_{R}$	0.50
$Frac_{BURN}$	0.00

Tab. 5-24 Emission factors (EFs) for the direct and PRP emissions

Direct emissions	Synthetic fertilizer	EF_1 = 0.01 kg N_2O-N/kg N
	Animal Waste	
	Sewage Sludge	
	N-crop residues	
Pasture, range & paddock manure	Cattle, pigs, poultry	EF_3 = 0.02 kg N_2O-N/kg N
	Sheep, others	EF_3 = 0.01 kg N_2O-N/kg N

5.4.2.3 Indirect emissions from managed soils (CRF 3.D.2)

In addition to the direct emissions of N_2O from managed soils that occur through a direct pathway (i.e. directly from the soils to which N is applied), emissions of N_2O also take place through two indirect pathways. The first of these ways is the volatilization of N as NH_3 and oxides of N (NO_x), and the deposition of these gases and their products NH_4^+ and NO_3^- onto soils and the surface of lakes and other waters.

Volatilization

The N_2O emissions from atmospheric deposition of N volatilized from managed soil are estimated using Equation 11.9. Conversion of N_2O-N emissions to N_2O emissions for reporting purposes is performed by factor 44/28.

Leaching/Runoff

The N_2O emissions from leaching and runoff in regions, where leaching and runoff occurs, are estimated using Equation 11.10. Conversion of N_2O-N emissions to N_2O emissions for reporting purposes is performed by factor 44/28.

The method for estimating indirect N_2O emissions includes two emission factors (Tab. 5-26): one associated with volatilized and re-deposited N (EF_4), and the second associated with N lost through leaching/runoff (EF_5). The overall value for EF_5 has been changed from 0.025 to 0.0075 kg N_2O-N/kg N leached/ in runoff water. The method also requires values for the fractions of N that are lost through volatilization ($Frac_{GASF}$ and $Frac_{GASM}$) or leaching/runoff ($Frac_{LEACH}$). The default values of these fractions are presented in the Tab. 5-25.

Tab. 5-25 IPCC default parameters/fractions used for indirect emission estimation

Parameters/Fractions	Default values
$Frac_{GASM}$	0.20
$Frac_{GASF}$	0.10
$Frac_{LEACH-(H)}$	0.30

Tab. 5-26 Emission factors (EFs) for indirect emission estimation

Indirect emissions	Atmospheric Deposition	EF_4 = 0.01 kg N_2O-per kg emitted NH_3 and NO_X
	Nitrogen Leaching	EF_5 = 0.0075 kg N_2O - per kg of leaching N

5.4.3 Uncertainty and time-series consistency

In relation to the consistency of the emission series for N_2O (agricultural soils) should be mentioned that emission estimates have been calculated in a consistent manner since 1996 according to the default methodology of IPCC 2006 Guidelines (IPCC, 2006). Emission estimates for 1990, 1992, 1994 and 1995 were obtained and reported in several recent years; the data for 1991 and 1993 are reported (together with year 2004) this year as part of the 2006 submission. Since in 2015 submission 2006 IPCC methods were applied to estimate the emissions.

The quantitative overview and emission trends during period 1990-2014 are shown in Fig. 5-1 and trend in N_2O emissions from agricultural soils is summarized in Tab. 5-19.

During 1990-2014 the total emissions from agricultural soils decreased by 42% (rapidly during period 1990-1995, about 40%), direct emissions decreased by 42% and indirect emissions by 48%. More than 15% reduction was reached in the animal production.

Following the ERT, the Czech emission inventory team verified the activity data required for this category and found that the previously reported data based on expert judgment of areas could not be confirmed and verified from the official statistics. According to the expert common consensus (I. Skorepova, P. Fott, E. Cienciala and Z. Exnerova), there are no cultivated histosols on agricultural land in this country and hence also no data for this category. Organic soils mostly occur on forest land and they are reported in the LULUCF sector. During in-country review 2009 was confirmed that there are no cultivated histosols on agricultural land in the Czech Republic.

On the basis of the recommendations of ERT (in-country review 2009) and the ARR (2009), several recalculations were performed (N_2O emissions from Animal manure applied to soils, Crop residues, N-fixing crops) and technical errors were corrected in the emission inventory of agricultural soils in the 2010 submission (see Chapter 10 - Recalculations).

Given that the value of Nex for cattle was revised based on the recommendation of ERT (2011), which led to changes in N_2O emissions from i) animal manure applied to soils, ii) PRP, iii) atmospheric deposition and iv) N lost through leaching and run-off. These changes apply to the entire reporting period.

During the centralized review in September 2012, the expert review team (ERT) identified a potential problem in the estimation of N_2O Direct emissions from Agricultural soils. The ERT noted that: i) the Czech Republic has not included N-fixing forage crops such as alfalfa and clover in the calculations of N_2O emissions for the entire time series and ii) the Czech Republic has not included potatoes and sugar beet crops produced in the country in the estimations of N_2O emissions from crop residues returned to soils for the entire time series. The ERT noted that this is not in line with the Revised 1996 IPCC Guidelines, and thus it was requested that these emission categories to be revised. The recalculation was submitted to ERT as a resolved issue of the “Saturday paper” regarding the 2012 NIR submission. Based on these recommendations and newly obtained country-specific data, the following improvements were implemented in the 2014 submission:

1. N-fixing forage crops such as alfalfa and clover were included in the calculations of N_2O emissions for the entire time series and

2. potatoes and sugar beet crops produced in the country were included in the estimations of N_2O emissions from crop residues returned to soils for the entire time series

On the basis of the recommendations of ERT (in-country review in August-Sept 2011 in Prague) and the following ARR document, N_2O emissions from agricultural soils were recalculated in the 2012 submission. Given that the value of Nex for cattle was revised in the Manure Management category, which led to changes in N_2O emissions from i) animal manure applied to soils, ii) pasture, range and paddocks, iii) atmospheric deposition and nitrogen lost through leaching and run-off. These changes apply to the entire reporting period.

On the basis of the recommendations of ERT (centralized review in September 2012, Bonn) Direct N_2O emissions from agricultural soils were recalculated and reported in the 2012 resubmission. This led to changes in N_2O emissions from N-fixing crops and crop residues.

Uncertainty estimates are based on expert judgment. The uncertainty in the activity data for estimation of direct and indirect emissions from agricultural soils equals to 20%; for Pasture, Range and Paddock Manure (PRP) this value equals to 10%. The uncertainty in the emission factor for estimation of direct and indirect emissions from agricultural soils equals to 50%; for estimation of emissions from PRP this value equals to 100%. The combined uncertainty for the direct and indirect emissions from agricultural soils equals to 53.85%; for N_2O emissions from PRP Manure this value equals to 100.5%.

5.4.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in section 5.1.3.

5.4.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

In response to recalculations in subsectors 3A and 3B, the values of emissions from Direct and Indirect emissions from managed soils were updated.

5.4.6 Source-specific planned improvements, including tracking of those identified in the review process

According to recommendation of ERT an adding data of sewage sludge for the entire reporting period will be conducted in the next submission. The analysis of uncertainties is in progress.

5.5 Prescribed burning of savanna (CRF 3.E)

This activity is prohibited by the Czech Law (Air Protection Act), thus prescribed burning of savanna does not occur in the Czech Republic.

5.6 Field burning of agricultural residues (CRF 3.F)

This activity is prohibited by the Czech Law (Air Protection Act), thus field burning of agricultural residues does not occur in the Czech Republic.

5.7 Liming (CRF 3.G)

5.7.1 Source category description

Liming is used to reduce soil acidity and improve plant growth in managed systems, particularly agricultural lands and managed forests. Adding carbonates to soils in the form of lime (e.g., limestone or dolomite) leads to CO_2 emissions as the carbonate lime dissolve and release bicarbonate, which evolves into CO_2 and water. The liming on all managed soils is reported under this category, i.e. arable lands, grasslands and forest lands.

5.7.2 Methodological issues

However, the reactions associated with limestone application also lead to evolution of CO_2, which must be quantified. The activity data are derived from the official national statistics (CzSO and Green Report of Forestry, see Tab. 5-27). Of the reported total limestone used in agriculture, 95% was ascribed to agricultural soils in cropland (5% to grassland) based on expert judgment (V. Klement, Central Institute for Supervising and Testing in Agriculture – pers. comm. 2005). The share of liming of forest lands in total liming in the Czech Republic was the highest in the 2000 – 2002 period, when the value was over 10% and as much as 18% in 2000. Liming in forests was not employed in 2014.

Tab. 5-27 Limestone quantity applied to managed soils (in thousand tons)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CL+GL	2650	700	230	220	230	248	255	210	204	196	209	210	196
FL	26.9	12.1	16.2	13.9	4.8	2.4	0.3	0.0	1.0	1.0	46.7	27.8	29.2
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	
CL+GL	172	158	143	160	174	203	145	135	182	263	308	342	
FL	6.5	15.3	2.6	16.8	7.2	12.3	0.1	5.1	0.0	0.0	0.0	0.0	

Notes: CL = Cropland, GL = Grassland, FL = Forest land

The quantification followed the Tier 1 method (Eq. 11.12., IPCC 2006 Guidelines), with an emission factor of 0.12 t C/t $CaCO_3$. To convert CO_2–C emissions into CO_2 factor 44/12 was used. Separate data are not available for limestone and dolomite, hence the aggregate estimates for total lime applications are reported. The application of agricultural limestone was previously intensive in this country, but decreased radically during the 1990s. Hence, the amount of limestone applied in 1990 equalled over 2.5 mil tones, but decreased to less than 200 thousand tons annually during the most recent years. The activity data on liming were repeatedly verified. They correspond to the trend reported for use of fertilizers, which decreased a lot in early 1990s (Sálusová *et al.*, 2006). The application of limestone on agricultural land in 2014 reached almost 342 thousand tons, while no liming was applied on forest areas.

5.7.3 Uncertainties and time-series consistency

Uncertainty estimates are based on expert judgment (AD) and default value (EF). The uncertainty in the activity data for estimation of emissions from Liming equals to 20%, the uncertainty in the emission factor equals to 50%. The combined uncertainty of emission estimation from Liming equals to 53.85%.

5.7.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in section 5.1.3.

5.7.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

No recalculation was performed in this submission.

5.7.6 Source-specific planned improvements, including tracking of those identified in the review process

The analysis of uncertainties is in progress.

5.8 Urea Application (CRF 3.H)

5.8.1 Source category description

Adding urea to soils during fertilization leads to a loss of CO_2 that was fixed in the industrial production process. Urea is converted into ammonium, hydroxyl ion and bicarbonate, in the presence of water and urease enzymes. This source category is included because the CO_2 removal from the atmosphere during urea manufacturing is estimated in the Industrial Processes and Product Use Sector (IPPU Sector).

5.8.2 Methodological issues

Tier 1 and Eq. 11.13 are utilized to estimate CO_2 emissions. Domestic production records for urea were used to obtain an approximate estimate of the amount of urea applied to soils on an annual basis (Tab. 5-28). The default emission factor is 0.20 for carbon emissions from urea applications, which is equivalent to the carbon content of urea on an atomic weight basis. To estimate the total CO_2-C emissions, the product of the amount of urea is multiplied by the emission factor. CO_2-C emissions are converted into CO_2 by multiplying by 44/12.

Until 2013, the values of urea application to agricultural land have ranged from 92 to 190 thousand tons. An extreme decline in urea production and its application to managed soils was recorded in 2013 (1100 tons only), due to significant restrictions on Czech production and a transition to the import policy. It is planned to prioritize the import of urea in the future period.

In this submission, new activity data were obtained and applied to the inventory. The statistical production data were replaced by more precise data corresponding to the real consumption by the Ministry of Agriculture. These data available for the 2000 – 2014 period are based on farmers' fertilizer records. These data were used to recalculate the appropriate time series. The application of urea to agricultural land in 2014 reached almost 78 kt of urea, which is about half that in 2013.

Tab. 5-28 Domestic production of urea (IPPU) applied to managed soils

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Urea (kt)	148	180	148	127	124	149	137	92	195	120	65	106	87
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	
Urea (kt)	83	96	101	113	166	137	117	152	151	185	171	78	

5.8.3 Uncertainties and time-series consistency

Uncertainty estimates are based on expert judgment (AD) and default value (EF). The uncertainty in the activity data for estimation of emissions from Urea application equals to 20%, the uncertainty in the emission factor equals to 50%. The combined uncertainty of emission estimation from Urea application equals to 53.85%.

5.8.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in a section 5.1.3.

5.8.5 Source-specific recalculations, including changes made in response to the review process and impact of emission trend

New activity data were obtained and applied to the inventory. The statistical production data were replaced by more precise data corresponding to the real consumption by the Ministry of Agriculture. These data available for the 2000–2014 period are based on farmers' fertilizer records. The following Fig. 5-2 presents a comparison of emissions from Urea application before and after recalculation.

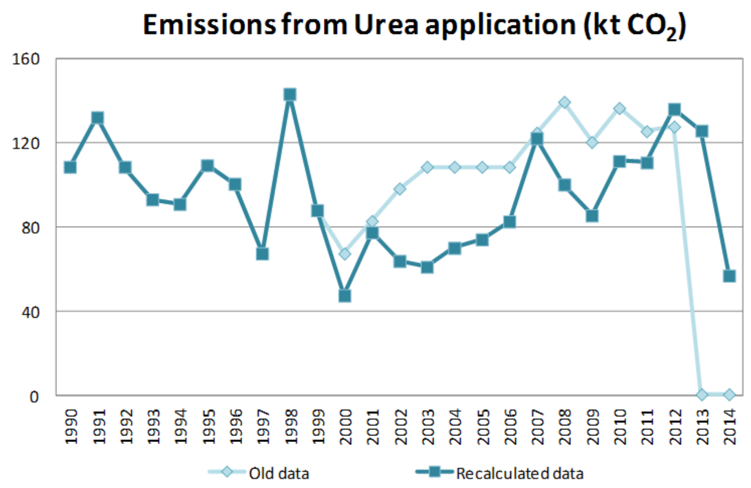


Fig. 5-2 A comparison of the old (light blue) and recalculated (dark blue) CO_2 emissions from Urea application. Since 2000 the significant differences of CO_2 emissions are obvious

5.8.6 Source-specific planned improvements, including tracking of those identified in the review process

The analysis of uncertainties is in progress.

6 Land Use, Land-Use Changes and Forestry (CRF Sector 4)

6.1 Overview of sector

The emission inventory of the Land Use, Land Use Change and Forestry (LULUCF) sector includes emissions and removals of greenhouse gases (GHG) resulting from land use, land-use change and forestry. The inventory was originally based on application of the IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (IPCC 2003, further also abbreviated as GPG for LULUCF) and the reporting format adopted by the 9th Conference of the Parties (COP) to UNFCCC. The reporting guidelines were revised at the 19th COP in 2013 by decision 24/CP.19. It demands that, starting in 2015, Parties included in Annex I to the Convention should apply the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) that are linked to the previously used methods outlined in Chapter 3 of GPG for LULUCF (IPCC 2003). In addition, decision 24/CP.19 encourages the use of the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (IPCC 2014a) in preparing the annual inventories under the Convention due in 2015 and beyond. The current LULUCF reporting is also guided by the 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (IPCC 2014b). This material is used, together with IPCC (2006), to prepare the assessment and reporting of annual changes in carbon stocks and associated CO_2 emissions and removals from the Harvested Wood Products (HWP contribution), which has been mandatorily reported under LULUCF since the 2015 NIR submission.

Reporting of the LULUCF sector in the Czech Republic has gradually incorporated the specific requirements on the inventory based on IPCC (2003, 2006, 2014a, 2014b) in the previous submissions. The current inventory of the LULUCF sector uses the revised reporting structure, including the estimated HWP contribution. In terms of land use representation and land-use change identification required for emission estimation for the LULUCF land use categories, the Czech inventory employs a refined system of land use identification at the level of the individual cadastral units. Although the Czech LULUCF inventory is still in the process of further refinement and consolidation, it represents a solid system for providing information on GHG emissions and removals in the LULUCF sector, as well as for providing additional information on the LULUCF activities required under the Kyoto protocol.

The current inventory includes CO_2 emissions and removals, and emissions of non-CO_2 gases (CH_4, N_2O, NO_X and CO) from biomass burned in forestry and disturbances associated with land-use conversion. The inventory covers all major LULUCF land-use categories, namely 4.A Forest Land, 4.B Cropland, 4.C Grassland, 4.D Wetlands, 4.E Settlements and 4.F Other Land, all linked to the Czech cadastral classification of lands. It also includes the HWP contribution, which is reported under category 4.G Harvested Wood Products. The emissions and/or removals of greenhouse-gases are reported for all the mandatory categories.

The current submission covers the whole reporting period from the base year of 1990 to 2014. The currently reported estimates changed in comparison with the previously reported values as a result of further refinements implemented in the land use representation and land use change identification system, as well as due to the revised estimates for some categories that resulted in recalculations for the entire reporting period. The current and previously reported sectoral estimates of greenhouse-gas emissions and removals are depicted in Fig. 6-1. The implemented changes led to somewhat different estimates for the individual years compared to the previously reported emission removals, generally leading to a higher sink for the sector. The major quantitative change is attributed to the current estimate of the HWP contribution, which is a result of the use of a different reporting method compared to that in the previous NIR submission. However, changes have also been implemented for several estimates in other categories, which also affect the total LULUCF assessment. Detailed information on the implemented changes and performed recalculations is provided below for the individual LULUCF categories.

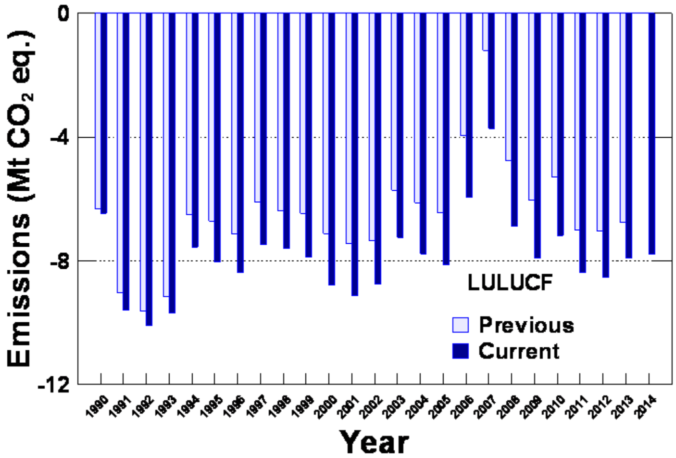


Fig. 6-1 The current and previously reported estimates of emissions for the LULUCF sector. The values are negative, hence correspond to net removals of green-house gases.

6.1.1 Estimated emissions

Tab. 6-1 provides a summary of the LULUCF GHG estimates for the base year of 1990 and the most recently reported year, 2014.

Tab. 6-1 GHG estimates in Sector 4 (LULUCF) and its categories in 1990 (base year) and 2014

Sector/category	Emissions 1990 kt CO_2 eq.	Emissions 2014 kt CO_2 eq.
4 Total LULUCF	-6 468	-7 774
4.A Forest Land	-4 839	-7 311
4.A.1 Forest Land remaining Forest Land	-4 518	-6 828
4.A.2 Land converted to Forest Land	-321	-482
4.B Cropland	121	17
4.B.1 Cropland remaining Cropland	-2	-76
4.B.2 Land converted to Cropland	123	93
4.C Grassland	-145	-569
4.C.1 Grassland remaining Grassland	0	-274
4.C.2 Land converted to Grassland	-145	-295
4.D Wetlands	22	27
4.D.1 Wetlands remaining Wetlands	(0)	(0)
4.D.2 Land converted to Wetlands	22	27
4.E Settlements	85	128
4.E.1 Settlements remaining Settlements	(0)	(0)
4.E.2 Land converted to Settlements	85	128
4.F Other Land	(0)	9
4.G Harvested Wood Products	-1 713	-94

Note: Emissions of non-CO_2 gases (CH_4 and N_2O) are also included.

In 2014, the net GHG flux for the LULUCF sector, estimated as the sum of emissions and removals, equalled -7.774 Gg CO_2 eq., thus representing a net removal of GHG gases. In relation to the estimated emissions in other sectors in the country for the inventory year 2014, the removals realized within the LULUCF sector decrease the GHG emissions generated in other sectors by 6.3%. Correspondingly, for the base year of 1990, the total emissions and removals in the LULUCF sector equalled -6.468 Gg CO_2 eq. In relation to the emissions generated in all the other sectors, the inclusion of the LULUCF estimate reduces the total emissions by 3.3% for the base year of 1990. It is important to note that the emissions within the LULUCF sector exhibit high inter-annual variability (Fig. 6-1) and the values shown in Tab. 6-1 should not be interpreted as trends. The entire data series can be found in the corresponding CRF Tables.

6.1.2 Key categories

Tab. 6-2 Key categories of the LULUCF sector (2014)

Category	Gas	Character of category	% of total GHG*
4.A.1 Forest Land remaining Forest Land	CO_2	LA, TA	5.96

KC: key category, LA - identified by level assessment, TA - identified by trend assessment
% of total GHG: relative contribution of category to net GHG (including LULUCF)

Of the main categories listed in Tab. 6-1, only one was identified as a key category according to the IPCC Good Practice (2006 IPCC Guidelines). This is 4.A.1 Forest Land remaining Forest Land with a contribution of 5.97% - this is the major LULUCF category identified by the level assessment for 2014 (Tab. 6-2). It was also identified as the key category by the trend assessment. The emissions in this category are mostly determined by changes in the biomass carbon stock.

6.1.3 Coverage of pools and methodological tiers

The current inventory submission of the LULUCF sector includes all the mandatory categories and carbon pools, as well as emissions related to HWP. The specific information related to methodological tiers and pools included in the category estimates is provided under the individual chapters by the IPCC land use categories (Chapters 6.4 to 6.9) and the category of HWP contribution (Chapter 6.10).

6.2 Information on approaches used for representing land areas and on land-use databases used for the inventory preparation

The reporting format requires the estimation of GHG emissions into the atmosphere by sources and sinks for six land-use categories and, since reporting year 2013, also for the land-unspecific category of Harvested wood products (4.G). The land-use categories are Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land. Each of these categories is divided into lands remaining in the given category during the inventory year, and lands that are newly converted into the category from a different one. Accordingly, GPG for LULUCF (IPCC 2003) and its follow up 2006 IPCC Guidelines (IPCC 2006) outline the appropriate methodologies for estimation of emissions.

Consistent representation of land areas and identification of land-use changes constitute the key steps in the inventory of the sector in accordance with the 2006 IPCC Guidelines (IPCC 2006). The adopted system of land-use representation and land-use change identification was constructed gradually. Since the 2008 NIR submission, this has been exclusively based on the cadastral land use information of the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz). The Czech land-use representation and the land-use change identification system use annually updated COSMC data, elaborated at the level of about 13 thousand individual cadastral units. The system was constructed in several steps, including 1) source data assembly 2) linking land-use definitions 3) identification of land-use change 4) complementing time series. These steps are described below. The result is a system of consistent representation of land areas having the attributes of both Approach 2 and Approach 3 (IPCC 2006), permitting accounting for all land-use transitions in the annual time step. The individual steps are described below.

6.2.1 Source data compilation

The methodology requirements and principles associated with the approaches recommended by the GPG for LULUCF (2006 IPCC Guidelines) imply that, for the reported period of 1990 to 2014, the required land use should be available for the period starting from 1969. Information on land use was obtained from the Czech Office for Surveying, Mapping and Cadastre (COSMC), which administers the database of “Aggregate areas of cadastral land categories” (AACLC). The AACLC data were compiled at the level of the individual cadastral units (1992-2014) and individual districts (since 1969). There are over 13 000 cadastral units, the number of which varies due to separation or division for various administrative reasons. In the period from 1992 to 2014, the total number of cadastral units varied between 13 027 and 13 079.

To identify the administrative separation and division of cadastral units within a given year, two approaches were employed. Previous to 2004, the cadastral units were crosschecked by comparing the areas in subsequent years using a threshold of half-hectare difference. Starting in 2004, the explicit change of land use was quantified within and for each year directly by the data provider, i.e., COSMC, at the request of the inventory team. The latter approach does not require reconciliation of individual cadastral units between the consecutive years, as it adopts the addressed land use change information available in the COSMC database.

To obtain information on land-use and land-use changes prior to 1993, a complementary data set from COSMC at the level of 76 district units was prepared. It covered the period since 1969 and was required for application of the IPCC default transition time period of 20 years for carbon stock change in soils. The spatial coverage of cadastral and district units is also shown in Fig. 6-2.

6.2.2 Linking land-use definitions

The analysis of land use and land-use change is based on the data from the “Aggregate areas of cadastral land categories” (AACLC), centrally collected and administered by COSMC and regulated by Act No. 265/1992 Coll., on Registration of proprietary and other material rights to real estate, and Act No. 344/1992 Coll., on the real estate cadastre of the Czech Republic (the Cadastral Act), both as amended by later regulations. AACLC distinguishes ten land categories, six of them belonging to land utilized in agriculture (arable land, hop-fields, vineyards, gardens, orchards, grassland) and four under other use (forest land, water surfaces, built-up areas and courtyards, and other land). For the explicitly addressed within-year land use change identification, three additional specific land-use subcategories were distinguished, namely water surface – waterlogged soil, other land – waterlogged soil and other land – unfertile land. The AACLC land use categories and sub-categories of the COSMC database were linked so as to most closely match the default definitions of the six major land-use categories (Forest Land, Cropland, Grassland, Wetlands, Settlements and Other Land) as given by the 2006 Guidelines for National Greenhouse Gas Inventories (IPCC 2006). The country-specific definition content can be found in the respective Chapters 6.4 to 6.9 devoted to each of the major land-use categories.

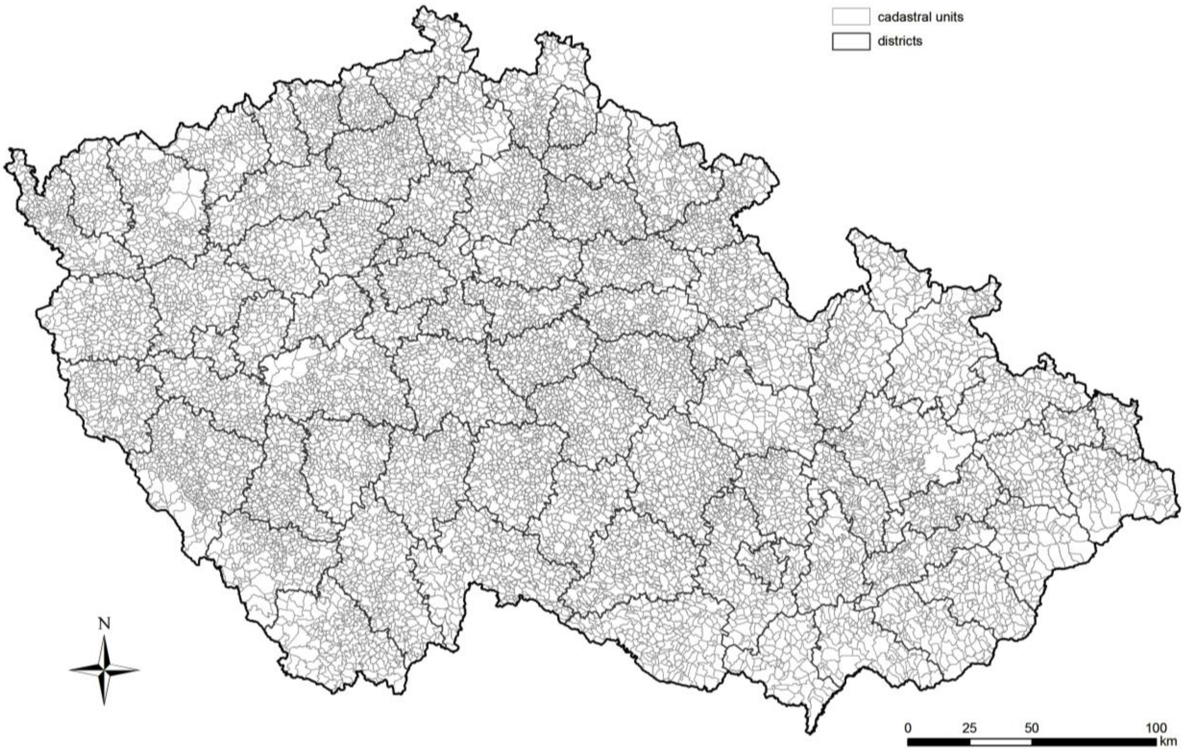


Fig. 6-2 Cadastral units (grey lines; n = 13 054) and districts (black lines; n=79), the basis of the Czech land use representation and land use change identification system.

6.2.3 Land-use change identification

The critical issue of any LULUCF emission inventory is the quantitative determination of land-use change. This inventory adopts two approaches for identifying and quantifying land-use changes on an annual basis: i) until 2003 by balancing the six major land-use areas for each of the individual or integrated cadastral units on use of the subsequent years of the available period and ii) since 2004, using the within-year explicitly addressed land-use conversions registered and estimated by COSMC, the authorized administrator of cadastral information in the country. Although both the approaches are in principle identical, the later approach is more accurate, as it captures virtually all changes within each individual cadastral unit, including theoretically possible bi-directional changes involving the same pair of land use categories within one particular year. In practice, the actual effect of the more advanced, latter approach is not significant under the conditions of the Czech Republic. However, it greatly improves the transparency of the system and the data are basically readily usable as supplied by the data provider (COSMC) without further processing. The resolution of the implemented land use representation and land use change identification system is demonstrated in Fig. 6-3. In the example of the cadastral unit of Kácov (ID 656305), it can be observed that during 2011, two land-use categories lost their land, while the other two increased their area. However, as shown in the table, there were six specific land-use changes involved in these land use changes, where Forest land and Grassland were partly converted to Settlements and Cropland. The latter approach and more detailed data available since 2004 also allowed an explicit estimation of changes associated with the category of Other land representing unfertile land with no specific type of land use, which was considered to be constant until 2003 (Fig. 6-4). All identified land-use transfers estimated at the individual cadastral unit level are summarized by each type of land-use change on an annual basis to be further used for estimation of the associated emissions.

Year (date)	ID CU (Name)	Forest land	Cropland	Grassland	Wetlands	Setttlements	Other land	Total
1.1.2011	661635 (Kácov)	1992637	2627349	1186759	376350	1124451	291370	7598916
31.12.2011	661635 (Kácov)	1979724	2633115	1181825	376350	1136533	291371	7598918
Difference		**-12913**	**5766**	**-4934**	0	**12082**	1	2

Conversion type	Area (m^2)
Forest land - Cropland	977
Forest land - Settlements	11936
Cropland - Settlements	247
Grassland - Cropland	4897
Grassland - Settlements	38
Settlements - Cropland	139

Fig. 6-3 Example of land-used change identification for 2011 and cadastral unit 661635 (Kácov); all spatial units are given in m^2.

6.2.4 Complementing time-series

The above described calculation of land-use changes at the level of individual cadastral units was performed for 1993 to 2014, because the data on that spatial resolution has been available only since 1992. For the years preceding 1993, i.e., for land-use change attributed to 1970 to 1992, an identical approach to that described above was used, but with aggregated cadastral input data at the level on the individual districts. Due to the IPCC default time period of 20 years used for reporting the converted land, the source information contains data on land use in the Czech Republic since 1969.

6.2.5 Land use representation and land use change identification system - status and development

Development of the Czech LULUCF land use representation and land use change identification system as described above involved collaboration with the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz), which administers the source information on land use used in the LULUCF emission inventory[3]. Based on internal analysis and the recommendations of COSMC, the current inventory retains exclusively use of the original data on land use without any further corrections and provides explicit information on land use for all six IPCC land use categories. The inventory team is working on further consolidation of the system to provide the specific information required for KP LULUCF activities.

6.3 Land- use definitions and the classification systems used and their correspondence to the land use, land-use change and forestry categories

The IPCC land use categories were linked to the Czech cadastral classification system, namely that of "Aggregate areas of cadastral land categories" (AACLC), centrally collected and administered by COSMC, as described in detail in Section 6.2 above. The specific attribution and linking of cadastral land use

[3] *The work of the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) is based on digitalisation of cadastral land use information in the Czech Republic, which is planned to be finalized in 2017. This major reconciliation of land-use information is in progress and explains the nature of the ongoing area rectifications in the official reports on areas of land and land use categories in the country.*

categories to IPCC land use categories is given in the source category description text under the corresponding Sections 6.4 to 6.9 below.

6.3.1 Land-use change – overall trends and annual matrices

The overall trends in the areas of the major land-use categories in the Czech Republic for the 1970 to 2014 period are shown in Fig. 6-4. A largest quantitative change is associated with the Cropland and Grassland land-use categories.

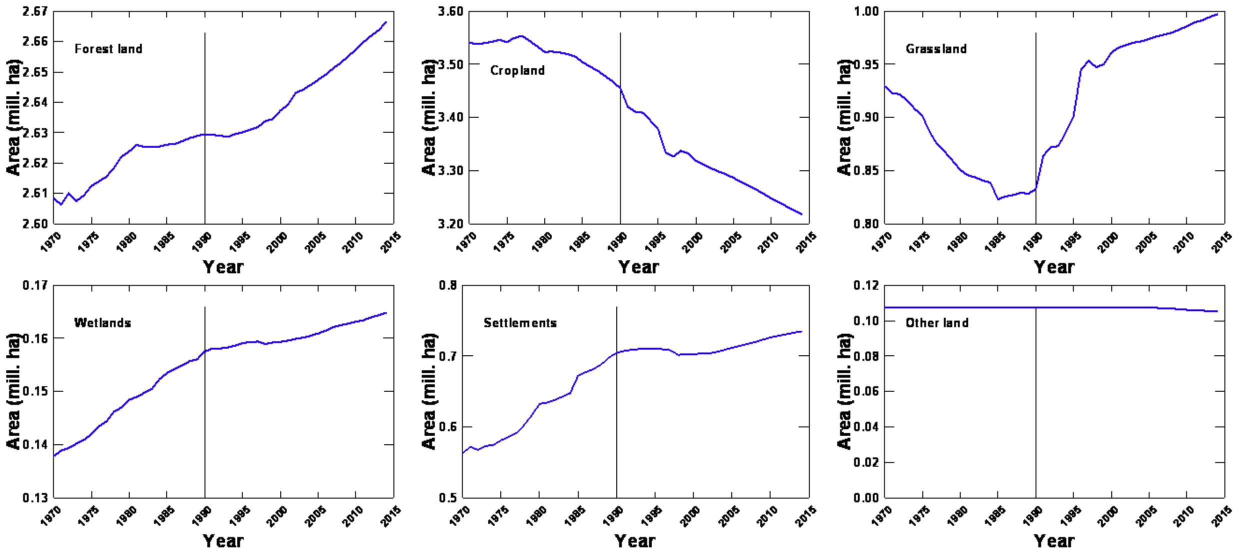


Fig. 6-4 Trends in areas of the six major land-use categories in the Czech Republic between 1970 and 2014 (based on information from the Czech Office for Surveying, Mapping and Cadastre).

Tab. 6-3 Land-use matrices describing annual initial and final areas of particular land-use categories and the identified annual land-use conversions among these categories, shown for 1990 and 2014.

1990		Initial (1989)						*Area (kha)*
	Category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	
Final (1990)	Forest Land	2628.6	0.5	0.4	0	0	0	2629.5
	Cropland	0	3454.5	0.4	0	0.1	0	3455
	Grassland	0.1	8.8	823.6	0	0	0	832.5
	Wetlands	0	0.4	0.4	155.9	0.8	0	157.5
	Settlements	0.3	3.7	3.7	0.1	696.9	0	704.6
	Other Land	0	0	0	0	0	107.2	107.2
	Area (kha)	2629	3467.9	828.5	156	697.8	107.2	7886.3
2014		Initial (2014)						*Area (kha)*
	Category	Forest land	Cropland	Grassland	Wetlands	Settlements	Other land	
Final (2014)	Forest Land	2663.1	0.7	0.4	0	1.8	0.3	2666.4
	Cropland	0.1	3217.3	0.6	0	0.3	0.1	3218.4
	Grassland	0.1	4	992.5	0.1	0.3	0.2	997.2
	Wetlands	0	0.4	0.2	164	0.1	0.1	164.8
	Settlements	0.3	2.7	0.7	0.2	730.6	0.4	734.8
	Other Land	0	0.3	0.1	0	0.1	104.5	105.1
	Area (kha)	2663.6	3225.4	994.5	164.3	733.2	105.6	7886.7

An insight into the net trends shown in Fig. 6-4 is provided by the analysis of gross land-use changes as described in Section 6.2. Tab. 6-3 shows a product of that analysis (for the base year 1990 and 2014), namely the areas of land-use change among the major land-use categories over the 1990 to 2014 period in the form of land-use change matrices for the individual years. It is important to note that the annual totals for the individual years in the matrices do not necessarily correspond to the areas that appear in the CRF Tables, which account for the progressing 20-year transition period that began in 1970. This is the recommended assumption of IPCC (2006) for estimation of changes in soil carbon stock.

6.4 Forest Land (CRF 4.A)

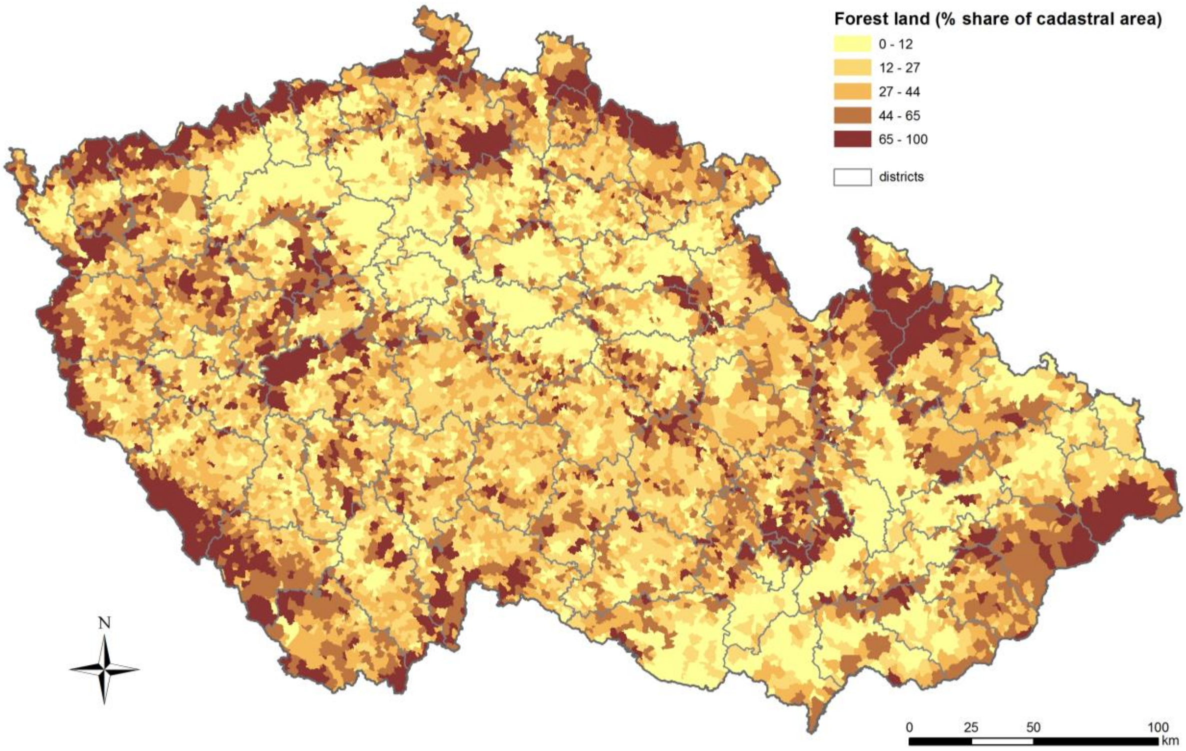


Fig. 6-5 Forest land in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2014).

6.4.1 Source category description

The Czech Republic is a country with a long forestry tradition. Practically all the forests can be considered to be temperate-zone managed forests under the IPCC definition of forest management (2006 IPCC Guidelines, Volume 4). Within the Czech land use representation and land use change identification system, land use category 4.A Forest land is represented by the forest land category of the Czech cadastral system. With respect to the definition thresholds of the Marrakesh Accords, forest is defined as land with woody vegetation and with tree crown cover of at least 30%, over an area exceeding 0.05 ha containing trees able to reach a minimum height of 2 m at maturity[4]. As this definition of forest excludes the areas of permanently unstocked cadastral forest land, such as forest roads, forest nurseries and land under power transmission lines, these are discounted in all emission estimates involving Forest Land using the annually updated information on the ratio of timberland to cadastral forest land. In this way, the area of cadastral forest land is also linked to the national definition of timberland (Czech Forestry Act 84/1996). In 2014 (1990), the area of Forest Land equalled 2 666 (2 629) thous. ha, whereas the stocked forest area (timberland) corresponded to 2602 (2 583) thousand ha, representing 97.6 (98.2)% of the cadastral forest land in the Czech Republic. Hence, the permanently unstocked area represents 2.4 (1.8)% of the forest land according to the Czech cadastral data.

Forests (cadastral forest land) currently occupy 34% of the area of the country (MAF, 2015). The tree species composition is dominated by conifers, which represent 72.5% of the timberland area. The four most important tree species in this country are spruce, pine, beech and oak, which account for 50.7, 16.5, 8.0 and 7.1% of the timberland area, respectively (MAF, 2015). Broadleaved tree species have been favoured in new afforestation since 1990. The proportion of broadleaved tree species increased from 21% in 1990 to over 26% in 2014. The total growing stock (merchantable wood volume) in forests in the country has increased during the reported period from 564 mil. m^3 in 1990 to 689 mil. m^3 (under bark) in 2014 (MAF, 2015).

Several sources of information on forests are available in the Czech Republic. The primary source of activity data on forests used for this emission inventory is the forest taxation data in Forest Management Plans (further denoted as FMP), which are administered centrally by the Forest Management Institute (FMI), Brandýs n. L. and supervised (since 2012) by Czech Forests, s.e. With a forest management plan cycle of 10 years, the annual update of the FMP database is related to 1/10 of the total forest area scattered throughout the country. The information in FMP represents an ongoing national stand-wise type of forest inventory. The second source of information corresponds to data from the first cycle of the statistical (sample based, tree level) National Forest Inventory (NFI) performed during 2001-2004 by FMI. The results of the first NFI cycle were published in 2007 (FMI, 2007). The second NFI cycle ran during the years 2011 to 2015. Its results are to be gradually released during 2016. The recent statistical information on forests at a county level is also provided by the Czech landscape inventory (CzechTerra; www.czechterra.cz), a project funded by the Ministry of Environment (Černý 2009, SP/2d1/93/07). It complemented its first cycle in 2008/2009. Its second cycle was conducted in 2014/2015 as part of the project funded by the Czech Science Foundation (GA ČR 14-12262S). These results were published by the end of 2015 (Cerny et al. 2015, Cienciala et al. 2015) and some of these data are already implemented in this emission inventory report. However, the inventory is still predominantly based on the FMP data. These have also been used for all the international reporting on forests in the Czech Republic to date. Wherever feasible, auxiliary information from the above mentioned inventory programs and/or other sources has also been utilized.

The FMP data were aggregated in line with the country-specific approaches at the level of the four major tree species (i-beech: all broadleaved species except oaks, ii-oak: all oak species, iii-pine: pines and larch, iv-spruce: all conifers except pines and larch) and age-classes (10-year intervals). For these categories, growing stock (merchantable volume, defined as tree stem and branch volume under bark with a minimum diameter threshold of 7 cm), the corresponding areas and other auxiliary information were available for each inventory year. It can be observed that the area of broadleaved species has steadily increased during the reporting period, mainly at the expense of spruce (Fig. 6-6). In addition to the four major categories by predominant tree species, clear-cut areas are also distinguished (Fig. 6-6), forming another, specific sub-category of Forest Land. A clear-cut area is defined as a temporarily unstocked area

[4] These parameters, together with the minimum width of 20 m for linear forest formations, were given in the Czech Initial Report under the Kyoto Protocol

following final or salvage harvest of forest stands. It ceases to exist once it is reforested, which must occur within two years according to the Czech Forestry Act. There is no detectable carbon stock change for this category and it is introduced solely for the purpose of consolidated, transparent and consistent reporting of forest land. In 2014, clear-cut areas represented 1.3% of Forest Land.

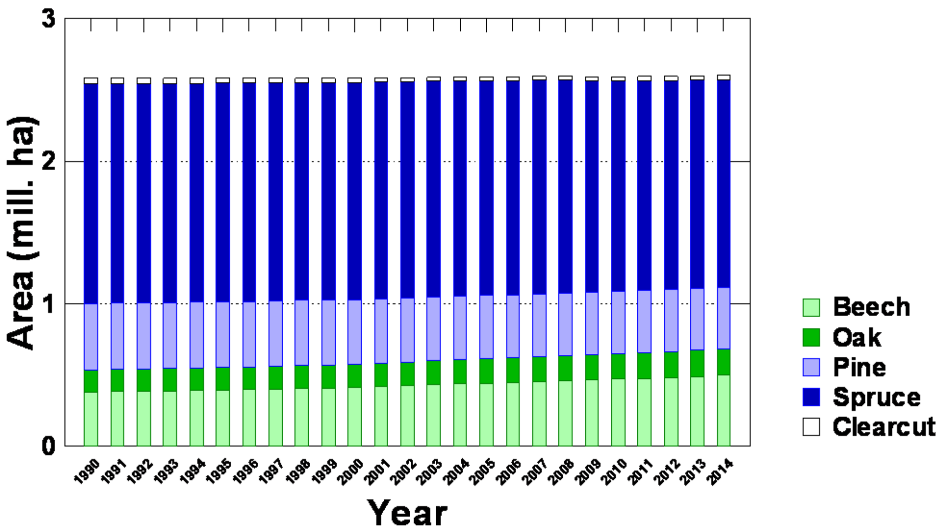


Fig. 6-6 Activity data – area for the four major groups of species and clearcut area during 1990 to 2014.

Fig. 6-7 shows that the average growing stock has increased steadily for all tree species groups since 1990 in this country.

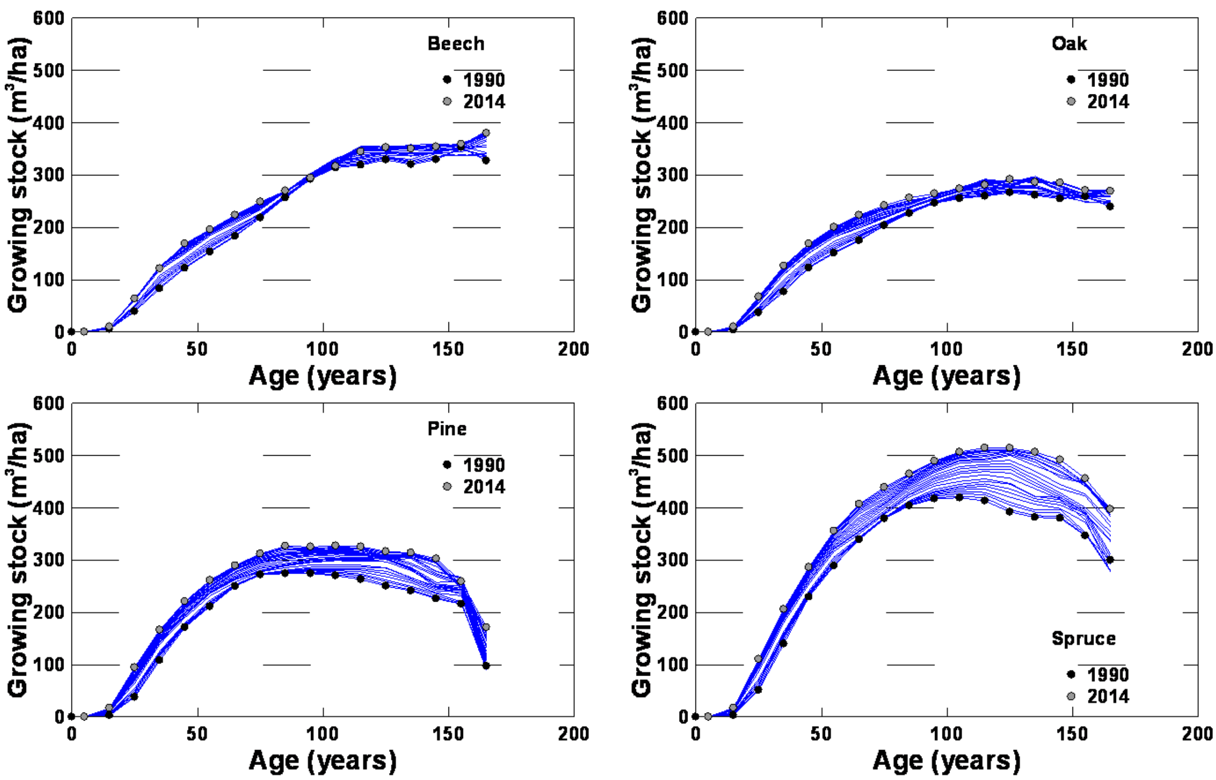


Fig. 6-7 Activity data – mean growing stock volume against stand age for the four major groups of species during 1990 to 2014; each line corresponds to an individual inventory year. The symbols identify only the situation in 1990 and 2014.

The annual harvest volume constitutes the other key information related to forestry. This value is available from the Czech Statistical Office (CzSO). CzSO collects this information on the basis of about 600 country respondents (relevant forest companies and forest owners) and includes commercial harvest and fuel wood, with compensation for the forest areas not covered by the respondents. According to this information, the total drain of merchantable wood from forests increased from 13.3 mil. m^3 in 1990 to 15.5 mil. m^3 (under bark) in 2014, down from the all-time high of 18.5 mil. m^3 harvested in 2007 (all data refer to under-bark volumes, MAF 2015).

The Czech emission inventory also includes the harvest loss due to disturbance events and for other reasons, the estimate of which has been revised for this inventory submission. Specifically, this includes the officially reported estimates from the Czech Statistical Office (CzSO), which have become available since 2009. This complements the previously employed harvest loss estimates increasing the reported harvest by an extra 5 and 15% applied to final and salvage logging volumes, respectively (see Section 6.4.2 below). Salvage logging operations are predominantly related to stands affected by windstorms, snow and bark-beetle calamities in this country. On this basis, the Czech emission inventory includes an explicit estimate of disturbance, which includes the categories of natural disasters, pollution, insects and other effects (CzSO, J. Kahuda, personal communication 2013). Therefore, the total applicable harvest loss is linked to the actual share of salvage logging that is annually reported by CzSO and elsewhere (MAF 2015). In 2014, the applicable volume of total annual harvest drain reached 17.3 mill. m^3, down from the maximum of nearly 21 mill. m^3 estimated for 2007. The harvest drain applicable for the emission inventory for the entire reporting period since 1990 to 2014 is shown in Fig. 6-8, and also for 1990 and 2014 in Tab. 6-4.

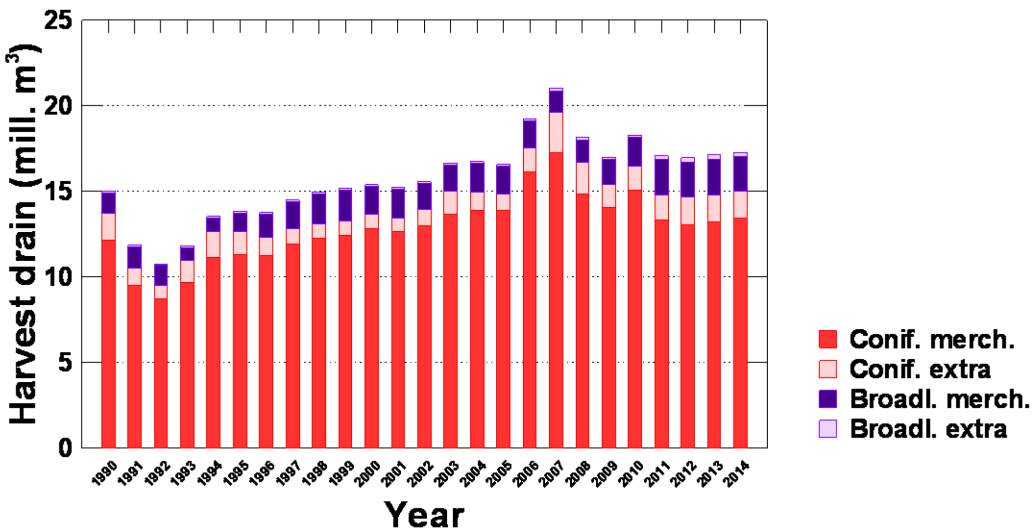


Fig. 6-8 The applicable total annual harvest drain for coniferous (Conif.) and broadleaved (Broadl.) tree species, which includes both the reported quantities of merchantable wood for the two categories (Conif. merch, Broadl. merch.) and the associated harvest loss (Conif. extra, Broadl. extra) for the entire reporting period of 1990 to 2014.

Tab. 6-4 The reported harvest, mean share of salvage logging and associated applicable additional harvest loss (1990 and 2014 shown) for beech, oak, pine and spruce species groups, respectively.

Variable	Unit	Year 1990	Year 2014
Reported harvest	Mm^{-3}	0.84; 0.31; 1.33; 10.84	1.56; 0.45; 1.80; 11.67
Share of salvage logging	%	71	29
Additional loss (IFER, CzSO)	Mm^{-3}	0.10; 0.04; 0.16; 1.31	0.18; 0.05; 0.21; 1.35

6.4.2 Methodological issues

Category 4.A Forest Land includes emissions and sinks of CO_2 associated with forests and non-CO_2 gases generated by burning in forests. This category is composed of 4.A.1 Forest Land remaining Forest Land, and 4.A.2 Land converted to Forest Land. The following text describes the major methodological aspects related to emission inventories for both forest sub-categories.

The methods of area identification described in Section 6.1.2 distinguish the areas of forest with no land-use change over the 20 years prior the reporting year. These lands are included in subcategory 4.A.1 Forest Land remaining Forest Land. The other part represents subcategory 4.A.2 Land converted to Forest Land, i.e., the forest areas "in transition" that were converted from other land-use categories over the 20 years prior to the reporting year. The areas of forest subcategories, i.e., 4.A.1 and 4.A.2 accumulated over a 20-year rolling period can be found in the corresponding CRF Tables. The annual matrices of identified land-use and land-use changes are given in Tab 6-3 above.

6.4.2.1 Forest Land remaining Forest Land

Carbon stock change in category 4.A.1 Forest Land remaining Forest Land is given by the sum of changes in living biomass, dead organic matter and soils. The carbon stock change in living biomass was estimated using the default method[5] according to eq. 2.7 of the 2006 IPCC Guidelines for LULUCF. This method is based on separate estimation of increments and removals, and their difference.

The reported growing stock of merchantable volume from the database of FMP formed the basis for assessment of the carbon increment (Eqs. 2.9 and 2.10 of 2006 IPCC Guidelines for LULUCF). The key input to calculate the carbon increment is the volume increment (I_v) data. In the Czech Republic, these values have been traditionally calculated at FMI[6] (FMP database administrator; see also Acknowledgment) and reported to the national and international statistics. The calculation is performed at the level of the individual stands and species using the available growth and yield data and models. The increment data were partly revised in the earlier NIR (2008) to unify two different base information sources (Schwappach, 1923; Černý et al., 1996) for increment estimates and to employ only the latest source across the entire reporting period. This procedure was implemented to comply with the GPG for LULUCF requirements of consistent time series. No change, apart from entering the actual increment for the latest reported year, has been made to the increment in the inventory submissions thereafter (Fig. 6-9).

[5] Alternative approaches of the stock-change method (Eq. 2.8; IPCC 2006) were also analyzed (Cienciala et al. 2006a) for this category. However, for several reasons the default method was finally adopted and is discussed in the cited study.

[6] Since 2012, Czech Forests, s.e. has supervised the administration of FMP and estimates of the increment are provided on request by the Czech Ministry of Agriculture, which is responsible for the forestry sector including Czech Forests, s.e.

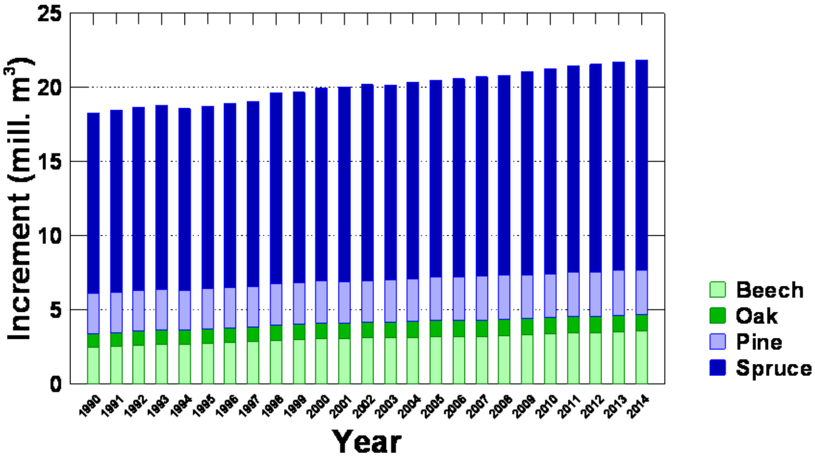


Fig. 6-9 Current annual increment (Increment, mill. m^3 underbark) by the individual tree species groups as used in the reporting period 1990 to 2014.

The merchantable volume increment (I_v) is converted to the biomass increment (G_{Total}), biomass conversion and expansion factors applicable for increment ($BCEF_i$) using Eqs. 2.9 and 2.10 (AFOLU, 2006) as follows:

$$\Delta C_G = \sum_j (A_j * G_{Total_j} * CF_j \qquad (1)$$

where A_j and CF_j represent the actual stand area (ha) and carbon fraction of dry matter (t C per t dry matter), respectively, for each major tree species type *j* (beech, oak, pine, spruce), while G_{Total} is calculated for each *j* as follows:

$$G_{Total} = \sum \{I_V * BCEF_i * (1 + R)\} \qquad (2)$$

where *R* is a root/shoot ratio to include the below-ground component. The total biomass increment is multiplied by the carbon fraction and the applicable forest land area. Tab. 6-5 lists the factors used in the calculation of the biomass carbon stock increment.

Tab. 6-5 Input data and factors used in carbon stock increment calculation (1990 and 2014 shown) for beech, oak, pine and spruce species groups, respectively

Variable or conversion factor	Unit	Year 1990	Year 2014
Area of forest land remaining forest land (*A*)	kha	381; 156; 466; 1539	501; 185; 432; 1464
Biomass conv. & exp. factor, incr. ($BCEF_i$)	Mg m^{-3}	0.74; 0.86; 0.52; 0.60	0.74; 0.85; 0.53; 0.60
Carbon fraction in biomass (*CF*)	t C/t biomass	0.48; 0.48; 0.49; 0.49	0.48; 0.48; 0.49; 0.49
Root/shoot ratio (*R*)	-	0.20	0.20
Volume increment (I_v)	m^{3}ha^{-1}	6.55; 5.96; 5.84; 7.89	7.19; 6.24; 7.01; 9.70

In Tab. 6-5, *A* represents only the areas of 4.A.1 Forest Land remaining Forest Land, updated annually. The applied biomass conversion and expansion factors applicable for the increment ($BCEF_i$) and growing stock volumes ($BCEF_h$) are based on national allometric studies (Cienciala et al., 2006a, 2006b, 2008a) or biomass compilations that include data from the Czech Republic (Wirth et al., 2004, Wutzler et al., 2008). Since the biomass conversion and expansion factors are age-dependent (Lehtonen et al., 2004, 2007), they respect the actual age-class distribution of the dominant tree species. Hence, the $BCEF_i$ values shown in Tab. 6-5 are weighted means considering the actual volumes of the individual age classes for each of the major tree species. In addition to the allometric equations noted above, the source dendrometrical material used for derivation of the country-specific $BCEF_i$ values consisted in the data from the CzechTerra landscape inventory program (Černý, 2009). The tree level data together with the information on age were used to assess the median $BCEF_i$ values for each age class and major tree species. Starting in the 2014 inventory submission, the carbon fraction in woody biomass (*CF*) of 0.50, a generally accepted default constant (IPCC 2003), has been replaced by somewhat more conservative values of 0.48 and 0.49 for broadleaved and coniferous tree species, respectively (Tab. 6-5). This is in accordance with the values suggested by IPCC (2006) based on a more extensive literature survey. *R* was selected as a conservative value from the range recommended for temperate-zone forests by IPCC (2003). It corresponds well to the available relevant experimental evidence (Černý, 1990; Green et al., 2006), as well as to the evidence apparent from the parameterized allometric equations for the major tree species (Wirth et al., 2004, Wutzler et al., 2008). I_v is the annually updated volume increment estimated per hectare and species group as described above.

The estimation of carbon drain (*L*; eq. 3) in the category 4.A.1 Forest Land remaining Forest Land basically follows Eqs. 2.11, 2.12 and 2.13 (AFOLU, 2006). It uses the annual amount of total harvest removals reported by CzSO for individual tree species in the country as well as the associated harvest loss, which is newly (since 2009) explicitly reported by CzSO. Therefore, the total harvest drain (*H*) covers thinning and final cut, the amount of fuel wood, which is reported as an assortment under the conditions of Czech Forestry, as well as the associated harvest loss. To include the biomass loss associated with harvest, factor F_{HL} was applied to the reported harvest volume; it was calculated from the annual harvest data and the share of salvage logging, assuming 5% loss under the planned forest harvest operations and 15% for accidental/salvage harvest. Hence, the harvest volume entering the actual emission calculation (*H* in eq. 3 below) includes correction by the above-described factor, F_{HL}. This estimate was used to account for harvest loss associated the reported harvest of merchantable wood volume until 2010. Since 2011, however, the newly introduced harvest loss estimate of CzSO is used exclusively. The calculation of the total carbon drain (*L*; loss of carbon) associated with wood removals follows Eq. 2.12 (AFOLU 2006) as

$$L_{wood\ removals} = H * BCEF_h * (1 + R) * CF \quad (3)$$

where $BCEF_h$ represents the biomass expansion and conversion factor applicable to harvested volumes, derived from national studies or regional compilations that include the data from the Czech Republic as noted and mentioned above. The application of $BCEF_h$ considers the share of the planned harvested volume and the actual salvage logging that was not planned. In the case of planned harvest volumes, the age-dependent $BCEF_h$ values also consider the mean felling age, which is taken from the national reports of the Ministry of Agriculture. For salvage logging, $BCEF_h$ represents the volume-weighted mean of all age classes for the individual dominant tree species, as the actual stand age of those harvested volumes is unknown. The other factors (*CF, R*) are identical to those described under Tab. 6-5. The specific values of the input variables and conversion factors used to calculate *L* are listed inTab. 6-6.

Tab. 6-6 Specific input data and factors used in calculation of the carbon drain (1990 and 2014 shown) for beech, oak, pine and spruce species groups, respectively

Variable or conversion factor	Unit	Year 1990	Year 2014
Harvest drain volume (*H, incl.*F_{HL})	Mm^3	0.95; 0.35; 1.49; 12.16	1.81; 0.54; 2.10; 12.68
Biomass expansion factor ($BCEF_h$)	$Mg\ m^{-3}$	0.69; 0.81; 0.52; 0.59	0.70; 0.82; 0.52; 0.57

The impact of disturbances (Eq. 2.14, AFOLU, 2006) is included in full in the total harvest drain volume (*H*). The available data on salvage logging from CzSO (and MAF 2015) can also be traced as the disturbance origin by categories including natural disaster, air pollution, insect and other. This information is mandatorily reported by the forestry practice, which must always prioritize salvage logging on account of the planned harvest. In this way, the prescribed (planned) logging volume is commonly composed of planned and salvage logging. Consequently, any salvage felling is flexibly allocated to the desired amount of planned wood removals, and it is thereby accounted for in the reported harvest volumes within Eq. 3. This also includes the occasional events of more significant local salvage loggings, when forest managers may request and receive temporary permissions to increase the planned harvest volumes for the affected forestry districts.

The assessment of the net carbon stock change in organic matter (deadwood and litter) followed the Tier 1 (default) GPG for LULUCF assumption of zero change in these carbon pools. This is a safe assumption, as the country did not experience significant changes in forest types, disturbance or management regimes within the reporting period.

The above assumption also applies to the soil carbon pool, in which the net carbon stock change was considered to equal zero (Tier 1, IPCC 2006). This concerns both mineral and organic soils. The organic soils occur only in the areas of the Spruce sub-category on 4.A.1 Forest Land remaining Forest Land. They represent protected peat areas in mountainous regions dominated by spruce stands, with no or specific management practices. No such areas occur under the other sub-categories with the predominant species of beech, oak and pine.

Emissions in category 4.A.1 Forest Land remaining Forest Land include, in addition to CO_2, also other greenhouse gases (CH_4, CO, N_2O and NO_X) resulting from burning. This encompasses both prescribed fires associated with burning of biomass residues and also emissions due to wildfires. The emissions from burning of biomass residues were estimated according to eq. 2.27 and the emission and combustion factors in Table 2.5 and 2.6 (Tier 1, IPCC 2006). Under the conditions in this country, part of the biomass residues is burned in connection with the final cut. Hence, this practice is limited to category 4.A.1 and does not occur in 4.A.2 Land converted to Forest land. There is no official estimate of the biomass fraction burned in forests in the country. The expert judgment employed in this inventory considers that 15% of the biomass residues including bark is burned. This is less than assumed for the inventory years until 2010, which corresponds with the trend in current forest management practices in the country. The biomass fraction burned was quantified on the basis of the annually reported amount of final felling volume of broadleaved and coniferous species, $BCEF_h$ and *CF* as applied to harvest removals (above). The amount of biomass burned (dry matter) was estimated as 590 Gg in 1990 and 336 Gg in 2014.

The emissions of greenhouse gases due to wildfires were estimated on the basis of known areas burned annually by forest fires and the average biomass stock in forests according to eq. 2.14 (IPCC 2006). This equation used a default factor for biomass left to decay after burning (0.45; Table 2.6). The associated amounts of non-CO_2 gases (CH_4, CO, N_2O and NO_X) were estimated according to eq. 2.27. The amount of biomass (dry matter) burned in wildfires was estimated as 10.2 Gg in 1990 and 39.4 Gg in 2014. The most extreme year of the reporting period was 1997, when about 228 Gg of biomass was burned due to wildfires on an area of almost 3.5 th. ha. In 1990 and 2014, the reported forest areas under wildfire were 168 and 529 ha, respectively. During the reporting period since 1990, there has been no single year without reported wildfire. The mean annual forest area affected by forest wildfires reached 645 ha during the 1990 to 2014 period. The full time series and the associated emissions of non-CO_2 gases can be found in the corresponding CRF Tables.

There are no direct N_2O emissions from N fertilization on Forest Land, as there is no practice of nitrogen fertilization of forest stands in the Czech Republic. Similarly, non-CO_2 emissions related to drainage of wet forest soils are not reported, as this activity no longer occurs in practice.

6.4.2.2 Land converted to Forest Land

The methods employed to estimate emissions in the 4.A.2 Land converted to Forest Land category are similar to those for the category of Forest Land remaining Forest Land, but they differ in some assumptions, which follow the recommendations of GPG for LULUCF (IPCC 2003) and AFOLU (IPCC 2006).

For estimation of the net carbon stock change in living biomass on Land converted to Forest Land by the Tier 1 method (IPCC 2006), the carbon increment is proportional to the extent of afforested areas and the growth of biomass. The revised methodology of land-use change identification (Section 6.2) provides areas of all conversion types updated annually. Land areas are considered to be under conversion for a period of 20 years, according the Tier 1 assumption of GPG for LULUCF. Under the conditions in this country, all newly afforested lands are considered as intensively managed lands under the prescribed forest management rules as specified by the Czech Forestry Act.

Until 2006, the increment applicable to age classes I and II (stand age up to 20 years) was estimated from the actual wood volumes and areas that were available per major species groups. Using the available activity stand level data categorized by species and age classes and the national growth and yield model SILVISIM (Černý, 2005), the wood increment was derived for all the age classes above 20 years. For age class one (1-10 years), the increment was simply calculated from the reported areas and volumes, assuming a mean age of five years. The increment of age class two (11 to 20 years) was estimated from linear interpolation between the increment of age classes I and III. For 2007 and the following years, the increment is derived for individual tree species using the ratio of increments for individual tree species to the total stand increment estimated for the 2000 to 2006 period.

Since the specific species composition of the newly converted land is unknown, the increment estimated for the major tree species was averaged using the weight of actual areas for the individual tree species known from the unchanged (remaining) forest land. Expressed in terms of aboveground biomass, the estimated aggregated mean increment for 2014 was 3.25 t/ha, a value matching that for temperate coniferous (3 t/ha) and somewhat lower than that for broadleaved (4 t/ha) forests given as defaults in GPG for LULUCF. The estimation of increments in terms of aboveground biomass is facilitated by the age- and species-dependent $BCEF_i$ values as described in Section 6.2.1 above. The estimated species-specific values of $BCEF_i$ applicable for young trees to 20 years of age were 0.99, 1.25, 0.65 and 0.93 for beech, oak, pine and spruce, respectively.

The carbon loss associated with biomass in the category of Land converted to Forest Land was assumed to be insignificant (zero). This is because the first significant thinning occurs in older age classes, which are implicitly accounted for within the category Forest Land remaining Forest Land. It is also important to note (in response to the previous inventory reviews) that under the conditions in this country, there is no biomass loss due to disturbance on the land converted to forest land. It actually represents the land of a newly established forest with tree age of 1 to 20 years. As is also apparent from the national statistics, there is no volume of salvage logging reported for this category, which reflects the actual conditions of forest ecosystems of the age concerned.

The net changes of carbon stock in dead organic matter (DOM) were estimated in accordance with the guidance of the Tier 1 method (IPCC 2006), using available country specific information. This approach assumes that deadwood and litter carbon pools increase linearly from zero to the reference default values for the given country-specific conditions. The changes in DOM were estimated separately for deadwood and litter components. For deadwood, conservative values of the transition period for developing deadwood carbon stock (100 years) and the reference mean carbon stock held in deadwood (0.7 t C/ha; CzechTerra landscape inventory 2009 and 2015, Cienciala et al. 2015) were used, respectively. For litter, the default (IPCC 2006) period of 20 years was used together with the country-specific estimate of reference mean carbon stock held in litter (11.12 t C/ha; CzechTerra landscape inventory 2009, Cienciala et al. 2015).

The net change of carbon stock in mineral soils was estimated using the country-specific Tier 2/Tier 3 method. This was based on the vector map of topsoil organic carbon content (Macků et al., 2007; Šefrna and Janderková 2007; see Fig. 6-9). The map constructed for forest soils utilized over six thousand soil samples, linking the forest ecosystem units - stand site types and ecological series available in maps 1:5 000 and 1:10 000, as used in the Czech system of forest typology (Macků et al., 2007). This represents the soil organic carbon content to a reference depth of 30 cm, including the upper organic horizon. The carbon content on agricultural soils was prepared so as to match the forest soil map in terms of reference depth and categories of carbon content, although based on interpretation of coarser 1:50 000 and 1:500 000 soil maps (Šefrna and Janderková, 2007). The polygonal source maps were used to obtain the mean carbon content per individual cadastral unit (n = 13 054 in 2014), serving as reference levels of soil carbon stock applicable to forest and agricultural soils. Since agricultural soils include both Cropland and Grassland land-use categories, the bulk soil carbon content obtained from the map was adjusted for the two categories. This was performed by applying a ratio of 0.85 relating the soil carbon content between Cropland and Grassland (J. Šefrna, personal communication 2007) and considering the actual areas of Cropland and Grassland in the individual cadastral units. This system permitted estimation of the soil carbon stock change among categories 4.A Forest Land, 4.B Cropland and 4.C Grassland. The estimated quantities of carbon stock change at the level of the individual spatial units were entered into 20-year accumulation matrices distributing carbon into fractions over 20 years (IPCC 2006). These quantities, together with the accumulated areas under the specific conversion categories, were used for estimation of emissions and removals of CO_2.

The net changes in carbon stock in organic soils, occurring only in the sub-category of stands dominated by spruce, were assumed to be insignificant (zero). This is in accordance with the general assumption of the Tier 1 method applicable for forest soils, as no other specific methodology is available for organic soils except for drained ones (IPCC 2006).

Non-CO_2 emissions from burning are not estimated for category 4.A.2 Land converted to Forest Land, as this practice is not employed in this country. The same applies to N_2O emissions from nitrogen fertilization, which is not carried out in this country on forest land.

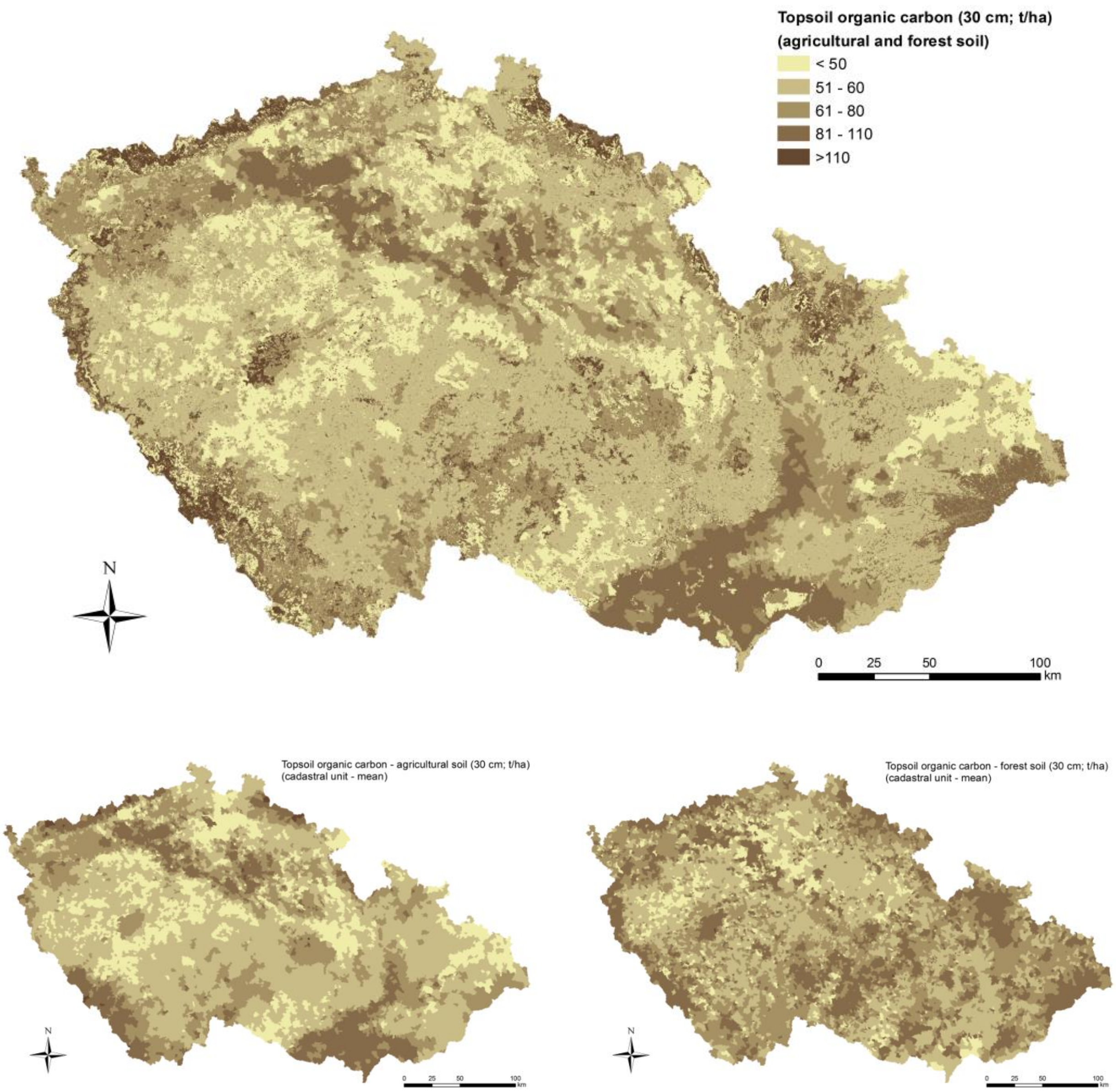


Fig. 6-10 Top - topsoil (30 cm) organic carbon content map adapted from Macků et al. (2007), Šefrna and Janderková (2007); bottom –topsoil carbon content for agricultural (left) and forest (right) soils estimated as cadastral unit means from the source maps. The unit (t/ha) and unit categories are identical for all the maps.

6.4.3 Uncertainties and time-series consistency

The methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2014.

The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and IPCC 2006 Gl. (IPCC, 2006) employing the following equations:

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2} \quad (4)$$

where U_{total} is the percentage uncertainty in the product of the quantities and U_i denotes the percentage uncertainties with each of the quantities (Eq. 3.1, Volume 1, Chapter 3, IPCC 2006).

For the quantities that are combined by addition or subtraction, we used the following equation to estimate the uncertainty:

$$U_{total} = \frac{\sqrt{(U_1 * x_1)^2 + (U_2 * x_2)^2 + \ldots + (U_n * x_n)^2}}{|x_1 + x_2 + \ldots + x_n|} \qquad (5)$$

where U_{total} is the percentage uncertainty of the sum of the quantities, U_i is the percentage uncertainty associated with source/sink *i*, and x_i is the emission/removal estimate for source/sink *i* (Eq. 3.2, Volume 1, Chapter 3, IPCC 2006).

It should be noted, however, that Eq. 5 as also exemplified in GPG for LULUCF is not well applicable for the LULUCF sector. Summing negative (removals) and positive (emission) members (x_i) in the denominator of equation 5 may easily produce unrealistically high uncertainties and theoretically lead to division by zero, which is not possible. In this respect, this approach is not correct. In previous inventory reports, we stressed this issue and recommended focusing on individual uncertainty components prior the resulting product of Eq. 5.

The adopted uncertainty values are listed below and/or under the corresponding subchapters of other land use categories. In addition to IPCC (2006), the source information for adjusted uncertainty values was obtained from the recently conducted CzechTerra statistical landscape inventory of the Czech Republic (Černý et al., 2009, Cienciala et al. 2015). Otherwise, the uncertainty estimation utilized primarily the default uncertainty values as recommended by UNFCCC (2005) and IPCC (2003, 2006) that concern areas of land use (5%), biomass increment (6%), amount of harvest (20%), carbon fraction in dry wood mass (7%), root/shoot factor (30%) and factor ($1-f_{BL}$; 75%), used in calculation of emissions from forest fires. The uncertainty applicable to *BCEF* was 22%, which was derived from the work of Lehtonen et al. (2007). The uncertainty associated with fractions of unregistered loss of biomass under felling operations was set by expert judgment at 30%.

The approach of uncertainty combination for individual sub-categories of tree species is based on calculating the mean error estimate from the components of carbon stock increase and carbon stock loss, which are both given in identical mass units of carbon per year. At the same time, we retained the recommended logics of combining uncertainties on the level of the entire land use category or on the level of the entire LULUCF sector according Eq. 5. This is calculated on the basis of CO_2 or CO_2 eq. units and the corresponding uncertainty estimates respect the actual direction of the source and sink categories to be combined.

For 2014, the uncertainty estimates for categories 4.A.1 Forest Land remaining Forest Land and 4.A.2 Land converted to Forest Land using the above described approach reached 18% and 29%, respectively. Correspondingly, the uncertainty for the entire 4.A Forest Land category reached 17%.

6.4.4 Source-specific QA/QC and verification

Following the recommendation of the previous in-country review, a sector-specific QA/QC plan was formulated, tightly linked to the corresponding QA/QC plan of the National Inventory System. The plan describes the key procedures of inventory compilation and provides a table of personal responsibilities and a timetable of sector-specific QA/QC procedures. This plan consolidates the quality assurance procedures and facilitates effective quality control of the LULUCF inventory.

Basically all the calculations are based on the activity data taken from the official national sources, such as the Forest Management Institute and the Ministry of Agriculture, the Czech Statistical Office, the Czech Office for Surveying, Mapping and Cadastre (COSMC) and the Ministry of the Environment. Data sources are verifiable and updated annually. The gradual development of survey methods and implementation of information technology, checking procedures and increasing demand on quality result in increasing accuracy of the emission estimates. The QA/QC procedures generally cover the elements listed in Table 6.1 of 2006 IPCC Guidelines (Volume1, Chapter 6, IPCC 2006).

The input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable.

Apart from official review process, emission inventory methods and results are internally reviewed among the technical experts involved in the emission inventory of the Agriculture and LULUCF sectors. Whenever feasible, the methods are subject to peer-review in case of the cited scientific publications, and expert team reviews within the relevant national research projects.

In 2014, a supplementary review of the Czech LULUCF inventory was conducted within the framework of the EU MS Assistance Program. Specifically, it was reviewed by Dr. Zoltan Somogyi, who together with the Czech LULUCF experts discussed the reporting issues and suggested improvements to be considered for gradual implementation. The full report of this expert venue is available on request from the Czech LULUCF inventory team.

6.4.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trends

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was due to the corrections associated with the adopted revised activity data on land areas and new estimates of dead organic matter on land converted to Forest Land. The effect of these corrections performed for category 4.A Forest Land can be seen in Fig. 6-11. On average, the emission removals increased by 0.6% compared to the previously reported estimates.

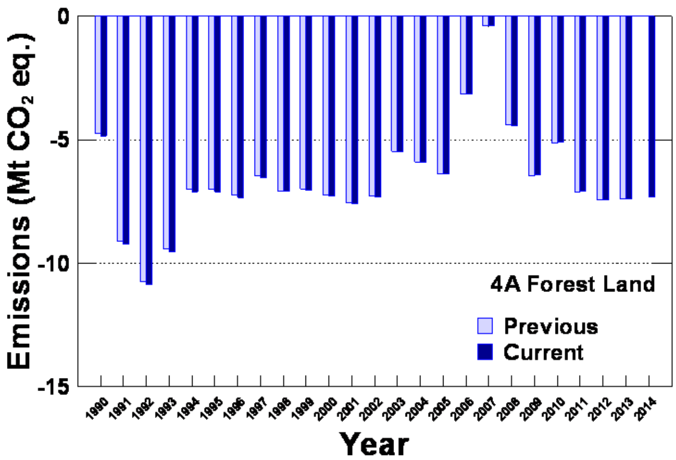


Fig. 6-11 Current and previously reported assessment of emissions for category 4.A Forest Land. The values are negative, hence representing net removals of green-house gases

6.4.6 Source-specific planned improvements, including those in response to the review process

The current inventory report applicable for 4.A Forest Land implemented the rectified land area data for the entire data set required for the LULUCF inventory and improved emission estimates for the carbon stock change on land converted to Forest Land. Other improvements remain under planning. This includes a further improvement in the uncertainty assessment (exploring the Monte-Carlo approaches) and further formalization and enhancement of QA/QC procedures. Over a longer term, more extensive utilization of the new data from the statistical inventory programs is planned, including the repeated survey of the Czech National Forest Inventory and CzechTerra Landscape inventory.

6.5 Cropland (CRF 4.B)

6.5.1 Source category description

In the Czech Republic, Cropland is predominantly represented by arable land (92.6% of the category in 2014), while the remaining area includes hop-fields, vineyards, gardens and orchards. These categories correspond to five of the six real estate categories for agricultural land from the database of “Aggregate areas of cadastral land categories” (AACLC), collected and administered by COSMC.

Cropland is spatially the largest land-use category in the country. Simultaneously, the area of Cropland has constantly decreased since the 1970s, with a particularly strong decreasing trend since 1990 (Fig. 6-4). While, in 1990, Cropland represented approx. 44% of the total area of the country, this share decreased to less than 41% in 2014. It can be expected that this trend will continue. The conversion of arable land to grassland is actively promoted by state subsidies. Conversion to grassland concerns mainly lands of less productive regions of alpine and sub-alpine regions. In addition, there is a growing demand for land for infrastructure and settlements.

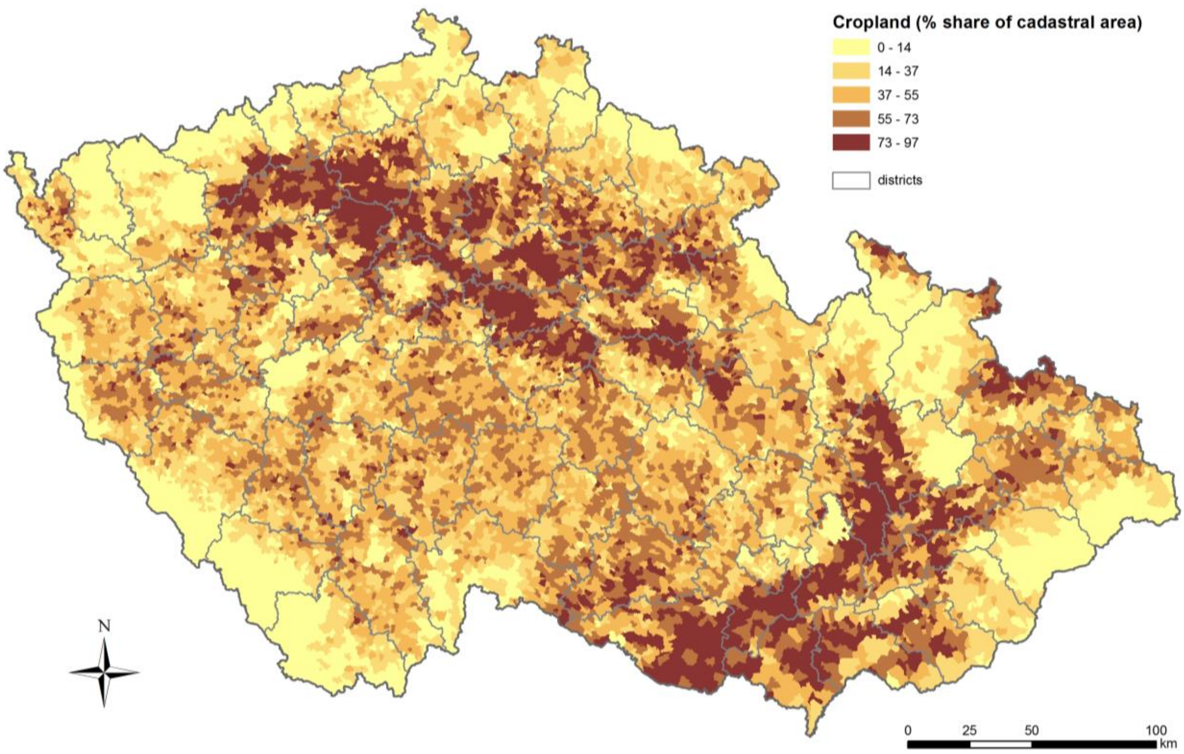


Fig. 6-12 Cropland in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2014).

6.5.2 Methodological issues

The emission inventory of Cropland concerns sub-categories 4.B.1 Cropland remaining Cropland and 4.B.2 Land converted to Cropland. The emission inventory of Cropland considers changes in living biomass, dead organic matter and soil. In addition, N_2O emissions associated with soil disturbance during land-use conversion to cropland are quantified for this category.

6.5.2.1 Cropland remaining Cropland

For category 4.B.1 Cropland remaining Cropland, the changes in biomass can be estimated only for perennial woody crops. Under the conditions in this country, this might be applicable to the categories of vineyards, gardens and orchards. Hence, to estimate emissions associated with biomass on Cropland, a default factor for the biomass accumulation rate (2.1 t C/ha/year, Table 5.1, IPCC 2006) was applied to estimate biomass carbon pool changes for the areas concerned.

The carbon stock change of dead organic matter follows the Tier 1 method assumption of IPCC (2006) that dead wood and litter stocks are not present on Cropland or are at equilibrium. Hence, no change is assumed for this pool.

The carbon stock change in soil in the category Cropland remaining Cropland is given by changes in mineral and organic soils. Organic soils basically do not occur on Cropland; they occur as peatland in mountainous regions on Forest Land. Hence, emissions were estimated for mineral soils. The estimation procedure was revised for this category following the recommendation of the recent inventory reviews. It used the locally-specific average carbon content on Cropland estimated specifically for each of the over 13 thousand cadastral units from the detailed soil carbon maps (Fig. 6-10). Next, the country-specific factor for cropland management (F_{MG}; 1.1035) was derived from the actual share of ecological agriculture and specific soil treatment (no- and reduced tillage, Hůla et al. 2010). The actual share (2014, 2.2%) of ecological agriculture on Cropland was derived from the detailed spatially explicit database of Land Parcel Identification System (LPIS), while the historical share was derived from the official annual report on Agriculture (MAA 2015). The other factors included the relative stock change factor for land use (F_{LU}; 1.0) applicable for cropland and input of organic matter (F_I; 1.0), respectively (Table 5.5; IPCC 2006). In line with the IPCC (2006) recommendation, the estimated quantity of soil carbon stock change is thereafter distributed over a 20-year period starting from the actual inventory year.

Until the NIR submission 2014, the Cropland category also included emissions due to liming. Due to the specific trend in lime application in this country, emissions from liming made the former 4.B.1 Cropland remaining Cropland the key category by trend. However, since the 2015 NIR submission, the emissions from liming are excluded from 4.B.1 Cropland remaining Cropland and reported under category 3.G Liming in the sector of Agriculture instead.

Non-CO_2 greenhouse gas emissions from burning do not occur in category 4.B.1 Cropland remaining Cropland, as there is this practice is not implemented on Cropland in this country.

6.5.2.2 Land converted to Cropland

Category 4.B.2 Land converted to Cropland includes land conversions from other land-use categories. Cropland has generally decreased in area since 1990, by far most commonly converted to Grassland. However, the adopted detailed system of land-use representation and land use change identification system is able to detect land conversions in the opposite direction, i.e., to Cropland.

The estimation of carbon stock changes in biomass in category 4.B.2 Land converted to Cropland was based on quantifying the difference between the carbon stock before and after the conversion, including the estimation of one year of cropland growth (5 t C/ha; Table. 5.9, IPCC 2006), which follows Tier 1 assumptions of GPG for LULUCF and the recommended default values for the temperate zone. For biomass carbon stock on Forest Land prior conversion, the annually updated average growing stock volumes, species-specific volume-weighted biomass conversion and expansion factors (*BCEF*), and other factors such as the below-ground biomass ratio were used as described in the 4.A Forest Land category in Section 6.2.1 above. For biomass carbon stock on Grassland prior to the conversion, the default factor of 6.8 t/ha for above-ground and below-ground biomass was used (Table 6.4, IPCC 2006). A biomass content of 0 t/ha was assumed after land conversion to 4.B Cropland.

The estimation of net carbon stock change in dead organic matter concerns land use conversion from Forest Land. In this case, the input information on standing and lying deadwood was obtained from the available statistical inventories in the country: the National Forest Inventory (FMI 2007) and the recently conducted field campaigns (2009 and 2015) of the CzechTerra landscape inventory (Cerny, 2009; Cienciala et al. 2015, www.czechterra.cz). They provide data on the mean standing deadwood biomass and volume of lying deadwood classified in four categories according to degree of decomposition. These categories are defined as follows: i) basically solid wood; ii) peripheral layers soft, central hard; iii) peripheral layers hard, central soft; iv) totally rotten wood. The amount of carbon held in lying deadwood was estimated as the product of the wood volume, density weighted by mean growing stock volume of major tree species (0.433 t/m^3), reduction coefficients of 0.8, 0.5, 0.5, 0.2 (Cerny et al., 2002; Carmona et al., 2002) applicable to the above described decomposition categories, respectively, and the carbon fraction in the wood (0.5 t C/t biomass). A default, conservative assumption that no deadwood is present following the land use change was adopted in this calculation.

Estimation of the carbon stock change in soils for category 4.B.2 Land converted to Cropland in the Czech Republic concerns mineral soils. The soil carbon stock changes following the conversion from Forest Land and Grassland were quantified by the country-specific Tier 2/Tier 3 approach and are described in detail in Section 6.4.2.2 above.

The Land converted to Cropland category represents a source of non-CO_2 gases, namely emissions of N_2O due to mineralization. The estimation followed the Tier 1 approach of Eqs. 2.25 and 11.8 (IPCC 2006). Accordingly, direct N_2O emissions were quantified on the basis of the detected changes in mineral soils employing a default emission factor of 0.01 kg N_2O-N/kg N (EF1, IPCC 2006), and C:N ratio of 15. Linked to this, indirect N_2O emissions from atmospheric deposition of N volatized from managed soils were estimated using Eq. 11.10 and the emission factor 0.0075 (EF5, IPCC 2006).

Other non-CO_2 emissions may be related to those from burning. However, this is not a common practice in this country and no other non-CO_2 emissions besides those described above are reported in the LULUCF sector.

6.5.3 Uncertainties and time-series consistency

The methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2014, and this also applies to the Cropland land use category. The uncertainty estimation was guided by the Tier 1 methods outlined in the 2006 IPCC Guidelines (IPCC 2006) and described in Section 6.4.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by UNFCCC (2005) and IPCC (2003, 2006). The following uncertainty values were used: land use areas 5%, biomass accumulation rate 75%, average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 68%, average growing stock volume in forests 8%, stock change factor for land use 50%, stock change factor for management regime 5%, reference biomass carbon stock prior and after land-use conversion 75%, average amount of standing deadwood 27%, average amount of lying deadwood 20%, carbon fraction of dry woody matter 7%. The uncertainty applicable to *BCEF* was 22%, which was derived from the work of Lehtonen et al. (2007). The adopted uncertainty associated with the emission factors involved in estimation of direct and indirect N_2O emissions was 250%.

For 2014, using the above uncertainty values, the total estimated uncertainty for category 4.B.1 Cropland remaining Cropland was 51%. The corresponding uncertainty for category 4.B.2 Land converted to Cropland was 38%. The overall uncertainty for category 4.B Cropland was estimated to be 32%, using absolute values of quantities estimated in the respective emission categories.

6.5.4 Source-specific QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of the 2006 IPCC Guidelines (IPCC 2006). The data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable. Other QA/QC elements were adopted in the same manner as described in Section 6.4..4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

6.5.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission, the emission estimates have been recalculated for the entire category and reporting period. This procedure was adopted based on the new estimates of soil carbon stock change in Cropland remaining Cropland following the suggestions in the recent reviews. Also, new activity data for changes in dead organic matter, applicable for land-use conversions from Forest land, affected the total estimates for Cropland. The current emission estimates for category 4.B Cropland are shown in Fig. 6-13. On average, the emissions decreased by 6% compared to the previously reported estimates.

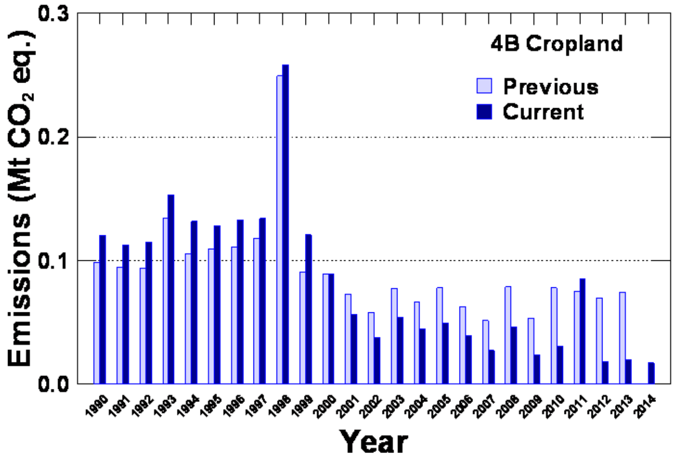


Fig. 6-13 Current and previously reported assessment of emissions for category 4.B Cropland

6.5.6 Source-specific planned improvements, including those in response to the review process

Similarly as for other categories, additional efforts will be exerted to further consolidate the current estimates for Cropland. Specific attention will be paid to estimates of soil carbon stock changes, involving additional activity data (soil erosion) and more relevant emission factors. A further improvement in uncertainty estimates are also planned in this category.

6.6 Grassland (CRF 4.C)

6.6.1 Source category description

Through its spatial share of about 13% in 2014, the category of Grassland ranks third among land-use categories in the Czech Republic. Its area has been increasing since 1990, specifically in the early 1990s (Fig. 6-4). Grassland as defined in this inventory corresponds to the grassland real estate category, one of the six such categories of agricultural land in the database of “Aggregate areas of cadastral land categories” (AACLC), collected and administered by COSMC. This land is mostly used as pastures for cattle and meadows for growing feed. Additionally, the fraction of permanently unstocked cadastral Forest Land is also included under Grassland. This is because it predominantly has the attributes of Grassland (such as land under power transmission lines).

The importance of Grassland will probably increase in this country, both for its role in production and for preserving biodiversity in the landscape. According to the national agricultural programs, the fraction of Grassland should further increase to about 18% of the area of the country. The dominant portion should be converted from Cropland, the share of which is still considered excessive. After implementation of subsidies in the 1990s, the area of Grassland has increased by nearly 20% (in 2014) since 1990.

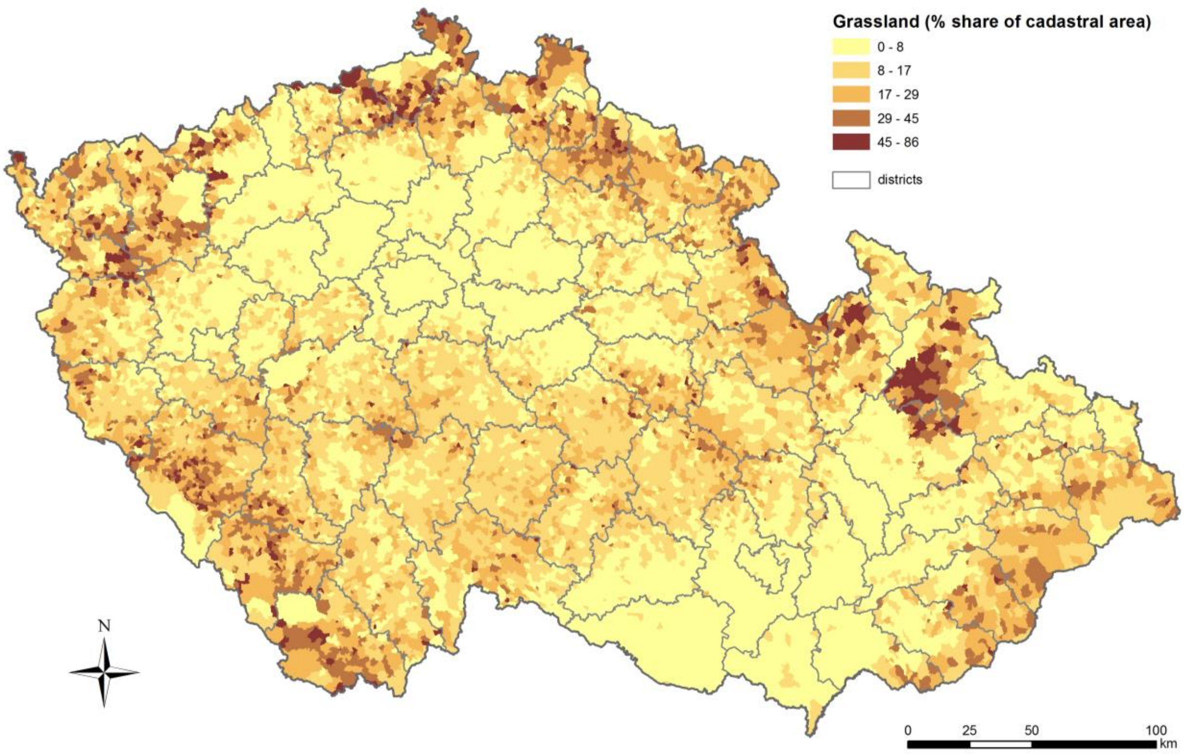


Fig. 6-14 Grassland in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2014).

6.6.2 Methodological issues

The emission inventory of 4.C Grassland concerns sub-categories 4.C.1 Grassland remaining Grassland and 4.C.2 Land converted to Grassland. The emission inventory of 4.C Grassland considers changes in living biomass, dead organic matter and soil.

6.6.2.1 Grassland remaining Grassland

The assumption of no change in carbon stock held in living biomass was employed for category 4.C.1 Grassland remaining *Grassland*, in accordance with the Tier 1 approach of IPCC (2006). This is a safe assumption for the conditions in this country and any application of higher tier approaches would not be justified with respect to data requirements and the expected insignificant carbon stock changes.

Similarly as for living biomass, the carbon stocks associated with dead organic matter (DOM), including deadwood and litter, are considered to be at equilibrium, i.e., it is assumed that there are no changes in carbon stocks.

The emissions from changes in soil carbon stock were estimated for category 4.C.1 Grassland remaining Grassland. These are given by changes in mineral and organic soils. Organic soils basically do not occur on Grassland; they occur as peatland in mountainous regions on Forest Land. Hence, emissions were estimated for mineral soils. The estimation procedure was revised for this category following the recommendations of the recent inventory reviews. It used the locally-specific average carbon content on Grassland estimated for each of the over 13 thousand cadastral units from the detailed soil carbon maps (Fig. 6-10). Next, the country-specific factor for grassland management (F_{MG}; 1.07) was derived from the actual spatial share of ecological agriculture and its specific management; the value is more conservative than that recommended by IPCC (2006) in its Table 6.2 due to uncertainty in the activity data (grazing area). The actual share (2014; 41.5%) of ecological agriculture on Grassland was derived from the detailed spatially explicit database of the Land Parcel Identification System (LPIS), while the historical share was derived from the official annual report on Agriculture (MAA 2015). The other factors included the relative stock change factor for land use (F_{LU}; 1.0) applicable for Grassland and input of organic matter (F_I; 1.0), respectively (Table 6.2; IPCC 2006). In accordance with the IPCC (2006) recommendation, the estimated quantity of soil carbon stock change is hereafter distributed over a 20-year period starting from the actual inventory year.

Until the 2014 NIR submission, the Grassland category also included emissions due to liming. However, similarly as for Cropland, since the 2015 NIR submission the emissions from liming have been reported under category 3.G Liming in the sector of 3 Agriculture instead.

Non-CO_2 gases on category 4.C.1 Grassland remaining Grassland are not relevant for the LULUCF sector in the Czech Republic.

6.6.2.2 Land converted to Grassland

For category 4.C.2 Land converted to Grassland, the estimation is related to carbon stock changes in living biomass, dead organic matter and soils.

For living biomass, the calculation used eq. 2.11 (IPCC 2006) with the assumed carbon content before the conversion of 4.B Cropland set at 5t C/ha (Table 364; IPCC 2006) and that of Forest Land calculated from the mean growing stock volumes as described in Section 6.5.2.2 above. The biomass carbon content immediately after the conversion was assumed to equal zero and carbon stock from one-year growth of grassland vegetation following the conversion was assumed to be 6.5 t C/ha (Table 6.4; IPCC 2006).

For dead organic matter, emissions are reported due to changes in deadwood and litter that are both relevant for category 4.C.2 Forest Land converted to Grassland. Apart from the actual areas concerned, the emission estimation is identical to that described in Section 6.5.2.2 (Land converted to Cropland) above.

The estimation of carbon stock change in soils for category 4.C.2 Land converted to Grassland in the Czech Republic is related to the changes in mineral soils. The soil carbon stock changes following the conversion from 4.A Forest Land and 4.B Cropland were quantified by the country-specific Tier 2/Tier 3 approach described in detail in Section 6.4.2.2 above.

6.6.3 Uncertainties and time series consistency

Similarly as for other land-use categories, the methods used in this inventory for Grassland were consistently employed across the whole reporting period from the base year of 1990 to 2014. The uncertainty estimation was guided by the Tier 1 methods outlined in 2006 IPCC Guidelines (IPCC 2006) and described in Section 6.4.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). The following uncertainty values were used: converted land use areas 5%, average growing stock volume in forests prior to conversion 8%, average biomass stock in cropland and grassland prior conversion 75%, biomass carbon stock after land-use conversion 75%, average amount of standing deadwood 27%, average amount of lying deadwood 20%, average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 68%, stock change factor for land use 50%, stock change factor for management regime 5%, and reference biomass carbon stock prior to and after land-use conversion 75%. The uncertainty applicable to *BCEF* was 22%, which was derived from the work of Lehtonen et al. (2007).

For 2014, the total estimated uncertainty for category 4.C.1 Grassland remaining Grassland reached 17%. The corresponding uncertainty for category 4.C.2 Land converted to Grassland reached 20%. The overall combined uncertainty for category 4. Grassland is 13%.

6.6.4 Source-specific QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of the adopted 2006 IPCC Guidelines (IPCC 2006). Data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable. Other QA/QC elements were adopted in the same manner as described in Section 6.4.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

6.6.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission, the emission estimates were recalculated for the entire category and reporting period. This was based on the revised activity data on land use, revised estimation of soil carbon stock changes and revised estimates for stock changes for deadwood, applicable for land-use conversions from Forest Land.

The resulting effect of the recalculation performed for category 4.C Grassland can be seen in Fig. 6-15. On average, the emission removals increased 36% as compared to the previously reported estimates.

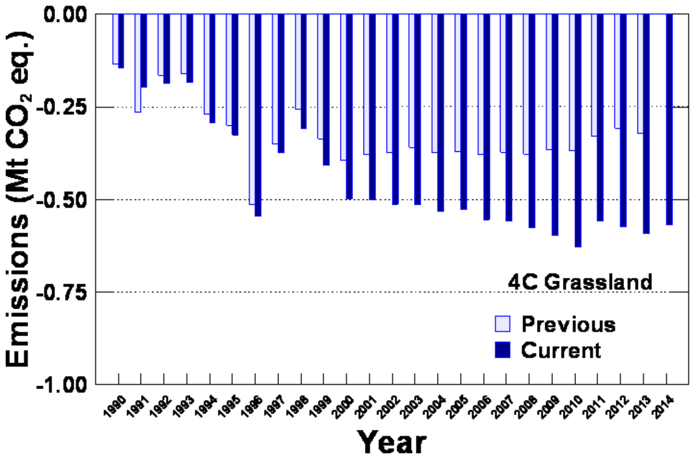


Fig. 6-15 Current and previously reported assessment of emissions for category 4.C Grassland. The values are negative, hence representing net removals of green-house gases

6.6.6 Source-specific planned improvements, including those in response to the review process

Further efforts to consolidate the emission estimates are expected for the category of Grassland. Specific attention will be paid to estimates of soil carbon stock changes, involving additional activity data (soil erosion) and more relevant emission factors. A further improvement in uncertainty estimates are also planned in this category.

6.7 Wetlands (CRF 4.D)

6.7.1 Source category description

Category 4.D Wetlands as classified in this emission inventory includes riverbeds and water reservoirs such as lakes and ponds, wetlands and swamps. These areas correspond to the real estate category of water area of the "Aggregate areas of cadastral land categories" (AACLC), collected and administered by COSMC. It should be noted that there are about 11 wetland areas identified as Ramsar[7] sites in this country. However, these areas are commonly located in several IPCC land-use categories and are not directly comparable with the actual content of the 4.D emission category.

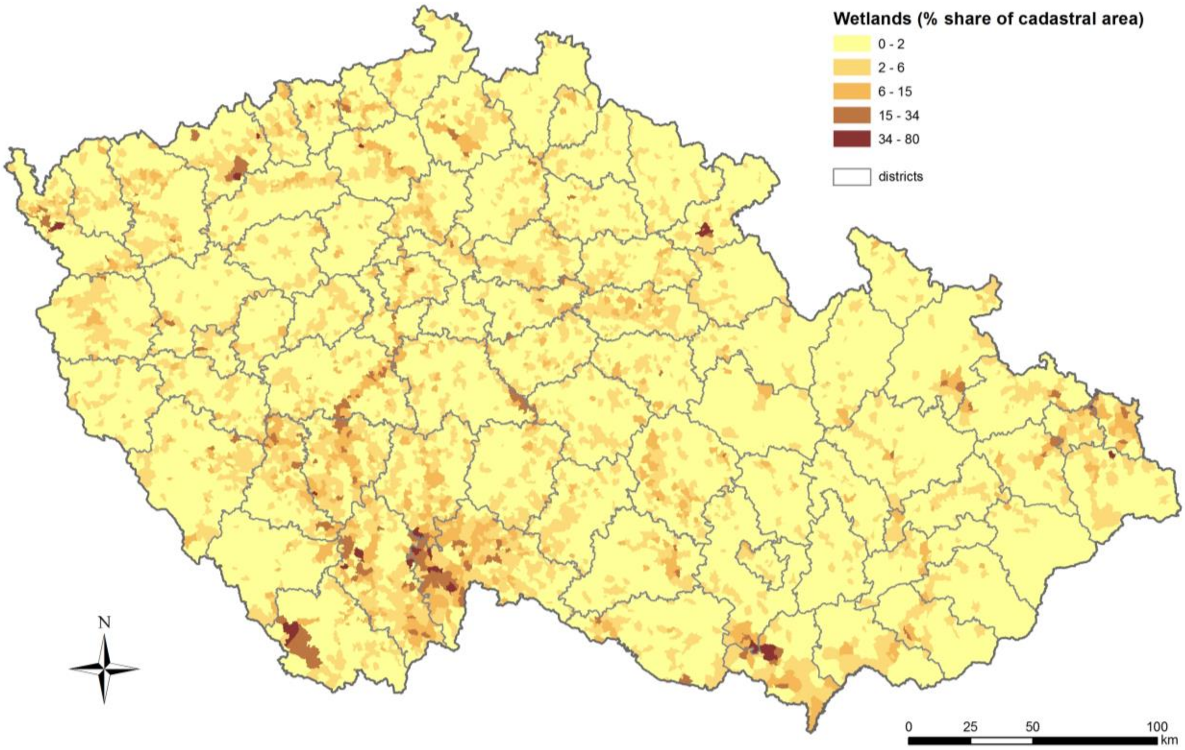


Fig. 6-16 Wetlands – distribution calculated as a spatial share of the category within individual cadastral units (as of 2014).

The area of 4.D Wetlands currently covers 2.1% of the total territory. It has been increasing steadily since 1990 (Fig. 6-4) with even a stronger trend earlier. It can be expected that this trend will continue and that the area of Wetlands will increase further. This is mainly due to programs aimed at increasing the water retention capacity of the landscape, specifically in relation to adaptation strategies proposed to deal with changing climate[8].

[7] Convention on Wetlands, Ramsar, Iran, 1971

[8] Based on the land-use history, the growth potential could be considered to be rather large. For example, as of 1990, the category included 50.7 th. ha of ponds, which represented only 28% of their extent during the peak period in the 16th Century (Marek 2002)

6.7.2 Methodological issues

The emission inventory of sub-category 4.D.1 Wetlands remaining Wetlands can address the areas in which the water table is artificially changed, which correspond to peat-land draining or lands affected by water bodies regulated through human activities (flooded land). Both categories are insignificant under the conditions in this country. Hence, the emissions for 4.D.1 Wetlands remaining Wetlands were not explicitly estimated and they can safely be considered negligible.

Sub-category 4.D.2 Land converted to Wetlands encompasses conversion from 4.A Forest Land, 4.B Cropland and 4.C Grassland. This corresponds to a very minor land-use change identified in this country, which corresponds to the category of land converted to flooded land. The emissions associated with this type of land-use change are derived from the carbon stock changes in living biomass and, for conversion from Forest land, also deadwood. The emissions were generally estimated using the Tier 1 approach and eq. 2.11 of the 2006 IPCC Guidance for LULUCF, which simply relates the biomass stock before and after the conversion. The corresponding default values were employed: the biomass stock after conversion equalled zero, while the mean biomass stock prior to the conversion in the 4.A Forest Land, 4.B Cropland and 4.C Grassland categories was estimated and/or assumed identically as described above in Sections 6.4.2.2 and 6.5.2.2. The latter section also describes the estimation of emissions related to the deadwood component, which was applied identically in this land use category.

6.7.3 Uncertainties and time series consistency

The methods used in this inventory for Wetlands were consistently employed across the whole reporting period from the base year of 1990 to 2014. Similarly as for the other land-use categories, the uncertainty estimation was guided by the Tier 1 methods outlined in 2006 IPCC Guidelines (IPCC 2006) and described in Section 6.4.3. It utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). The following uncertainty values were used: converted land use areas 5%, average growing stock volume in forests prior conversion 8%, average biomass stock in cropland and grassland prior conversion 75%, biomass carbon stock after land-use conversion 75%, average amount of standing deadwood 27%, average amount of lying deadwood 20%, carbon fraction of dry woody matter 7%, and average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 68%. The uncertainty applicable to *BCEF* was 22%, which was derived from the work of Lehtonen et al. (2007).

Since the emission estimate concerns only category 4.D.2 Land converted to Wetlands, the uncertainty is estimated for this category. For 2014, the estimated uncertainty for category 4.D.2 was 66%.

6.7.4 Source-specific QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of IPCC 2006 Guidelines (IPCC 2006). Data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the coordinator of NIR. Hence, all the background data and calculations are verifiable. Other QA/QC elements were adopted in the same manner as described in Section 6.4.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

6.7.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Compared to the last submission, the emission estimates differ slightly in individual inventory years (Fig. 6-17), due to the revised activity data estimates of land use areas and dead organic matter applicable for land-use conversions from Forest Land. However, the mean estimates for category 4.D Wetlands and the reporting period do not differ between the current and previous inventory submissions.

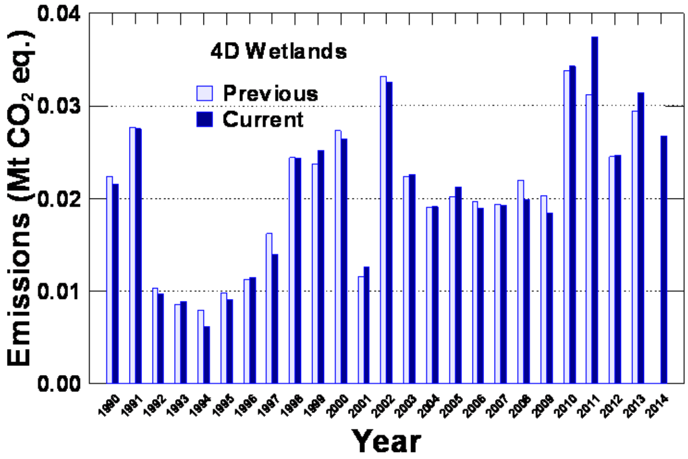


Fig. 6-17 Current and previously reported assessment of emissions for category 4.D Wetlands

6.7.6 Source-specific planned improvements, including those in response to the review process

For category of 4.D Wetlands, attention will be paid to further consolidation of the uncertainty assessment.

6.8 Settlements (CRF 4.E)

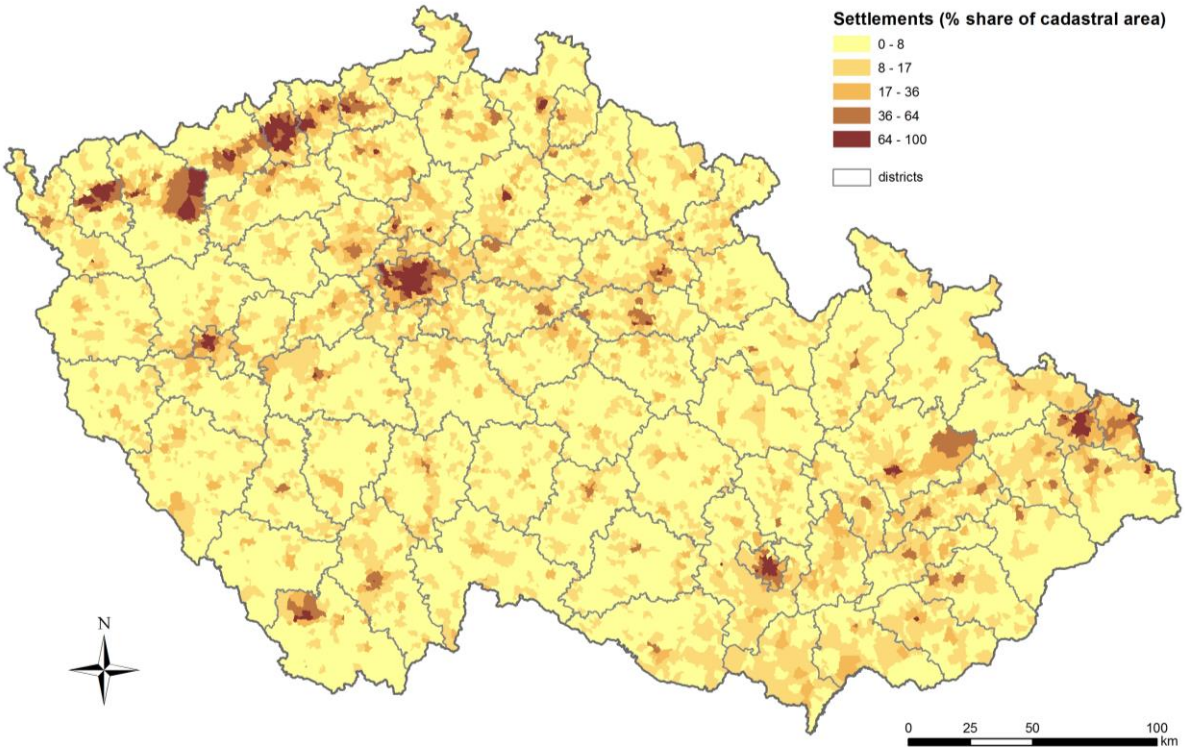


Fig. 6-18 Settlements – distribution calculated as a spatial share of the category within individual cadastral units (as of 2014).

6.8.1 Source category description

Category 4.E Settlements is defined by IPCC (2006) as all developed land, including transportation infrastructure and human settlements. For this emission inventory, the area definition under category 4.E Settlements has been revised since the NIR 2013 submission to better match the IPCC (2006) default definition. The category currently includes two categories of the "Aggregate areas of cadastral land categories" (AACLC) database, collected and administered by COSMC, namely "Built-up areas and courtyards" and "Other lands". Of the latter AACLC category, all types of land-use were included with the exception of "Unproductive land", which corresponds to category 4.F Other Land. Hence, the Settlements category also includes all land used for infrastructure, as well as that of industrial zones and city parks. This category also includes all military areas (previously considered as Grassland) in the country.

The category of Settlements as defined above currently represents about 9.3% of the area of the country. The area of this category has increased since 1990, especially during the most recent years (see Fig. 6-4).

6.8.2 Methodological issues

Following Tier 1 assumption of IPCC (2006), the carbon stocks in biomass, dead organic matter and soil are considered in balance for category 4.E.1 Settlements remaining Settlements. Hence, the emission inventory for this category concerns primarily 4.E.2 Land converted to Settlements.

Hence, emissions quantified in this inventory are related to category 4.E.2 Land converted to Settlements, specifically Forest land converted to Settlement. The emissions result from changes in biomass carbon stock and dead organic matter (DOM). The biomass carbon stock change was quantified based on eq. 2.11 (IPCC 2006). Changes in DOM were related to the deadwood carbon pool.

The corresponding default values were employed: the biomass stock after conversion equalled zero, while the mean biomass stock prior to the conversion was estimated and/or assumed identically as described above in Sections 6.4.2.2 and 6.5.2.2. The latter section describes estimation of the emissions related to the deadwood component, which was employed identically in this land use category. The carbon stock prior conversion was estimated as described in Section 6.4.2. All biomass is assumed to be lost during the conversion, according to the Tier 1 assumption of Guidelines for LULUCF. An additional contribution to emissions comes from the deadwood component, using the actual areas of the land use change concerned.

6.8.3 Uncertainties and time series consistency

The methods used in this inventory for 4.E Settlements were consistently employed across the whole reporting period from the base year of 1990 to 2014. The uncertainty estimation was guided by the Tier 1 methods outlined in 2006 IPCC Guidelines (IPCC 2006) and described in Section 6.4.3. It utilized primarily the default uncertainty values as recommended by IPCC (2006). As reported above, uncertainty estimation was revised for this submission, which applies also to this land use category. The following uncertainty values were used: carbon fraction in dry matter 7%, land use areas 3%, reference biomass carbon stock prior and after land-use conversion 75%, average growing stock volume in forests 8%, average amount of standing deadwood 27%, average amount of lying deadwood 20% and average above-ground to below-ground biomass ratio *R* (root-shoot-ratio) 68%. The uncertainty applicable to *BCEF* was 22%,derived from the work of Lehtonen et al. (2007).

The emission estimate concerns only category 4.E.2 Land converted to Settlements; therefore, the uncertainty is estimated only for this category. For 2014, the estimated uncertainty for category 4.E.2 was 102%.

6.8.4 Source-specific QA/QC and verification

The emission estimates are based on the activity data taken from the official national sources and follow the recommendations of the 2006 IPCC Guidelines (IPCC 2006). The data sources are verifiable and updated annually. All the input information and calculations are archived by the expert team and the NIR coordinator. Hence, all the background data and calculations are verifiable. Other QA/QC elements were adopted in the same manner as described in Section 6.5.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

6.8.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

Since the last submission, the emission estimates were revised and recalculated for the entire reporting period. This was a result of the revised activity data on land use and data on deadwood that are related to land use conversion from Forest Land. Therefore, the emission estimates differ compared to the previously reported values and the current emission estimates for the reporting period are higher by 7% (Fig. 6-19).

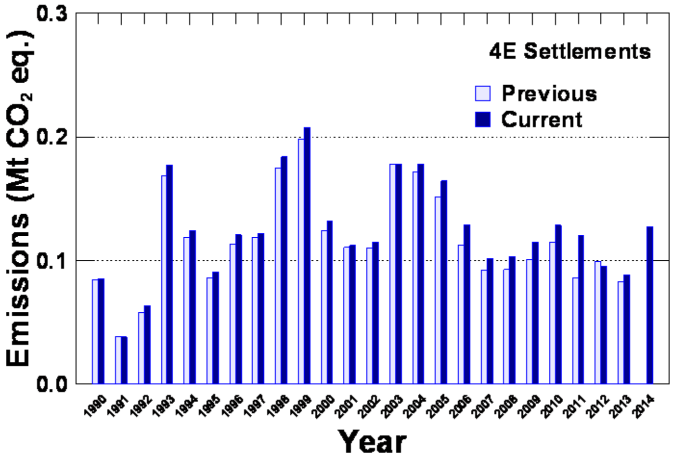


Fig. 6-19 Current and previously reported assessment of emissions for the category 4.E Settlements

Further efforts to consolidate the emission estimates are expected for the category of Settlements. Specifically, the inventory team will consider revising the definition of the Other land use category, which may be fully considered under the Settlement category. This would further enhance the transparency and accuracy of the inventory involving these two land-use categories. Further improvements are also planned for uncertainty assessment.

6.9 Other Land (CRF 4.F)

6.9.1 Source category description

Since the NIR 2008 submission, category 4.F Other Land represent has represented unmanaged (unmanageable) land areas, matching the IPCC (2006) default definition. These areas were assessed from the database of “Aggregate areas of cadastral land categories” (AACLC), collected and administered by COSMC. It is part of the AACLC “Other lands” category with the specific “Unproductive land” land use category assessed from the 2006 land census of COSMC. Since this inventory submission, the newly acquired data on land use from COSMC permitted more detailed assessment of changes in areas of “Unproductive land” since 2004. Hence, this is considered to be constant until 2004, involving land-use conversions only since that year. The Other Land category represents only 1.3% of the territory of the country.

6.9.2 Methodological issues

Changes in carbon stocks and non-CO_2 emissions are not considered for 4.F.1 Other Land remaining Other Land (IPCC 2006). However, emissions are estimated for 4.F.2 Land converted to Other Land, which is newly included in this inventory.

The emission estimates specifically concern Forest land converted to Cropland. The emissions result from changes in biomass carbon stock and dead organic matter (DOM). Biomass carbon stock change was quantified based on eq. 2.11 (IPCC 2006). Changes in DOM were related to the deadwood carbon pool.

The corresponding default values were employed: the biomass stock after conversion equalled zero, while the mean biomass stock prior to the conversion was estimated and/or assumed identically to that described above in Sections 6.4.2.2 and 6.5.2.2. The latter section describes the estimation of emissions related to the deadwood component, which was applied identically in this land use category. The carbon stock prior to conversion was estimated as described in Section 6.4.2. All biomass is assumed to be lost during the conversion, according to the Tier 1 assumption of the Guidelines for LULUCF. An additional contribution to emissions comes from the deadwood component, using the actual areas of the land use change concerned.

6.9.3 Uncertainties and time series consistency

The uncertainty estimates follow the procedure described in Chapter 6.8.3 above.

The emission estimate concerns only category 4.F.2 Land converted to Other Land; therefore, the uncertainty is estimated only for this category. For 2014, the estimated uncertainty for the category 4.F.2 was 101%.

6.9.4 Source-specific QA/QC and verification

The QA/QC elements were adopted in the same manner as described in Section 6.5.4 above, following the application of the QA/QC plan applicable for LULUCF sector 7, limited to those elements relevant for this specific land-use category.

6.9.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

The estimates are new for the category 4.F Other Land due to the newly implemented activity data on land areas.

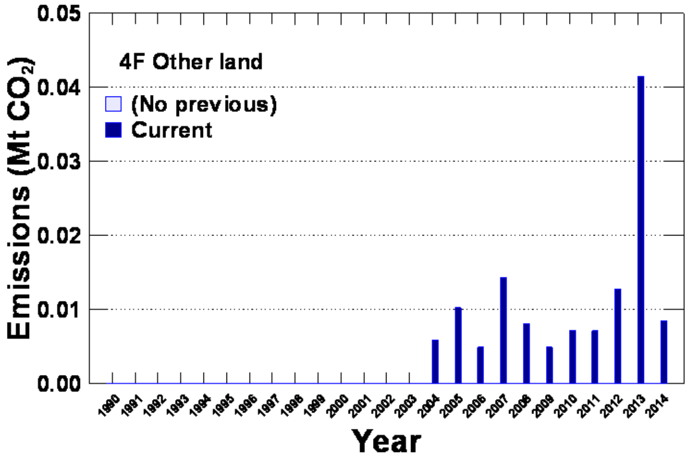


Fig. 6-20 Current and previously reported assessment of emissions for the category 4.E Settlements

6.9.6 Source-specific planned improvements, including those in response to the review process

The current revision based on newly acquired activity data from COSMC on land use areas is considered temporary. The inventory teams consider unifying areas of "Other land" with the category of "Settlements, which would apparently not affect the joint emission estimates, but further improves the consistency of the reporting.

6.10 Harvested Wood Products (CRF 4.G)

6.10.1 Source category description

The contribution of Harvested wood products (HWP), mandatorily included by Decision 2/CMP7 in emission inventories under UNFCCC and KP since the 2015 inventory submission, is newly estimated for the Czech emission inventory. Changes in the pool of HWP may represent CO_2 emissions or removals, which are included within the LULUCF sector as a specific category (CRF 4.G) in addition to the six IPCC land use categories. The HWP pool considers primary woody products generated from wood produced in the country. Hence, these emissions originate in land use category 4.A Forest land. The eventual fraction of wood from deforested land, i.e., Forest land converted to any other land use categories, is also considered, although it is treated differently (see Section 6.10.2 below).

6.10.2 Methodological issues

The methodology for estimating the contribution of HWP to emissions and removals was based on IPCC (2006) and IPCC (2014b). The latter material was followed to adopt the agreed principles on accounting for HWP, which includes only domestically produced and consumed HWP. The estimation follows the Tier 2 method of first order decay, which is based on Eq. 2.8.5 (IPCC 2014). This equation considers carbon stock in the particular HWP categories, which is reduced by an exponential decay function using the specific decay constants. The default half-life constants were used for the major HWP categories: 35 years for sawnwood, 25 years for wood-based panels and 2 years for paper and paperboard. The second part of Eq. 2.8.5 (IPCC 2014) adds the material inflow in the particular year and HWP categories.

The activity data (production and trade of sawnwood, wood-based panels and paper and paperboard) were derived and/or directly used from the FAO database on wood production and trade (http://faostat3.fao.org/download/F/FO/E). The data have been available since 1961 as an aggregate for the former Czechoslovakia. Since 1993, when Czechoslovakia was split into the Czech Republic and Slovakia, data have been available specifically for the two countries. To estimate the corresponding share of HWP in the 1961 to 1992 period, the data applicable for Czechoslovakia were multiplied by a country-specific share that was derived for each HWP category from the data reported for each follow-up country in the 1993 to 1997 period (Cienciala and Palán 2014). The conversion factors are used for disaggregated HWP categories as in Table 2.8.1 (IPCC, 2014).

The fraction corresponding to source material originating from deforested land was estimated based on deforested areas as reported under Act. 3.3 Deforestation of the Kyoto protocol. Although quantitatively insignificant (0.016 and 0.022% in 1990 and 2014, respectively), the HWP contribution of this fraction was estimated using instantaneous oxidation, which is a formal requirement of the IPCC guidelines (IPCC 2014).

Tab. 6-7 The country-specific shares applicable for the HWP quantities as given for the former Czechoslovakia in the FAO database, derived from the period 1993-1997

	Production		Import		Export	
Country / HWP category	Czech Republic	Slovakia	Czech Republic	Slovakia	Czech Republic	Slovakia
Sawn wood	0.834	0.166	0.868	0.132	0.723	0.277
Wood-based panels	0.716	0.284	0.719	0.281	0.851	0.149
Paper and paperboard	0.655	0.345	0.772	0.228	0.598	0.402

The resulting estimates reported for HWP produced and consumed domestically for the reporting 1990 to 2014 period are shown in Fig. 6.19. The emission estimates of the HWP contribution differ due to the different reporting approach selected in the CRF Reporter. The emissions in the current report are estimated using Approach B (B1), while the previously submitted values were erroneously reported using Approach A in the reporting software. The emissions fluctuate during the reporting period, where the mean contribution reached -1.04 Mt CO_2/year.

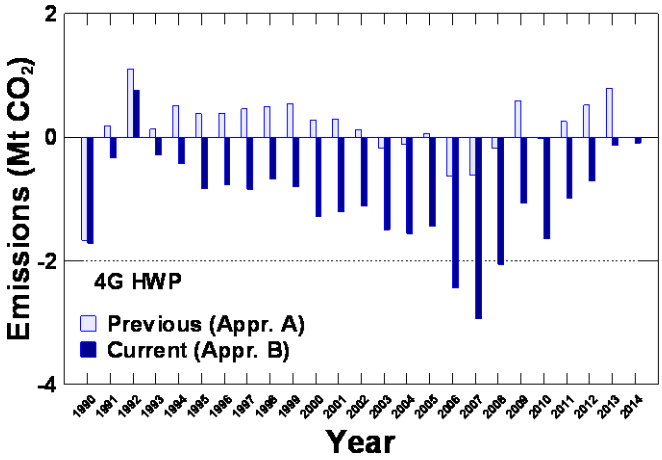


Fig. 6-21 The reported assessment of HWP contribution to emissions in the LULUCF sector for the category 4.G HWP

6.10.3 Uncertainties and time series consistency

The uncertainty estimates use the following inputs: roundwood harvest 20%, sawnwood, wood panel and paper products 15%, wood density factors 25%, carbon content in wood products 10%, half-life factors 50%. Using Eq. 4 for combining uncertainties, this gives an approximate uncertainty estimation of 62% for the HWP contribution, which is general for all the HWP categories.

Time series consistency is ensured as the inventory approaches and/or assumptions are applied identically across the whole reporting period from the base year of 1990 to 2014.

6.10.4 Source-specific QA/QC and verification

The QA/QC elements were adopted in the same manner as described in Section 6.5.4 above, following the application of the QA/QC plan applicable for LULUCF sector 7, limited to those elements relevant for this specific land-use category.

6.10.5 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

No recalculations are related to category 4.G HWP, but the estimates were newly reported under Approach B (B1) in this inventory submission.

6.10.6 Source-specific planned improvements, including those in response to the review process

No specific improvements are planned for this category for the next submission.

Acknowledgement

The authors would like to thank Jan Hána, Patrik Pacourek and Miroslav Zeman, Forest Management Institute in Brandýs n. Labem, for compiling the required increment data concerning forests in previous years. Some of the analyses required for this inventory were performed within the CzechCarbo project (VaV/640/18/03), while some of the critical data were obtained from the CzechTerra project funded by the Czech Ministry of the Environment (SP/2d1/93/07) and the Czech Science Foundation (14-12262S). We greatly appreciate the assistance of the staff at the Czech Office for Surveying, Mapping and Cadastre, specifically Petr Souček, Zuzana Loulová, Bohumil Janeček and Helena Šandová, related to data on land use areas and advice in related issues. The authors would also like to thank Jan Apltauer, former IFER employee, for his contribution to previous NIRs. Specific thanks belong to IFER employees Ondřej Černý, who significantly assisted with land use activity data compilation, and Šárka Holá and Zuzana Exnerová, for their technical assistance with the current NIR submission.

7 Waste (CRF sector 5)

7.1 Overview of sector

Waste sector comprises emissions from human activities associated with waste management in general. Waste is final product of most human and economic activities, therefore performance of this sector is closely tied with economic state of the country. Origin of most processes in the sector is biological or biochemical, therefore changes in management practices takes longer time to be reflected in emissions. Overview of the whole sector is shown in Fig. 7-1.

Fig. 7-1 Trend of emissions from Waste sector, by gases, 1990-2014

The sector consists of several categories. The main source category of this sector is 5.A Solid waste disposal. In 2014, this category emitted approximately 133 kt of CH_4, equalling 3331 kt of CO_2 eq. The second biggest source category is 5.D Wastewater Treatment and Discharge followed by two additional categories, quantifying emissions from waste incineration and from biological treatment of waste. Additional category quantifying emissions from waste management is incineration of waste for energy purposes which is reported in category 1.A.1.a Other fuels however.

Tab. 7-1 Overview of significant categories in this sector (2014)

Category	Gas	Character of category	% of total GHG*
5.A Solid Waste Disposal	CH_4	LA, TA	2.69
5.D Wastewater treatment and discharge	CH_4	LA	0.59

** assessed without considering LULUCF*
KC: key category,LA, LA: identified by level assessment with and without considering LULUCF, respectively*
TA, TA: identified by trend assessment with and without considering LULUCF, respectively*

The Waste sector is quantified and managed by the Charles University Environmental Center (CUEC).

7.2 Solid waste disposal (CRF 5.A)

7.2.1 Source category description

The treatment and disposal of municipal, industrial and other solid waste produces significant amounts of methane (CH_4). The decomposition of organic material, derived from biomass sources (e.g., crops, wood), is the primary source of CO_2, released from waste. These CO_2 emissions are not included in the national totals, because the carbon is of biogenic origin and net emissions are accounted for under land use change and forestry.

This source category might produce emissions of other micropollutants, such as non-methane volatile organic compounds (NMVOCs), as well as smaller amounts of nitrous oxide (N_2O), nitrogen oxides (NO_X) and carbon monoxide (CO). In line with the IPCC 2006 Gl. methodology, only CH_4 is addressed in this chapter. Overview of this category is shown in Fig. 7-2.

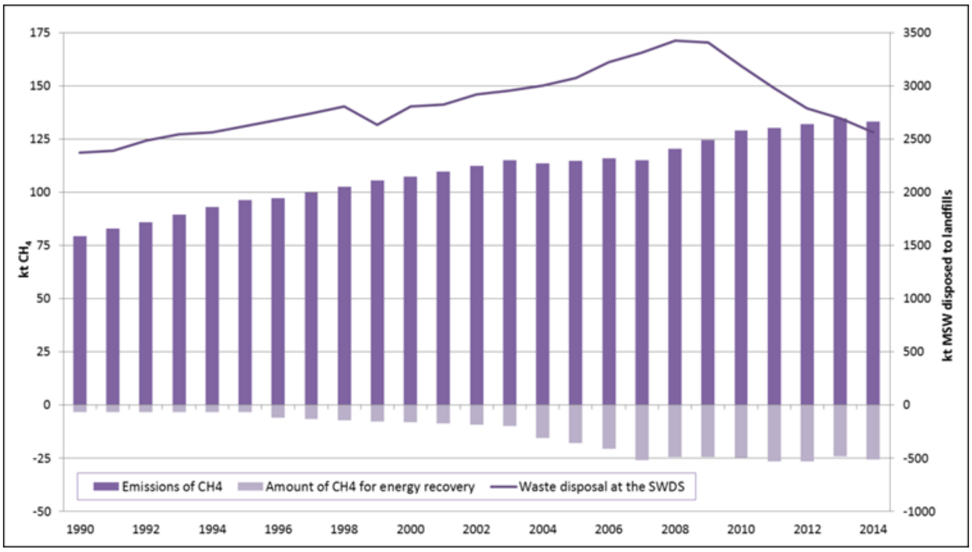


Fig. 7-2 Development of emissions from SWDS and total amount of waste disposed to SWDS, 1990-2014

7.2.2 Methodological issues

Waste disposal to SWDS

The key activity data for methane quantification from 5.A.1 is the amount of waste disposed in landfills. Annual disposal is shown in Tab. 7-2. The data for annual disposal are obtained from mixed sources, since the application of the FOD model requires data from 1950 to the present day. These data are not available in the Czech Republic and therefore assumptions about the past had to be used. These assumptions are described in the working paper published in this issue (Havránek, 2007); however, the method can be simply described as intrapolation and extrapolation between points in time; correlation of waste production with social product (predecesor of the present-day GDP) was performed as a test method. The higher of the two estimates was used in the quantification.

The data, used for this submission, are based on the information system of waste management in the Czech Republic (ISOH), managed by CENIA – Czech Environmental Information Agency. The system contains bottom up data from about 60 000 respondents and the reporting obligation to this system is based on national legislation. Since 2011, a slight decline in waste deposited into landfills was experienced for a first time in modern history. The decrease of landfilled waste is a long term target of the Czech national environmental policy.

National legislation about landfill management is based on European legislation. In general, it sets the condition for how landfilling is to be done, stipulates the relevant actors and state bodies responsible for admionistration and control and the duties and obligation of all the stakeholders. The most important regulations in this area are Act No. 185/2001 Coll., the "Act on waste" and the main directive relevant for landfilling, Decree No. 294/2005 Coll., the "Decree on the conditions of depositing waste in landfills and its use on the surface of the ground". Management of waste is complicated and the full regulative framework can be found on the website of the Ministry of Environment.

Tab. 7-2 MSW disposal in SWDS in the Czech Republic [kt], 1990-2014

Year	MSW in SWDS	Year	MSW in SWDS	Year	MSW in SWDS	Year	MSW in SWDS
1990	2371	**1997**	2739	**2004**	3000	**2011**	2981
1991	2388	**1998**	2804	**2005**	3070	**2012**	2786
1992	2484	**1999**	2632	**2006**	3221	**2013**	2692
1993	2543	**2000**	2803	**2007**	3314	**2014**	2563
1994	2561	**2001**	2826	**2008**	3424		
1995	2621	**2002**	2920	**2009**	3406		
1996	2683	**2003**	2952	**2010**	3185		

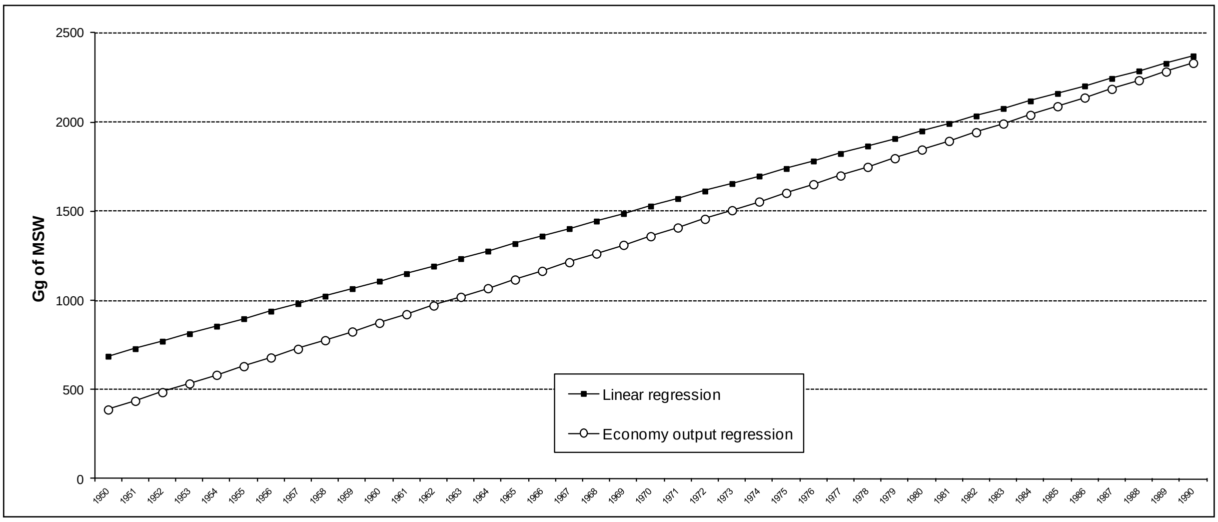


Fig. 7-3 MSW disposal in SWDS in the Czech Republic, 1950-1990

The method, used for estimation of methane emissions from this source category, is the tier 1 FOD approach (first-order decay model). The first-order decay (FOD) model assumes gradual decomposition of waste, disposed in landfills. The GHG emissions were calculated from the IPCC Spreadsheet for Estimating Methane Emissions from Solid Waste Disposal Sites, which is part of the 2006 Guidelines (IPCC, 2006) referred further to as IPCC model (IPCC, 2006).

Waste composition, sludge, k-rate and DOC

The waste composition is crucial for emission estimations. Several attempts to obtain country-specific data about waste composition were made (Tab. 7-3). The data for the time period 1990-1995 are based on the IPCC default values for Eastern Europe, the data for the periods 1996-2000 and 2002-2004 are based on intrapolation between data points. The data for year 2001 and the period 2005-2009 are based on waste surveys performed in R&D projects, dealing with waste composition. There are no data for current years and therefore latest available data were used. Endeavour to encourage continuation of waste composition monitoring was made.

As it can be noted, the table does not include all possible waste streams, which might be deposited into a landfill. The missing item is sludge. The reason is that the projects,from which the expert derived the waste composition, did not include any sludge as part of the waste mixture. However, the inventory team is aware, that the research covered only limited number of landfills. Furthermore since the practice of sludge deposition is not wide spread, the researchers did not encounter its deposition. Therefore sludge is not calculated into the waste mixture, although in reality some small part of the sludge might end up in landfills. Doing so emissions were not underestimated however, because the mass, deposited to landfills already include sludge (data are bottom up total mass data from landfills) and the average DOC, using current waste mixture is higher than default DOC of sludge.

The table also contains the methane generation rate (k-rate) employed. This rate is closely related to the compostion of a particular substance and the available moisture. The IPCC default k-rates for a wet temperate climate (as the average temperature of the Czech Republic is about 7 °C and the annual precipitation is higher, than the potential evapotranspiration) were used. The average DOC for particular waste stream is also based on the IPCC default values for individual categories of waste. The average DOC for each particular year is in the last column of the table.

Tab. 7-3 MSW composition for the Czech Republic used in the quantification (fractions of total, 1990-2014)

	Paper	Food	Textil	Wood and straw	DOC (calculated)
k-*rate*	0.06	0.185	0.06	0.03	
DOC (default)	0.4	0.15	0.24	0.43	
	Share of particular waste streams				
1990-1995	0.22	0.30	0.05	0.08	0.176
1996	0.22	0.29	0.05	0.08	0.179
1997	0.23	0.28	0.06	0.08	0.181
1998	0.24	0.27	0.06	0.08	0.184
1999	0.25	0.26	0.07	0.08	0.187
2000	0.26	0.25	0.07	0.08	0.191
2001	0.27	0.23	0.08	0.08	0.195
2002	0.24	0.25	0.08	0.09	0.194
2003	0.22	0.27	0.07	0.11	0.193
2004	0.19	0.30	0.07	0.13	0.192
2005	0.16	0.32	0.07	0.14	0.191
2006	0.16	0.32	0.07	0.14	0.187
2007	0.17	0.32	0.08	0.13	0.193
2008	0.16	0.32	0.07	0.14	0.188
2009-2014*	0.16	0.35	0.08	0.13	0.194

**Since 2009 last available data are used*

Methane correction factor

The methane correction factor (MCF) is a value, expressing overall management of the landfills in the country. Better-managed and deeper landfills have higher MCF value. Shallow SWDS ensure that far more oxygen penetrates into the body of the landfill to aerobically decompose DOC. The suggested IPCC values are given in Tab. 7-4.

In Tab. 7-5 are shown the values, used in this inventory. The choice of the values is based on data in recent years (1992+) and by expert judgement in early years of the timeline.

Tab. 7-4 Methane correction values (IPCC, 2006)

	MCF
Unmanaged, shallow	0.4
Unmanaged, deep	0.8
Managed, anaerobic	1.0
Managed, semi-aerobic	0.5
Uncategorised	0.6

Tab. 7-5 MCF values employed, 1950-2014

	MCF
1950 – 1959	0.6
1960 – 1969	0.6
1970 – 1979	0.8
1980 – 1989	0.9
1990 – 2014	1.0

Oxidation factor

As methane moves from the anaerobic zone to the aerobic and semi-aerobic zones close to the landfill surface, part of it becomes oxidized to CO_2. There is no conclusive agreement in the scientific community on the intensity of the oxidation of methane. The oxidation is indeed site-specific, due to the effects of local conditions (including fissures and cracks, compacting, landfill cover etc.). No representative measurement or estimations of the oxidation factor are available for the Czech Republic. Some studies are quoted in Straka, 2001, which mention a non-zero oxidation factor, but these figures seem to be site-specific (and with really high values compared to default). Therefore they cannot be used as representative for the whole country. However, the methodology (IPCC, 2006) suggests that an oxidation factor higher than 0.1 should not be used, if no site measurements are available (a larger value adds uncertainty). The author used the recommended oxidation factor of 0.1 in the report.

Delay time

When waste is disposed in SWDS, decomposition (and methanogenesis) do not start immediately. The assumption, used in the IPCC model, is that the reaction starts on the first of January in the year after deposition, that is equivalent to an average delay time of six months before decay to methane commences. It is good practice to assume an average delay of two to six months. If a value greater than six months is chosen, evidence to support this must be provided. The Czech Republic has no representative country-specific value for delay time, so the author used a default value of 6 months.

Fraction of methane

This parameter indicates the share (mass) of methane in the total amount of Landfill Gas (LFG). In previous calculations of methane emissions from SWDS (NIR, 2004), a value 0.61 was used. This figure was based on measurement of a limited number of sites (Straka, 2001). This value is higher than the range of 0.5-0.6, suggested by IPCC. Revision of these values was made, based on collected data from MIT (MIT, 2005+). MIT receives annual reports from landfills, capturing LFG; SWDS report the net calorific value of their captured LFG.This value was compared with the gross calorific value of pure methane and yielded a value of 0.55, which well fits within the IPCC range and therefore is used in the quantification.

Recovered methane

On SWDS in the country, methane is sometimes collected by an LFG collection systems and incinerated for energy purposes. Based on 2006 Guidelines (IPCC, 2006), this methane, that is being converted to CO_2 and, having biogenic origin, is not considered to constitute an emission of GHG, hence recovered methane (R) is substracted from the emission. There is no default value for R, so country estimates were used, based on various sources. As mentioned in the previous paragraph, the Ministry of Industry and Trade conducts an annual survey of all SWDS. All the energy data about LFG, used for energy purposes, is collected. An attempt to update old estimates as much as possible is made. Since the start of the survey in 2005, it was possible to provide estimates for the time series between 2003 and 2014. The estimates in Straka, 2001 were used for the 1990-1996 period. Linear intrapolation of recovered methane was used for the period between 1996 and 2003. In 2014 more than 60 facilities in the country were recovering LFG.

Total emissions of methane are based on the equation from the IPCC CH_4 model. The detailed time series from 1950, including the breakdown into individual waste components, are given in the paper by Havranek 2007. Following table 7-6 shows emissions of methane from this category.

Tab. 7-6 Emissions of methane from SWDS [kt], Czech Republic, 1990-2014

	CH_4 generation	CH_4 recovery	CH_4 oxidized	CH_4 emission
1990	91	3.3	9.1	79.2
1991	95	3.3	9.5	82.8
1992	99	3.5	9.9	86.0
1993	103	3.5	10.3	89.5
1994	107	3.5	10.7	93.0
1995	110	3.5	11.0	96.2
1996	114	6.0	11.4	97.1
1997	118	6.6	11.8	99.9
1998	121	7.1	12.1	102.6
1999	125	7.7	12.5	105.5
2000	127	8.2	12.7	107.3
2001	131	8.8	13.1	109.8
2002	134	9.3	13.4	112.3
2003	138	9.9	13.8	115.1
2004	142	15.6	14.2	113.4
2005	145	18.0	14.5	114.7
2006	149	20.6	14.9	116.0
2007	154	25.9	15.4	114.8
2008	158	24.6	15.8	120.4
2009	163	24.5	16.3	124.5
2010	168	24.7	16.8	129.0
2011	171	26.6	14.4	130.2
2012	173	26.5	14.6	131.9
2013	174	24.2	15.0	134.6
2014	174	25.7	14.8	133.2

7.2.2.1 Uncertainties and time-series consistency

Overall quantification of the uncertainity for this category is still incomplete. This is considered a high priority and will be conducted in the following years as soon as budget constraints permit. This category entails the difficulty, that the uncertainty does permeate through the whole waste management period of 1950-2014 and therefore it cannot be correctly quantified by simple analysis. Combined uncertainty was estimated based on default factors and activity data uncertainties by expert judgement (Tab. 7-7).

Tab. 7-7 Uncertainty estimates for 5A category

Gas	Category	AD uncertainity [%]	EF uncetrainity [%]	Origin of the parameters
CH_4	5.A.1 SWDS	30	40	Combined uncertainty of quantification parameters Expert judgement M. Havránek, verification P. Slavíková (CENIA)

7.2.2.2 Source-specific QA/QC and verification

Quality assurance entails structured checklists of activities, that are dated and signed by sector reporter and verified by external control of activity data. The activity data used for this sector are approved by the data producer and are verified by him before they are proceeded for further calculation.

Since the waste sector is fairly small, external QC is not provided, instead QC is done by NIS coordinator and the results are communicated to the sectoral expert.

Activity data from the national agencies and ministries are the subjects of internal QA/QC mechanisms and NIS team has only limited insinghts in to it. The processes to ensure that state agencies produce correct data are in place on all state agencies and ministries.

7.2.2.3 Source-specific recalculations, including changes made in response to the review process

The data for 2013 were recalculated due to changes in last year's activity data. This is a fairly regular recalculation, as some data needed for this source category are available only in a preliminary version before the inventory is submitted.

7.2.2.4 Source-specific planned improvements, including those in response to the review process

There are not improvements planned for this category.

7.2.3 Unmanaged Waste Disposal Sites (CRF 5.A.2)

This category is not relevant for the Czech Republic.

7.2.4 Uncategorized Waste Disposal Sites (CRF 5.A.3)

This category is not relevant for the Czech Republic.

7.3 Biological Treatment of Solid Waste (CRF 5.B)

The biological treatment of waste includes two categories. Aerobic processes for treating organic waste include (5.B.1) Composting and – 5.B.2 Anaerobic digestion. Composting is mostly aerobic process; therefore the production of methane is insignificant. Anaerobic digestion is booming in the recent years, as there is an active support from the state for this type of waste treatment (i.e. energy production). However, it is controlled process, which has capturing of produced biogas as a main objective; hence emissions from this source category are also relatively small. Overall picture of this source category is shown in Fig. 7-4.

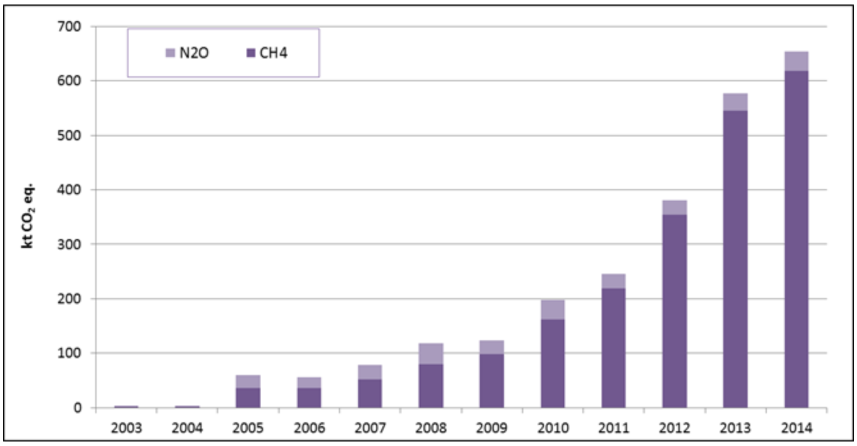


Fig. 7-4 Development of emissions from biological treatment of solid waste, 2003-2014

7.3.1 Composting (CRF 5.B.1)

7.3.1.1 Source category description

This category quantifies emissions from industrial composting facilities. Estimation of emissions from household composts were not attempted, as this would introduce high levels of uncertainty in the results (no data are available) and those emissions are considered to be negligible, as household composts are in general very small, ensuring that the processes are not generating methane emissions at all.

7.3.1.2 Methodological issues

This source category quantifies emissions from composting, based on statistical data about management of waste. The data about composting are obtained from ISOH managed by CENIA (for more details about ISOH see source category 5.A.1).

In line with the IPCC 2006 Gl., composted waste was split in to two groups – municipal solid waste (MSW) and other waste. Composted MSW is a self-explanatory category. Composted other waste is collection category of all waste streams, that are noted in ISOH as composted, but the exact nature of the waste stream is unknown. However being composted, one can assume that a certain composition standards are met; therefore both categories use identical EF. For both streams fresh (wet) weight data and default EF from IPCC 2006 Gl. were used. Both of the categories have no data before 2005 so a further research has been launched to determine the reasons for this case. Considering that the industrial composting is a relatively new field in the country the data for earlier years could be non-existing because such activity did not occur. The amount of composted MSW is gradually increasing, which is long term aim of the Czech environmental policy. Overall development of the category is shown in Tab. 7-8.

Tab. 7-8 Emissions of GHG from composting [kt], Czech Republic, 2005-2014

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MSW (tons)	48 760	61 475	79 801	114 437	134 601	144 136	181 914	153 500	202 832	303 110
Other waste (tons)	288 814	222 672	296 390	428 739	221 276	358 242	190 058	228 284	247 045	207 233
Emission factor (kg CH_4/ton)	4									
Emission factor (kg N_2O/ton)	0.24									
Total Composting CH_4 (kt)	1.35	1.14	1.50	2.17	1.42	2.01	1.49	1.53	1.80	2.04
Total Composting N_2O (kt)	0.08	0.07	0.09	0.13	0.09	0.12	0.09	0.09	0.11	0.12
Total composting GHG (kt CO_2 eq.)	57.90	48.74	64.52	93.17	61.04	86.17	63.80	65.48	77.16	87.53

7.3.1.3 Uncertainties and time-series consistency

This category has default uncertainty, as there is only default factors used. Uncertainty of reported activity data is estimated to be small (+/- 5%), however biggest source of uncertainty is what official data does not capture – household composting.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2014.

7.3.1.4 Source-specific QA/QC and verification

During the previous year QA/QC plan for the sector was updated. Quality assurance entails structured checklists of activities, that are dated and signed by sector reporter and verified by external control of activity data. The activity data used for this sector are approved by the data producer and are verified by him before they are proceeded for further calculation.

Since waste sector is fairly small, external QC is not provided, instead QC is done by NIS coordinator and the results are communicated to the sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms and NIS team has only limited insinghts in to it. The processes to ensure that state agencies produce correct data are in place on all state agencies and ministries.

7.3.1.5 Source-specific recalculations, including changes made in response to the review process

This year recalculation was done due to errata in IPCC methodology. Default factor for N_2O from composting was changed from 0.3 kg N_2O/ton to 0.24 kg N_2O/ton. This change influences emissions from whole waste category in average by -0.15%. (Tab. 7-9 and Fig. 7-5).

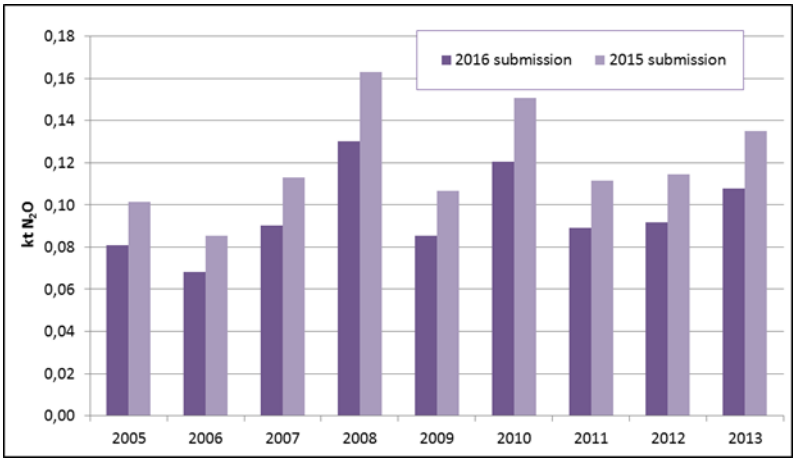


Fig. 7-5 Recalculation of composting [kt N_2O], Czech Republic, 2005-2013

Tab. 7-9 Recalculation of composting [kt N_2O], Czech Republic, 2005-2013

	2005	2006	2007	2008	2009	2010	2011	2012	2013
2016 submission	0.081	0.068	0.090	0.130	0.085	0.121	0.089	0.092	0.108
2015 submission	0.101	0.085	0.113	0.163	0.107	0.151	0.112	0.115	0.135
Difference	-0.020	-0.017	-0.023	-0.033	-0.021	-0.030	-0.022	-0.023	-0.027

7.3.1.6 Source-specific planned improvements, including those in response to the review process

A research was initiated to obtain data about composting before 2005. In future submissions, if the resources permit an attempt to estimate the emissions from household composts will be performed. However, with respect to the almost negligible emissions from industrial composting, currently this is not of a high priority.

7.3.2 Anaerobic Digestion at Biogas Facilities (CRF 5.B.2)

7.3.2.1 Source category description

Anaerobic digestion (AD) accounts for emissions from digestion facilities. AD in the Czech Republic is increasing, going from 21 digesting facilities to 404 facilities in 2014. This rapid increase is fuelled by increasing technological availability and massive support on energy from biogas produced using AD. AD is also a new category that was added into the inventory for the first time.

7.3.2.2 Methodological issues

For the estimation of emissions from AD default emission factors were used. Since production of biogas from AD facilities is carefully monitored (due to government subsidies) the data about biogas production were used as an activity data. The Ministry of industry and trade monitors the amount of biogas and additional data, such as calorific value of produced gas, energy produced and total volume of gas. The heating value of methane was used to convert above mentioned values to mass unit of produced methane. The production does not mean emission of biogas, yet. The IPCC 2006 Gl. states that in controlled AD facilities, focused on energy production, leakages are very small, ranging between 0-10 percent. For the estimation of emissions of biogas from AD, a mean value of 5% for all produced methane was used.

Since data about production are used as an activity data, all possible emissions from AD are calculated, not just emissions from digested waste. Some of the material used in AD might not be waste by definition (e.g. agricultural residues, industrial by-products etc.). Overview of the sector is shown in Tab. 7-10.

Tab. 7-10 Emissions from Anaerobic digestion stations, 2007-2014

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of biogas stations (count)	8	10	9	14	21	49	86	115	186	317	388	404
Energy (TJ)	121	105	104	291	555	1 007	2 503	4 481	7 294	12 630	20 002	22 674
Convertsion (TJ/kt)	50.009											
Activity data (kt of CH_4) – R	2.4	2.1	2.1	5.8	11.1	20.1	50.0	89.6	145.9	252.6	400.0	453.4
Emission (default 5%) kt CH_4	0.1	0.1	0.1	0.3	0.6	1.0	2.5	4.5	7.3	12.6	20.0	22.7

7.3.2.3 Uncertainties and time-series consistency

Time series are consistent, using same method, factors and data source. Uncertainty in this source category is given by the range of EF from -100% to +100%.

Tab. 7-11 Uncertainty estimates for 5B category

Gas	Category	AD uncertainity [%]	EF uncetrainity [%]	Origin of the parameters
CH_4	5.B.1 Composting	20	NA	AD Expert judgement M. Havránek; EF IPCC default, verification of AD Jiří Valta (CENIA)
N_2O	5.B.1 Composting	20	NA	AD Expert judgement M. Havránek; EF IPCC default, verification of AD Jiří Valta (CENIA)
CH_4	5.B.2 Anaerobic digestion	20	100	AD Expert judgement M. Havránek; EF IPCC default, verification of AD Jiří Valta (CENIA)

7.3.2.4 Source-specific QA/QC and verification

During the year 2015 QA/QC plan for the sector was updated. Quality assurance entails structured checklists of activities, that are dated and signed by sector reporter and verified by external control of activity data. The activity data used for this sector are approved by the data producer and are verified by him before they are proceeded for further calculation.

Since waste sector is fairly small, external QC is not provided, instead QC is done by NIS coordinator and the results are communicated to the sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms and NIS team has only limited insinghts in to it. The processes to ensure that state agencies produce correct data are in place on all state agencies and ministries.

7.3.2.5 Source-specific recalculations, including changes made in response to the review process

Since last inventory recalculation has been conducted. We have prolonged time series from year 2007 to year 2003. We used same method and activity data for estimation that are used for normal inventory.

7.3.2.6 Source-specific planned improvements, including those in response to the review process

Improvements in this category are planned in terms of reviewing the data sources of emissions before 2003 and verifying the factor for estimated leakages, which is crucial for the whole quantification.

7.4 Incineration and Open Burning of Waste (CRF 5.C)

7.4.1 Waste Incineration (CRF 5.C.1)

This category contains emissions from waste incineration in the Czech Republic. The types of waste, incinerated include industrial, hazardous and clinical waste. The waste incineration is defined as the combustion of waste in controlled incineration facilities. Modern waste incinerators have tall stacks and specially designed combustion chambers, which ensure high combustion temperatures, long residence time, and efficient waste agitation, while introducing air for more complete combustion. This category includes emissions of CO_2, CH_4 and N_2O from such practices.

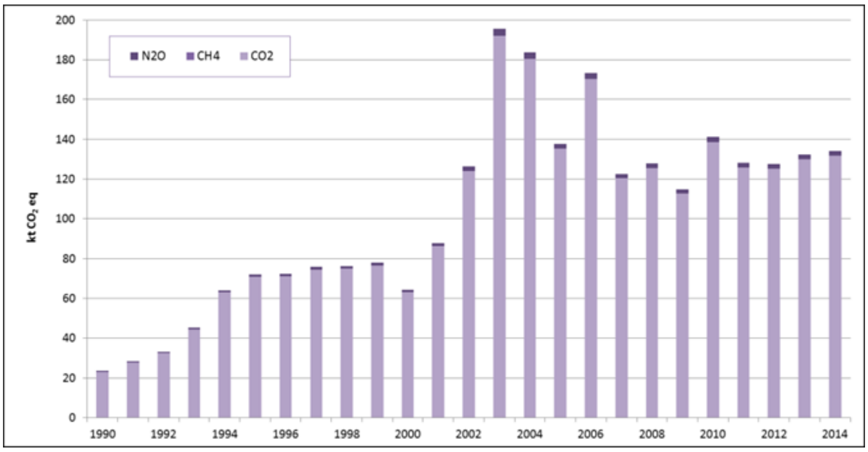


Fig. 7-6 Development of emissions from waste incineration, 1990-2014

This year, the timeline 2005-2014 was recalculated due to changes in activity data explained in data section. Waste used as a fuel is included in Energy sector. This chapter includes only waste that is not used for energy production. Development of this category is shown in Fig. 7-6 and in detail in Tab 7-12.

7.4.1.1 Source category description

There are three MSW incineration facilities and also 76 other facilities, incinerating or co-incinerating industrial and hazardous waste with a total capacity of 600 kt of waste. Most of this capacity is not used however. More and more of the incinerators have energy recovery hence in recent years steady decreasing trend on waste incineration is observed.

7.4.1.2 Methodological issues

In this source category only CO_2 emissions resulting from oxidation of fraction of fossil carbon in waste (e.g. plastics, rubber, liquid solvents, and waste oil) during incineration are considered in the net emissions and are included in the national CO_2 emissions estimates. Additionally, incineration plants produce small amounts of methane and nitrous oxide. All emissions are reported in category 5.C.1. Estimations of emissions from hazardous/industrial waste (H/IW) biomass are reported under the same category, but the CO_2 emissions are described as an information item and are not included in the national totals.

Estimation of CO_2 emissions from H/IW incineration is based on the Tier 1 approach (IPCC, 2006). It assumes that the total fossil carbon dioxide emissions are dependent on the amount of carbon in the waste, on the fraction of fossil carbon and on the combustion efficiency of the waste incineration. Due to the lack of country-specific data for the necessary parameters, the default data for the calculations were taken from the IPCC 2006 Guidelines, see Tab. 7-12. The results are divided into biogenic and non-biogenic fractions of the waste only for important gases – CO_2. Methane and nitrous oxide are listed together in the table although they are reported in the UNFCCC reporter separately from the biogenic and fossil fractions of the waste.

The activity data are the main issue in this category. This year, the 2005-2014 timeline was recalculated to fit with the official statistics. The activity data are based on the statistical surveys performed by ISOH. The system uses categorization of waste management activities and this source category is listed under D10 – incineration on land in the ISOH system. The problem is that the system does not contain data before 2002 and incineration data in ISOH are consistent since 2005 when a new methodology was used; hence, estimates obtained from MIT are used prior to that date. MIT issued a special report on the history of incineration in the Czech Republic, which was used to derive data for this category before 2005. The Czech legislation does not explicitly discern between types of wastes required by the IPCC methodology. However, it is certain that all MSW is incinerated for energy purposes (R1 category by ISOH) and hence the author concluded that category D10 consists of components consisting of waste with hazardous parameters (which is supported by evidence in ISOH where applicable).

Tab. 7-12 H/IW incineration in 1990 – 2014 with used parameters and results

	Used factors								
Amount of carbon fraction	0.5								
Fosil carbon fraction	0.9								
Combust efficiency fraction	0.995								
C-CO_2 ratio	3.7								
Emission factor kt CH_4/kt	5.6E-07								
Emission factor kt N_2O/kt	1.0E-04								
	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**
Waste incinerated (kt)	14.1	43.1	38.4	82.3	84.4	76.7	76.3	79.2	80.2
Total kt CO_2 Fossil	23.1	70.7	63.0	135.2	138.6	125.8	125.2	130.1	131.7
Total kt CO_2 Bio.	2.6	7.9	7.0	15.0	15.40	14.0	13.91	14.45	14.64
Total CH_4 (kt CH_4)	7.9E-06	2.4E-05	2.2E-05	4.6E-05	4.7E-05	4.3E-05	4.3E-05	4.4E-05	4.5E-05
Total N_2O (kt N_2O)	1.4E-03	4.3E-03	3.8E-03	8.2E-03	8.4E-03	7.7E-03	7.6E-03	7.9E-03	8.0E-03

The suggested default emission factors for hazardous waste incineration were 100 kg of N_2O per kt of incinerated HW and 0.56 kg of methane per kt of incinerated HW. Last year the biogenic emissions of

CO_2 from this category were estimated. The approach is based on the default factor for fossil carbon, assuming that the rest of the carbon in the material is from non-fossil origin.

7.4.1.3 Uncertainties and time-series consistency

Time series has been recalculated since 2005 to ensure consistency with latest available data. Activity data comes from two sources; hence there might be inconsistency due to different data providers. Effort has been made to tackle this inconsistency by choosing year 2005 as a change year to new AD (in 2005 there has been effort to harmonise methodology). However switching to ISOH is more sustainable solution as the system has institutional and legislative backing at MoE and is providing and will likely provide more reliable data about waste incineration in the future.

Tab. 7-13 Uncertainty estimates for 5.C category

Gas	Category	AD uncertainity [%]	EF uncetrainity [%]	Origin of the parameters
CO_2	5.C.1 Waste incineration	15	5	AD Expert judgement M. Havránek; EF IPCC default
N_2O	5.C.1 Waste incineration	20	70	AD Expert judgement M. Havránek; EF IPCC default
CH_4	5.C.1 Waste incineration	20	80	AD Expert judgement M. Havránek; EF IPCC default

7.4.1.4 Source-specific QA/QC and verification

The QA/QC plan of the National inventory system was used for the whole waste category. For this particular subcategory, bottom-up data provided by the official sources (Ministry of Industry and Trade, MIT) and additionally the data from ISOH – information system on waste management run by the MoE/CENIA was used. However, the inaccuracy or uncertainty of this data is not quantified, but it is estimated by expert judgment. The compiler cross-checked the data on incineration with the top-down data, produced by other state agencies.

7.4.1.5 Source-specific recalculations, including changes made in response to the review process

Time period 2005-2013 was recalculated to be fully consistent with data from ISOH category D10 – incineration on land. Data and results prior 2005 were not changed. Result of recalculation is shown in Tab 7-14. This recalculation changed emissions in whole waste category by -1.6%.

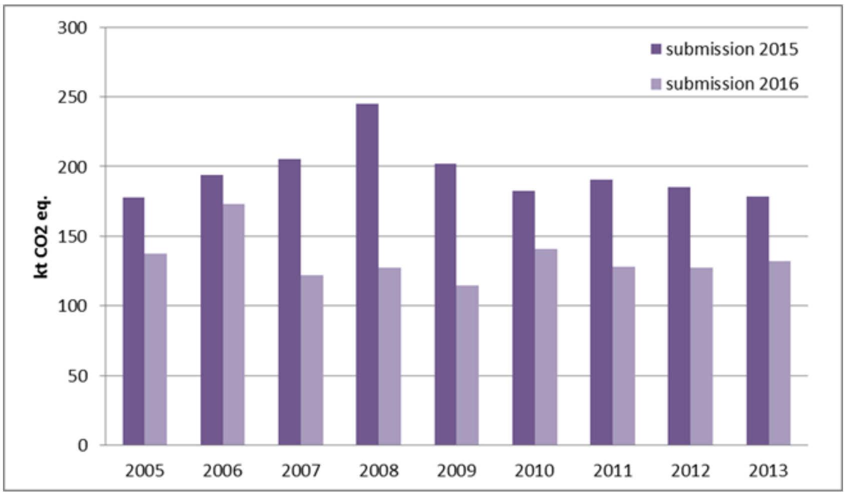


Fig. 7-7 Recalculation of emissions from waste incineration, 2005-2013

Tab. 7-14 Recalculation of 5.C.1, kt of CO_2 eq., 2005-2013

	2005	2006	2007	2008	2009	2010	2011	2012	2013
2016 submission	137.4	173.1	122.3	127.6	114.6	140.9	127.9	127.3	132.2
2015 submission	178.1	193.8	205.1	244.7	202.2	182.6	190.4	185.2	178.5
Difference	-41	-21	-83	-117	-88	-42	-63	-58	-46

7.4.1.6 Source-specific planned improvements, including those in response to the review process

In future submissions, the inventory team considers dividing the reported part of waste, used for energy production and adding it to the Energy sector, as the data on the topic becomes available. The inventory team continuously encourages the state administration to gather data useful for GHG inventories.

7.4.2 Open Burning of Waste (CRF 5.C.2)

Open burning of waste is illegal in the Czech Republic; hence this category does not occur. However, on the basis of suspicion that this category does, in fact, occur, research has currently been begun on fringe phenomena like fires in landfills and fires in general, where a significant amount of material could be openly burned. This is a medium priority improvement.

7.5 Wastewater Treatment and Discharge (CRF 5.D)

This source category consists from two sub categories – emissions from domestic wastewater treatment and emissions from industrial waste water treatment. Overall development of this source category is shown in Figure 7-8.

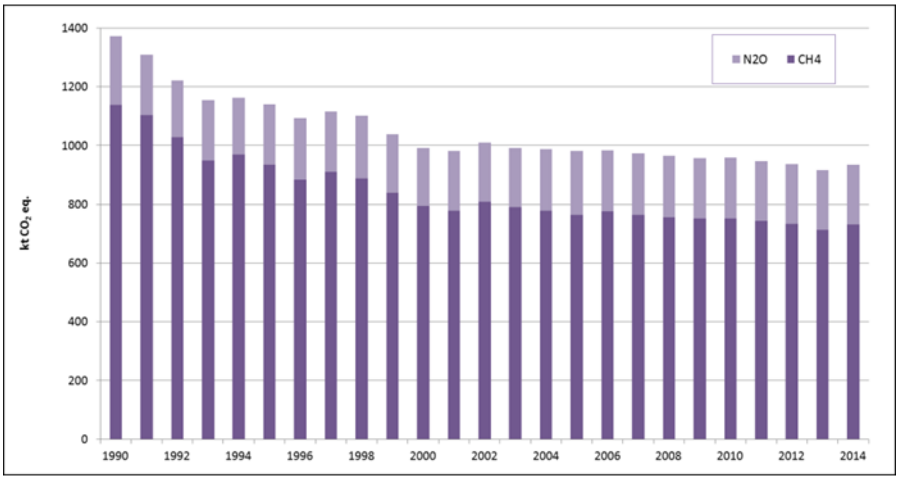


Fig. 7-8 Development of emissions from wastewater treatment and discharge, 1990-2014

7.5.1 Domestic Wastewater Treatment (CRF 5.D.1)

7.5.1.1 Source category description

Treatment of domestic wastewater is in the Czech Republic mostly centralised, more than 82% of population is connected to sewage systems. The rest of the population, mainly rural population in small municipalities, have on-site treatment – septics, sump tanks, latrines or household treatment plants. Wastewater treatment plants treat about 97% of all collected water. There is increased usage of anaerobic technology to produce biogass from sludge.

This category was recalclulated this year to fully reflect complexity and pathways that are used to treat wastewater in the country effectively modifying Tier 1.

7.5.1.2 Methodological issues

The basic factor for determining methane emissions from wastewater handling is the content of organic pollution in the water. The content of organic pollution in municipal wastewater and sludge is given as BOD_5 (the biochemical oxygen demand).

The current IPCC methodology employs BOD for evaluation of municipal wastewater and sludge and COD for industrial wastewater. The new method used is based on default Tier 1 where sludge treatment is not considered, however available data about biogass production from sludge treatment are used to reduce TOW (total organic waste). Outline of TOW flow is in the folowing figure (Fig. 7-9).

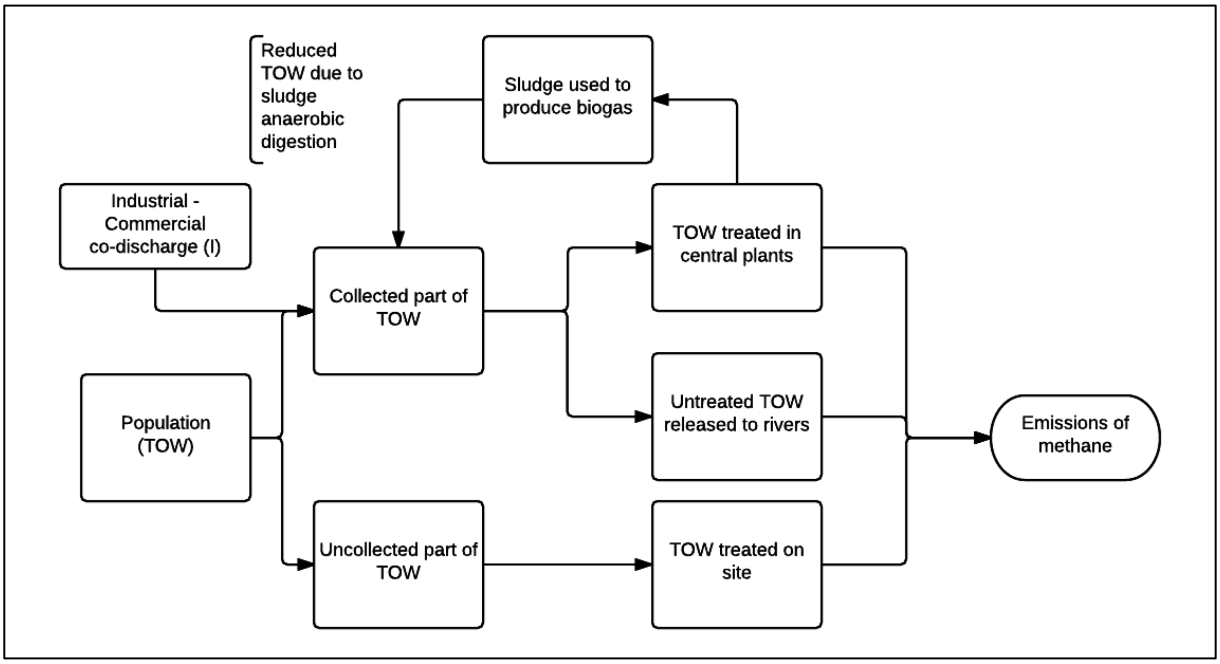


Fig. 7-9 Outline of total organic waste flow

The basic activity data (and their sources) for determining emissions from this subcategory are as follows, tabelar overview of those factors is shown in Tab. 7-15 to Tab. 7-16:

- the number of inhabitants (source: Czech Statistical Office);
- the organic pollution produced per inhabitant (source: IPCC default value);
- the conditions under which the wastewater is treated (source: Czech Statistical Office, with some specific national factors);
- the amount of proteins in the diet of the population (source: FAO).
- The amount of biogas produced from wastewater treatment plants (source: MIT)

The methodological steps are following:

- Estimation of total TOW of the country by using population and default BOD value production
- Split total TOW to two streams, one is TOW collected by cetral wastewater treatment plants, the other is uncollected TOW (mixture of latrines, septic tanks, root treatment plants and household biodisc plants etc.).
- Uncollected TOW is multiplied by implied EF based on IPCC Gl 2006 resulting in methane emissions
- Collected TOW is multiplied by default co-discharge correction factor
- Biogass produced by wastewater treatment plants is converted to TOW required to produce this biogass and is substracted from collected TOW
- Collected TOW is divided in two streams treated TOW and untreated TOW.
- Treated TOW is treated by well managed central treatment plants (default factors) resulting in methane emissions
- Untreated TOW is discharged in to watersheds resulting in methane emissions
- Methane emissions from all three streams are summed up resulting in emissions from this source category.

Tab. 7-15 Activity data used for 5.D.1 category, 1990-2014, Czech Republic

	Total population (thous. pers.)	Sewer connection (%)	Water treated (%)		Total population (thous. pers.)	Sewer connection (%)	Water treated (%)
1990	10 362	72.6	73.0	**2002**	10 201	77.4	92.6
1991	10 308	72.3	69.6	**2003**	10 202	77.7	94.5
1992	10 317	72.7	78.7	**2004**	10 207	77.9	94.9
1993	10 330	72.8	78.9	**2005**	10 234	79.1	94.6
1994	10 336	73.0	82.2	**2006**	10 267	80.0	94.2
1995	10 330	73.2	89.5	**2007**	10 323	80.8	95.8
1996	10 315	73.3	90.3	**2008**	10 486	81.1	95.3
1997	10 303	73.5	90.9	**2009**	10 492	81.3	95.2
1998	10 294	74.4	91.3	**2010**	10 517	81.9	96.2
1999	10 282	74.6	95.0	**2011**	10 496	82.6	96.8
2000	10 272	74.8	94.8	**2012**	10 509	82.5	97.1
2001	10 224	74.9	95.5	**2013**	10 511	82.8	97.4
				2014	10 524	83.9	96.9

Tab. 7-16 Parameters used for 5.D.1 category, 1990-2014

Used parameters							
B_0 kg CH_4/kg BOD	0.6	**Correction factor for industrial co-discharge**	1.25	**NCV of CH_4** (MJ/kg)	50.009	**TOW** gBOD/person/year	60

Tab. 7-17 Methane emissions from 5.D.1 category, 1990-2014

	Uncollected TOW emissions (kt of CH_4)	Untreated TOW emissions (kt of CH_4)	Treated TOW emissions (kt of CH_4)	Biogas reduction (fraction of treated TOW)	Total emissions (kt of CH_4)
MCF	0.3	0.1	0.1		
1990	11.2	2.7	7.2	0.20	21.1
1991	11.3	3.0	6.8	0.20	21.0
1992	11.1	2.2	7.7	0.20	21.0
1993	11.1	2.1	7.8	0.20	21.0
1994	11.0	1.8	8.1	0.20	20.9
1995	10.9	1.0	8.9	0.20	20.9
1996	10.9	1.0	9.0	0.20	20.8
1997	10.8	0.9	9.0	0.20	20.7
1998	10.4	0.9	9.2	0.20	20.5
1999	10.3	0.5	9.6	0.20	20.4
2000	10.2	0.5	9.6	0.20	20.3
2001	10.1	0.5	9.6	0.20	20.2
2002	9.1	0.8	9.6	0.20	19.5
2003	9.0	0.6	9.7	0.21	19.3
2004	8.9	0.6	9.5	0.23	18.9
2005	8.4	0.5	9.5	0.25	18.4
2006	8.1	0.6	9.6	0.24	18.3
2007	7.8	0.4	10.0	0.24	18.3
2008	7.8	0.5	9.9	0.25	18.1
2009	7.7	0.5	10.0	0.25	18.2
2010	7.5	0.4	10.0	0.27	17.9
2011	7.2	0.3	9.9	0.28	17.4
2012	7.2	0.3	9.8	0.29	17.4
2013	7.1	0.3	9.9	0.29	17.3
2014	6.7	0.3	9.9	0.29	16.9

The determination of N_2O emissions from municipal waste-water is part of a broader complex of calculations, concerned particularly with the area of agriculture. Tier 1 calculation is based on the number of inhabitants and estimation of the average annual protein consumption, and correction for co-discharge from industry. Data and used factors for the estimation of this source sub category are shown in Tab. 7-18.

Tab. 7-18 Indirect N_2O [kt] from 5.D.1 and 5.D.2, 1990-2014, Czech Republic

	Proteins g/capita/day	Population (number)	Fnpr kg N/kg protein	Fnon-noc	Find-com	Nefluent kg N/yr	EF kg N_2O/kg N	Emissions kt N_2O
1990	105.77	10363000	0.16	1.25	1.25	100018624	0.005	0.786
1991	92.98	10309000				87465937		0.687
1992	87.37	10318000				82260383		0.646
1993	92.86	10330600				87536080		0.688
1994	88.4	10336200				83376957		0.655
1995	93.15	10330800				87811154		0.690
1996	95.61	10315400				89995804		0.707
1997	93.26	10303600				87683378		0.689
1998	96.83	10294900				90963033		0.715
1999	91.29	10282800				85657909		0.673
2000	90.1	10272500				84456642		0.664
2001	92.68	10203269				86289556		0.679
2002	92.9	10201000				86475152		0.679
2003	92.92	10201651				86499288		0.680
2004	95.94	10206923				89356762		0.702
2005	99.23	10234000				92666183		0.728
2006	95.13	10267000				89123848		0.700
2007	94.95	10322689				89437713		0.703
2008	93.67	10467542				89470137		0.700
2009	92.36	10492000				88425002		0.695
2010	92.49	10517247				88762540		0.697
2011	90.72	10496672				86893550		0.683
2012	90.72*)	10509286				86997971		0.684
2013	90.72	10510719				87009834		0.684
2014	90.72	10524783				87126259		0.685

**)Latest available data used*

The values of factors in the table are default factors. Activity data about population are from the Czech statistical office and the amount of proteins consumed in the Czech Republic is derived from the nutrition statistics of FAO (Faostat, 2015).

7.5.1.3 Uncertainties and time-series consistency

For the whole time series was recalculated and should be more consistent in terms of data sources. The uncertainty of this category is high because the data about organic pollution are based on population only and science behind formation of N_2O is also not robust and varies significantly.

Tab. 7-19 Uncertainty estimates for 5.D.1 category

Gas	Category	AD uncertainity [%]	EF uncertainty [%]	Origin of the parameters
CH_4	5.D.1 Domestic wastewater	21	50	Combined uncertainty of quantification parameters Expert judgement M. Havránek
N_2O	5.D.1 Domestic wastewater	26	50	AD Expert judgement M. Havránek; EF IPCC default

7.5.1.4 Source-specific QA/QC and verification

Quality assurance entails structured checklists of activities that are dated and signed by sector reporter and verified by external control of activity data. Activity data taken for this sector are approved by the data producer and are verified by him before they are used for calculation.

Because waste sector is fairly small we do not use external subject to provide QC instead QC is done by NIS coordinator and its results are communicated to sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms and NIS team has only limited insinghts in to it. Processes to ensure that state agencies produce correct data are in place on all state agencies and ministries.

7.5.1.5 Source-specific recalculations, including changes made in response to the review process

This year whole time series were recalculated to better suit activity data available in the country and to be more in line with default IPCC method. Previous methodological approach was creating increasing discrepancy between assumed biogass production (R) and real measured amount of captured biogass and was creating review questions about sludge management. New methodological approach tackles both problems by including biogas production from sludge as a activity data that is effectively reducing amount of TOW, that is treated in central plants and is therefore closer to reality. Recalculation result is shown in Tab. 7-20 and in Fig. 7-10. This recalculation increased total emissions from waste sector approximatelly by 4.7% in 1990 to 2.5% in 2013.

Tab. 7-20 Recalculation of 5.D.1 category, kt CO_2 eq, 1990-2013

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2016 submission	761	731	717	729	718	727	731	723	724	710	705	707
2015 submission	606	574	562	572	562	572	573	567	574	557	554	549
Difference	156	157	154	157	156	155	157	156	151	153	151	158
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
2016 submission	689	684	683	678	667	666	662	663	655	639	638	635
2015 submission	547	509	515	522	514	515	519	517	517	511	512	512
Difference	142	175	168	156	153	151	143	146	138	128	126	124

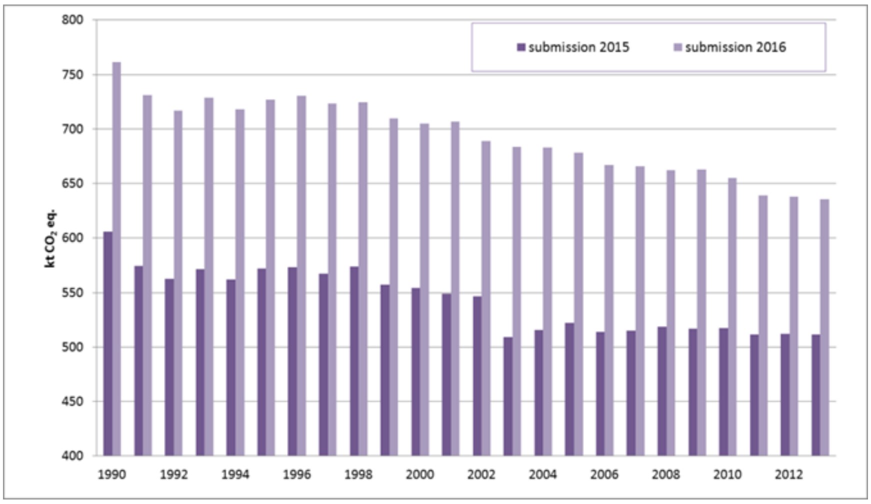


Fig. 7-10 Recalculation of 5.D.1 category, kt CO_2 eq., 1990-2013

7.5.1.6 Source-specific planned improvements, including those in response to the review process

No improvements are planned.

7.5.2 Industrial Wastewater (CRF 5.D.2)

7.5.2.1 Source category description

This source category deals with emissions from treatment of industrial wastewater. Most of the industries in the country have own wastewater treatment, however significant amount of industries are part of municipal sewage systems. This does not create problem as both categories 5.D.1 and 5.D.2 are based on production statistics not on collection systems.

7.5.2.2 Methodological issues

The main activity data for estimation of methane emissions from this subcategory is determination of the amount of degradable pollution in industrial wastewater. In this inventory specific production of pollution - the amount of pollution per production unit - kg COD / kg product is used. Further it is multiplied by the production, or the value obtained from the overall amounts of industrial wastewater and from a qualified estimate of their concentrations (in kg COD/m^3). The procedure used is based on the IPCC 2006 Guidelines . The necessary activity data were taken from the the annual report of CzSO (Statistical Yearbook) and the other parameters required for the calculation were taken from the 2006 Guidelines (IPCC, 2006). On the basis of the information on the total amount of industrial wastewater, which is equal to 149 mil.m^3 (actually only 148 mil.m^3 were treated), the inventory team was able to correct the overestimation of possible wastewater generation of industry (45 mil.m^3), which was assigned an average concentration of 3 kg COD/m^3. In previous years this factor was positive; in 2008, for the first time, this correction factor started to be negative. In addition, it was estimated that the amount of sludge equaled to 10% of the total pollution in industrial water (25% was assumed in the Meat and Poultry, Paper and Pulp and in Vegetables, Fruits and Juices category). These estimates are based on Dohanyos and Zábranská (2000); Zábranská (2004), see Tab. 7-21.

Tab. 7-21 Estimation of COD generated by individual sub-categories 2014

	Production [kt/year]	COD/m³ [kg /m³]	Waste-water/t [m³/t]	Share of sludge [%]	COD of sludge [t]	COD of waste-water [t]
Alcohol Refining	19	11.0	24.00	0.10	512	4604
Dairy Products	1188	2.7	7.00	0.10	2245	20203
Malt & Beer	2758	2.9	6.30	0.10	5038	45345
Meat & Poultry	325	4.1	13.00	0.25	4335	13004
Organic Chemicals	153	3.0	67.00	0.10	3075	27678
Pet. ref./Petrochemicals[9]	0	1.0	0.60	0.10	0	0
Plastics and Resins	1248	3.7	0.60	0.10	277	2494
Pulp & Paper	882	9.0	162.00	0.25	321460	964380
Soap and Detergents	21	0.9	3.00	0.10	5	48
Starch production	81	10.0	9.00	0.10	733	6598
Sugar Refining	559	3.2	9.00	0.10	1610	14489
Textiles(natural)	36	0.9	172.00	0.10	557	5017
Vegetable Oils	123	0.9	3.10	0.10	32	292
Vegetables, Fruits & Juices	121	5.0	20.00	0.25	3037	9111
Wine & Vinegar	63	1.5	23.00	0.10	218	1966
Unidentified waste-water	-57541	3.0	1.00	0.10	-17262	-155361
Total					325873	959868

Tab. 7-22 Parameters for CH_4 emissions calculation from industrial waste-water 1990-2014

	MCF	1990	1993	1996	1999	2002	2005	2009	2010	2011	2013	2014
Non-treated	0.05	29%	18%	13%	5%	7%	3%	2%	1%	1%	1%	1%
Aerobic treatment of water	0.06	67%	73%	70%	70%	65%	68%	69%	70%	69%	69%	69%
Anaerobic treatment of water	0.70	4%	8%	17%	25%	28%	29%	30%	29%	30%	30%	30%
Aerobic treatment of sludge	0.10	40%	40%	40%	40%	30%	27%	27%	27%	27%	27%	27%
Anaerobic treatment of sludge	0.30	60%	60%	60%	60%	70%	73%	73%	73%	73%	73%	73%

In accordance with the 2006 Guidelines (IPCC, 2006), the maximum theoretical methane production B0 was considered to be equaled to 0.25 kg CH_4/kg COD. This value is in accordance with the national factors, presented in Dohanyos and Zábranská (2000).

The calculation of the emission factor for wastewater is based on a qualified estimate of the ratio of the use of individual technologies, during the entire recalculated time series. In the future, this ratio will shift towards anaerobic treatment of wastewater and sludge, because of the energy advantages of this means of treating wastewater. Tab. 7-22 describes this trend. The conversion factor for anaerobic and aerobic treatment are 0.06 and 0.7 respectively.

In contrast to the quite stable ratio for wastewater treatment technologies, the ratio for sludge keeps shifting in favor of anaerobic treatment. This is mostly due to its economic efficiency. Calculation of the emission factor for sludge was based on the assumption that 27% is treated anaerobically with a conversion factor of 0.3 and the remaining 73% by other, especially aerobic methods, with a conversion factor of 0.1. Similarly as in 5.D.2, it is assumed that all the methane from anaerobic processes is burned (mostly usefully in cogeneration units, as flaring is being phased out and cogeneration technology seems to be economically effective); however, in contrast to municipal water, methane from anaerobic sludge

[9] *Due to changes in the statistical data, we are no longer able to identify Pet. ref./Petrochemicals*

and wastewater is included. This assumption is based on national standards and regulations presented in the subchapter below (Zábranská, 2004). For calculation of methane emissions, it is sufficient to consider only aerobic processes (where the methane is not oxidized to biogenic CO_2). Experts at the University of Chemical Technology recommended the conversion factors and other parameters given in this part, see Dohanyos and Zábranská, 2000; Zábranská, 2004. Emissions from the whole timeseries are shown in Tab. 7-23.

Tab. 7-23 Emissions of CH_4 (kt) from 5.D.2, 1990-2014, Czech Republic

	1990	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
CH_4 production	49.8	63.5	66.4	77.4	75.4	77.4	76.9	80.6	80.9	78.0	76.0	79.8	79.3	77.8	78.0	79.8
Oxidized CH_4	25.3	50.3	55.5	64.5	63.0	65.0	64.7	67.9	68.1	65.9	64.2	67.5	67.0	65.9	66.0	67.5
Total CH_4 emissions	24.5	11.5	10.9	12.9	12.3	12.2	12.1	12.7	12.3	12.1	11.8	12.2	12.2	11.9	11.3	12.3

7.5.2.3 Uncertainties and time-series consistency

This particular category is methodologically consistent and is quantified each year, using the same method. The data sources for methane activity data are the same and therefore an assumption for the consistency of the activity data was made. Very few country-specific factors are used (mainly the fraction of each treatment technology in the country) and most of the activity data are based on the statistics of the Czech Statistical Office.

The uncertainty in most of the factors (default IPCC values) is determined according to the 2006 Guidelines. The overall uncertainty of the source category is not fully quantified yet and it is anticipated that a software tool will be implemented for this purpose in the following years.

However IPCC expert team reviewed waste sector and suktested and developed new uncertainty ranges.

Tab. 7-24 Uncertainty estimates for 5.D.2 category

Gas	Category	AD uncertainity [%]	EF uncetrainity [%]	Origin of the parameters
CH_4	5.D.2 Industrial wastewater	40	50	Combined uncertainty of quantification parameters + IPCC Default values, Expert judgement M. Havránek

7.5.2.4 Source-specific QA/QC and verification

Quality assurance entails structured checklists of activities that are dated and signed by sector reporter and verified by external control of activity data. Activity data taken for this sector are approved by the data producer and are verified by him before they are used for calculation.

Because waste sector is fairly small we do not use external subject to provide QC instead QC is done by NIS coordinator and its results are communicated to sectoral expert.

Activity data from national agencies and ministries are the subjects of internal QA/QC mechanisms but NIS team has limited insight into it.

7.5.2.5 Source-specific recalculations, including changes made in response to the review process

Year 2000 and 2013 were as recalculated, due to obtaining of new activity data. This recalculation decreased the emissions for the two years with 13.5% and 5.8% respectively.

7.5.2.6 Source-specific planned improvements, including those in response to the review process

A recalculation of the industry wastewater source category is planned for the next year. In this report the inventory team have focused on 5.D.1 category and plans to recalculate 5.D.2 in similar way. The reason is that due to extensive use of biogas, the Ministry of Industry and Trade started to gather data about water treatment and gas production. In the light of this data, a review of this category and recalculation it according to the new findings will be performed in future submissions.

7.6 Other (CRF 5.E)

This category is not relevant for the Czech Republic.

7.7 Long-term storage of carbon (CRF 5.F)

The long-term stored carbon in SWDS is reported as an information item in the Waste sector. Fossil and non-degradable biogenic carbon disposed in to SWDS remains stored underground and does not contribute to anthropogenic climate change. The amount of carbon stored in the SWDS is estimated by using the FOD model described in 5.A.1 using the same data described there. The year 2013 was recalculated due to changes of activity data (for details see 5.A.1). Results are shown in Tab 7-25.

Tab. 7-25 Long-term stored carbon, 1990-2014, Czech Republic

	Long-term stored carbon (kt)	Accumulated Long-term stored carbon (since 1950) (kt)
1990	209	4 243
1991	210	4 453
1992	218	4 672
1993	224	4 895
1994	225	5 120
1995	230	5 351
1996	240	5 591
1997	249	5 839
1998	259	6 098
1999	247	6 345
2000	268	6 613
2001	276	6 889
2002	283	7 172
2003	285	7 457
2004	288	7 745
2005	293	8 038
2006	302	8 340
2007	321	8 660
2008	322	8 983
2009	330	9 313
2010	309	9 621
2011	289	9 910
2012	270	10 180
2013	261	10 441
2014	248	10 689

8 Other (CRF sector 6)

No sector 6 is defined in the Czech inventory.

9 Indirect CO_2 and nitrous oxide emissions

9.1 Description of sources of indirect emissions in GHG inventory

The estimation of indirect CO_2 and N_2O emissions is based on the official Czech inventories for the precursor gases (CO, NMVOC, NH_3 and NO_x) reported under the United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) and the CH_4 emissions reported to the UNFCCC.

A detailed description of the methodology used to estimate these emissions should be available in the Czech Informative Report (IIR), Submission under the UNECE / CLRTAP Convention. The precursor gases totals correspond under the two submissions, where the differences between the reporting formats (NFR-CRF) are taken into account.

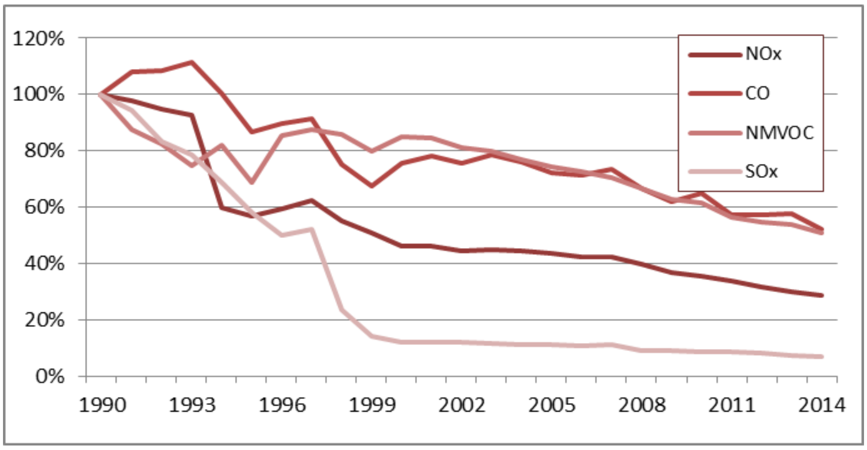
In this chapter, indirect emissions and precursor gases are estimated for all the sectors, except Agriculture and LULUCF, i.e. the Energy, IPPU and Waste sectors. The estimates are not included in the national totals, but reported as memo items.

Tab. 9-1 presents a summary of emission estimates for precursors and SO_x for the period from 1990 to 2014 and the National Emission Ceiling (NEC) as set out in the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone. These reduction targets should be met by 2010 by Parties to the UNECE / CLRTAP Convention who signed this Protocol.

Emissions of precursor gases decreased in the period from 1990 to 2014, for NMVOC by 49.38%, for CO by 47.78% and for NO_X by 71.35%. SO_x (reported as SO_2) emissions decreased by 93.21% compared to 1990 level. NH_3 decreased by 1.21% in 2014 compared to the year 2000 (currently last available data).

Tab. 9-1 Indirect emissions and their trends from 1990 – 2014

	NO_x [kt]	NO_x (w/o LULUCF) [kt]	CO [kt]	CO (w/o LULUCF) [kt]	NMVOC [kt]	SO_x [kt]	NH_3 [kt]
1990	738.52	737.35	1068.64	1027.58	300.70	1870.91	NE
1991	723.47	722.60	1153.04	1122.44	272.97	1767.49	NE
1992	699.43	698.52	1158.25	1126.19	257.47	1554.42	NE
1993	684.06	683.01	1189.87	1152.84	233.04	1466.04	NE
1994	441.29	440.20	1070.90	1032.73	255.31	1284.80	NE
1995	418.85	417.83	927.52	891.66	215.35	1090.23	NE
1996	437.65	436.31	960.26	913.23	265.16	931.11	NE
1997	461.65	460.21	976.05	925.43	271.86	977.45	NE
1998	408.21	406.95	802.10	757.73	267.15	438.27	NE
1999	375.14	373.98	720.96	679.86	247.17	264.35	NE
2000	339.09	338.02	808.26	770.53	255.39	224.54	4.40
2001	339.67	338.56	834.32	795.04	254.72	223.85	4.43
2002	329.32	328.12	807.50	765.23	243.57	219.98	4.57
2003	329.89	328.39	840.59	787.77	240.24	215.59	4.86
2004	327.61	326.23	814.81	766.36	230.68	211.54	4.79
2005	320.54	319.23	773.11	726.87	223.34	208.26	4.91
2006	313.44	311.81	761.32	704.05	218.30	203.29	4.99
2007	311.59	309.48	784.64	710.17	212.14	208.78	5.09
2008	294.00	292.33	711.35	652.50	200.04	168.71	5.14
2009	272.20	270.78	660.23	610.54	189.23	165.87	5.06
2010	262.03	260.55	692.74	640.29	185.43	160.39	4.85
2011	248.02	247.36	610.95	587.77	169.23	160.53	4.83
2012	234.62	233.92	611.93	587.07	163.99	154.82	4.71
2013	222.35	221.69	617.45	594.38	161.60	138.03	4.53
2014	211.59	210.86	558.05	532.40	152.21	127.08	4.46
Trend	**-71.35%**	**-71.40%**	**-47.78%**	**-48.19%**	**-49.38%**	**-93.21%**	**1.21%**
NEC	**286**		**-**		**220**	**265**	**101**



On Fig. 9-1 can be observed the overall decreasing trend, in percentage of indirect GHG emissions, where year 1990 is equal to 100%. Overall trend in percentual share of total indirect GHG can be examined on Fig. 9-2.

Fig. 9-1 Indexed emissions of indirect GHG for 1990-2014 (1990 = 100%), [%]

The categories with highest amounts of indirect GHG for NO_X are 1.A.1 Energy Industries, 1.A.3 Transport and 1.A.4 Other sectors; for CO are 1.A.2 Manufacturing industries and construction, 1.A.3 Transport, 1.A.4 Other sectors; for NMVOC are 1.A.3 Transport, 1.A.4 Other sectors and 2.D Non-energy products from fuels and solvent use; for SO_X are 1.A.1 Energy industries, 1.A.2 Manufacturing industries and construction and 1.A.4 Other sectors. Total production from the main CRF categories can be seen on Tab. 9-2.

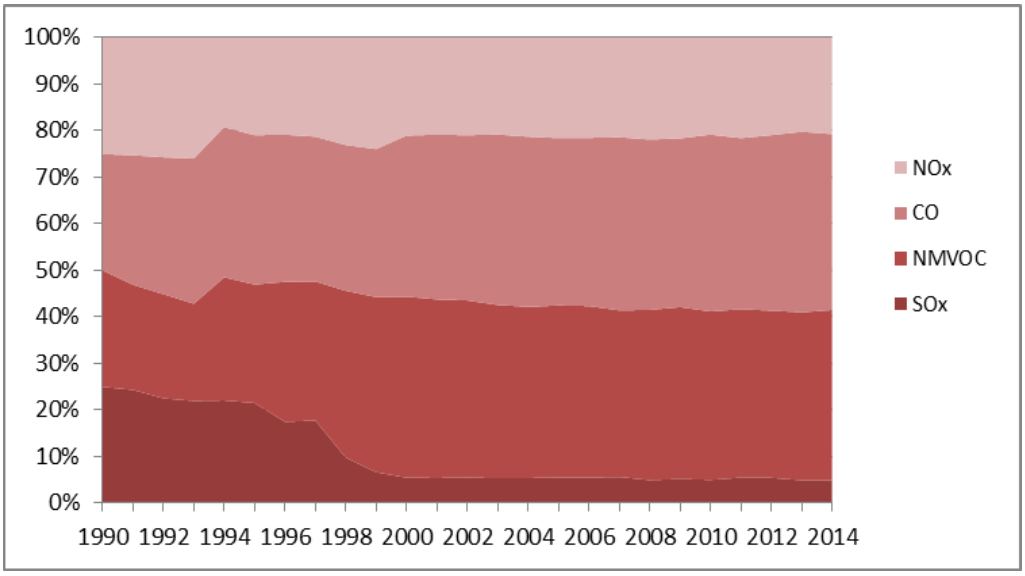


Fig. 9-2 Overall trend in percentual share of indirect GHG

Tab. 9-2 Indirect GHG emissions in sectors of origin for 2014

	NO_x [kt]	CO [kt]	NMVOC [kt]	SO_x [kt]	NH_3 [kt]
Total emissions	**211.59**	**558.05**	**152.21**	**127.08**	**4.46**
1. Energy	208.41	517.61	77.39	125.38	4.34
1.A Fuel combustion	208.18	517.39	68.72	123.16	4.32
1.A.1 Energy Industries	58.44	9.54	5.29	84.87	0.00
1.A.2 Manufacturing industries and construction	24.04	112.12	1.79	20.32	0.16
1.A.3 Transport	79.70	138.15	33.81	0.25	4.15
1.A.4 Other sectors	45.99	257.58	27.83	17.72	0.01
1.A.5 Other	IE	IE	IE	IE	IE
1.B Fugitive emissions from fuels	0.23	0.22	8.67	2.22	0.02
2. Industrial processes and product use	2.32	14.77	73.17	1.69	0.12
2.A Mineral industry	0.00	0.00	0.06	0.07	0.03
2.B Chemical industry	1.01	0.16	1.33	1.12	0.07
2.C Metal industry	1.25	14.50	0.35	0.50	0.00
2.D Non-energy products from fuels and solvent use	0.00	0.00	71.28	NA	NO
2.G Other product manufacture and use	0.06	0.10	0.15	0.01	0.02
3. Agriculture	-	-	-	-	-
4. LULUCF	0.73	25.66	-	-	-
5.Waste	0.13	0.02	1.65	0.01	NO

9.2 Production of indirect emissions from precursor gases

9.2.1 Indirect N_2O emissions from nitrogen oxides

Emissions of NO_X are formed during the combustion of fuels, depending on the temperature of combustion, the content of nitrogen in fuels and the excess of combustion air. NO_X emissions decreased from 739 to 212 kt during the period 1990 - 2014. In 2014, NO_X emissions were 71.35% below the 1990 level. Slightly more than 98% of total NO_X emissions originate from 1. Energy, mainly subsectors 1.A.1 Energy industries (27.7%), with subsector 1.A.1a Public electricity and heat production (26.1%); 1.A.3 Transport (37.8%), highest part, represented by 1.A.3.b Road transportation (36.1%) and 1.A.4 Other sectors (21.8%), mainly from 1.A.4.c Agriculture/Forestry/Fishing (15.9%) (Fig. 9-3). Hence the indirect N_2O emissions correspondingly decreased from 3.53 to 1.01 kt in 2014.

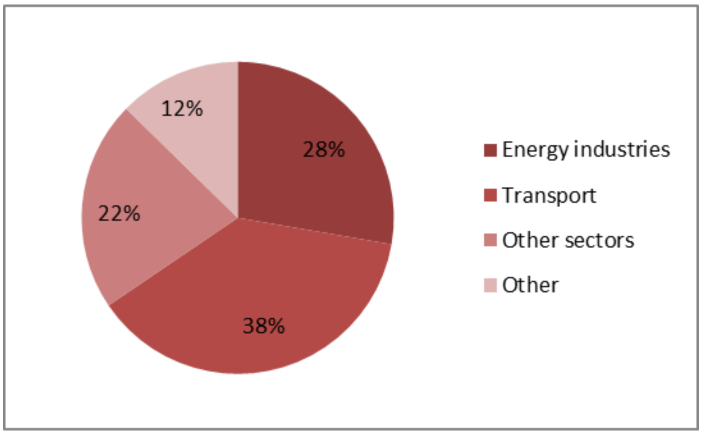


Fig. 9-3 The share of sectors on NO_x emissions in 2014

9.2.2 Indirect N_2O from ammonia

Emissions of anthropogenic NH_3 for 2014 are mainly produced from categories: 1.A.3 Transport (93.1%), where 99.97% from the total production comes from 1.A.3.b Road transport and 1.A.2 Manufacturing industries and construction (3.62%) (Fig. 9-4). In 2014, emissions of NH_3 were 4.47 kt. The declining trend of the emissions is calculated based on the last available data. A research is undertaken for the investigation of the whole time series.

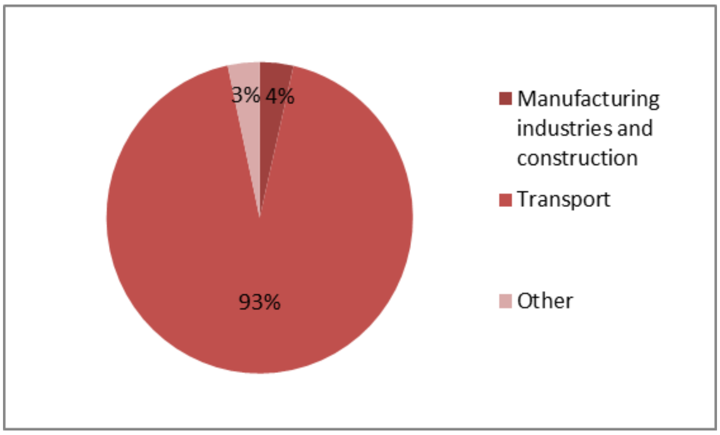


Fig. 9-4 The share of sectors on NH_3 emissions in 2014

Total indirect N_2O emissions from NH_3 for 2014 are 0.06 kt.

9.2.3 Indirect CO_2 from carbon monoxide

Emissions of CO are produced during the combustion of carbon-containing fuels at low temperatures and by insufficient amount of combustion air. CO emissions decreased from 1,068 to 558 kt during the period 1990 - 2014. In 2014, CO emissions were 47.78% below the 1990 level. In 2014, approximately 97% of total CO emissions originated from 1. Energy, subsectors 1.A.2 Manufacturing industries and construction (21.1%); 1.A.3 Transport (25.9%), mostly resulting from 1.A.3.b Road transportation (25.6%) and 1.A.4 Other sectors (48.4%), mainly from 1.A.4.b Stationary: Residential stationary combustion (44.3%) (Fig. 9-5). Further subsector 2.C Metal industry contributes with 2.7% to the total emissions.

Total indirect CO_2 emissions from CO in 2014 are 837 kt, which is 48.2% less than 1990.

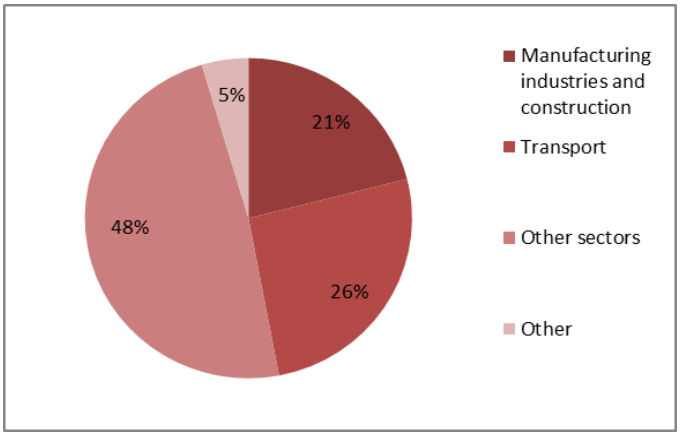


Fig. 9-5 The share of sectors on CO emissions in 2014

9.2.4 Indirect CO_2 from non-methane volatile organic compounds

NMVOC emissions decreased from 301 to 152 kt during the period between 1990 and 2014. In 2014, NMVOC emissions were 49.38% below the 1990 level. There are two main emission source categories: firstly 2. Industrial processes and product use (48.1% of the national total, with main subsector 2.D Non-energy products from fuels and solvent use, representing 46.8%) and secondly 1. Energy (50.8% - mainly subsectors 1.A.3 Transport (22.2%) and 1.A.4 Other sectors (18.3%) (Fig. 9-6). The release of NMVOC emissions is partly regulated, but most of these pollutants are released in the form of fugitive emissions and their reduction is difficult. NMVOC emissions are also produced by insufficient combustion of fossil fuels.

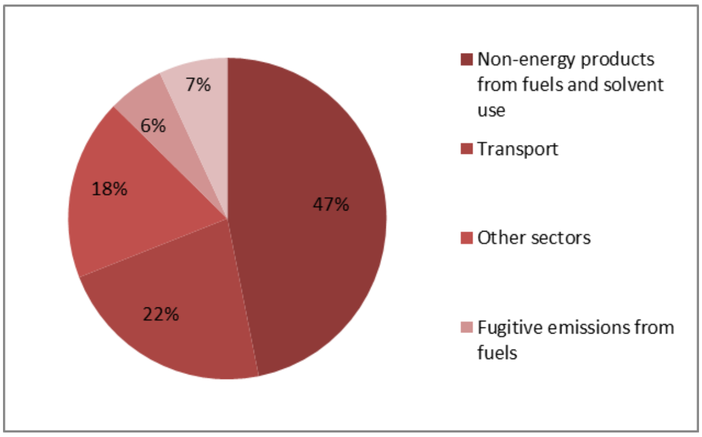


Fig. 9-6 The share of sectors on NMVOC emissions in 2014

9.2.5 Indirect CO_2 from methane

CH_4 emissions, used for the calculation of indirect emissions are mainly produced from categories 1.B.1 Solid fuels and 5.A Solid waste disposal. For more information on CH_4 emissions, consult respective chapters.

Total indirect CO_2 emissions from CH_4 produced in 2014 are 1,063 kt, which is 32.2% less than in 1990.

9.3 Production of indirect CO_2 and N_2O emissions from source categories

Estimations of indirect CO_2 and N_2O for the whole time series for each sector can be observed on Tab. 9-3.

Tab. 9-3 Time series and trend of indirect emissions per sector and total

	Energy		IPPU		Waste		Total	
	CO_2 [kt]	N_2O [kt]	CO_2 [kt]	N_2O [kt]	CO_2 [kt]	N_2O [kt]	CO_2 [kt]	N_2O [kt]
1990	2827.26	3.46	747.20	0.07	342.93	0.004	3917.38	3.53
1991	2718.01	3.38	775.37	0.07	349.05	0.003	3842.42	3.46
1992	2594.56	3.26	804.31	0.08	349.52	0.003	3748.38	3.34
1993	2590.78	3.19	775.96	0.08	350.39	0.003	3717.13	3.27
1994	2542.91	2.04	640.79	0.06	362.11	0.003	3545.80	2.11
1995	2187.46	1.95	665.61	0.05	367.27	0.003	3220.33	2.00
1996	2324.74	2.03	658.97	0.05	364.23	0.003	3347.94	2.09
1997	2333.76	2.15	657.71	0.05	374.79	0.003	3366.26	2.20
1998	2138.92	1.90	537.84	0.04	379.97	0.003	3056.74	1.95
1999	1960.81	1.74	475.65	0.04	382.30	0.003	2818.76	1.79
2000	2232.03	4.83	287.76	0.40	385.47	0.015	2905.26	5.24
2001	2230.28	4.95	285.00	0.31	390.73	0.008	2906.01	5.27
2002	2115.24	5.03	278.29	0.29	400.79	0.015	2794.31	5.34
2003	2145.91	5.30	272.27	0.26	406.97	0.016	2825.15	5.57
2004	2075.48	5.31	264.29	0.19	400.95	0.012	2740.72	5.51
2005	2016.14	5.31	291.28	0.25	406.61	0.015	2714.03	5.57
2006	2007.65	5.36	280.68	0.23	411.22	0.016	2699.54	5.60
2007	1951.27	5.47	281.29	0.17	408.63	0.033	2641.20	5.67
2008	1849.34	5.38	262.04	0.21	426.14	0.030	2537.52	5.63
2009	1743.31	5.27	236.67	0.16	438.80	0.028	2418.78	5.46
2010	1794.93	5.13	235.80	0.12	458.34	0.002	2489.08	5.24
2011	1681.70	5.00	263.27	0.16	467.08	0.001	2412.05	5.16
2012	1668.48	4.84	256.52	0.16	485.46	0.002	2410.46	5.00
2013	1578.92	4.67	256.52	0.11	511.52	0.001	2346.95	4.79
2014	1469.52	4.57	246.35	0.11	518.42	0.001	2233.05	4.68
Trend	**-48.0%**	**32.3%**	**-67.0%**	**52.9%**	**51.2%**	**-83.1%**	**-43.0%**	**32.6%**

The indirect production of CO_2 from waste has an upwards trend, which can be explained by the increased CH_4 production from this sector. The trend of total indirect emissions of N_2O increased due to the increase in the emissions from the Energy sector, which represent 97.7% of the total indirect N_2O emissions.

On Fig. 9-7 is visually presented percentual division of indirect emissions of CO_2 and N_2O between the examined sectors.

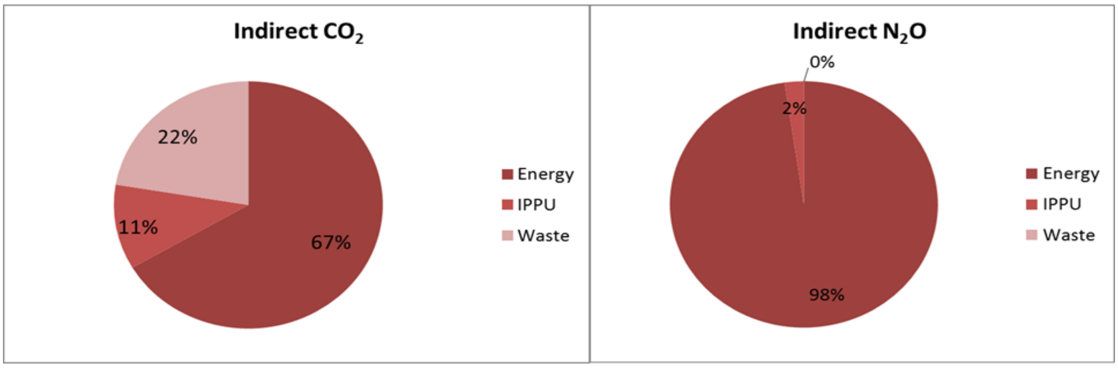


Fig. 9-7 Division of indirect emissions of CO_2 and N_2O between the producing sectors for 2014 (in %)

Energy sector covers 65.8% of the total production of indirect CO_2 and 97.7% of the total production of indirect N_2O. 70.5% of indirect CO_2 are from 1.A Fuel combustion; from which 51.0% are from 1.A.4 Other sector. 99.9% of the N_2O emissions from Energy are from 1.A Fuel combustion; 41.4% from which are from 1.A.3 Transport, followed by 1.A.1 Energy industries (26.6%) and 1.A.4 Other sectors (20.9%).

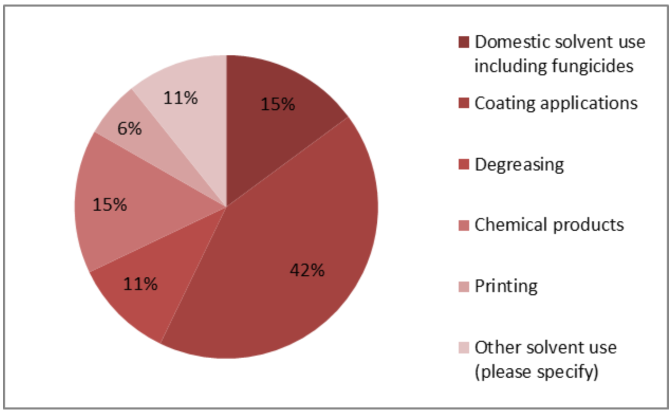


Fig. 9-8 Production of indirect CO_2 from sector 2. D Non-energy products from fuels and solvent use (NFR categories)

For sector IPPU, the main category, producing indirect CO_2 is 2.D Non-energy products from fuels and solvent use, with its NMVOC production, resulting to 63.7% of the total production from this sector. The distribution of the production of indirect CO_2 from sector 2.D is visually presented on Fig. 9-8. The most of the remaining emissions from the sector are attributed to category 2.C Metal industry (32.46%).

Indirect N_2O emissions from IPPU are almost equaly divided between two categories: 2.B Chemical industry (45.6%) and 2.C Metal industry (47.5%). The total share of IPPU sector from the total production of indirect CO_2 is 11.1% and concerning indirect N_2O is 2.3%.

Sector Waste represents 23.2% from the total indirect CO_2 emissions and 0.01% from total N_2O emissions. 71.4% from the Waste production of indirect CO_2 emissions are emitted from category 5.A Solid waste disposal and 94.4% from the indirect production of N_2O are produced from category 5.C Incineration and open burning of waste.

9.4 Methodological issues

The above reported data are obtained from the Czech Informative Report (IIR), Submission under UNECE/CLRTAP Convention. The inventory is performed every year, in accordance with the national legislation for the prevention of air polluting and reduction of air pollution from 2012. The inventory combines the direct approach, i.e. the collection of data reported by the sources operators with the data from model calculations based on data, reported by the sources operators or gained within statistical surveys, carried out primarily by CzSO. The results of emission inventories are presented as emission balances processed according to various territorial and sector structures. Further, after obtaining the data, synchronization between the two reporting systems categorization (NFR-CRF) is conducted.

9.4.1 Indirect CO_2 emissions

Indirect emissions of CO_2 were calculated using the default IPCC Tier 1 method. The following equations were used for calculating the indirect emissions, respectively from CO, CH_4 and NMVOC.

$$Emissions_{CO2} = Emissions_{\ CO} \cdot \frac{44}{28}$$

$$Emissions_{CO2} = Emissions_{\ CH4} \cdot \frac{44}{16}$$

$$Emissions_{CO2} = Emissions_{NMVOC} \cdot Percent\ carbon\ in\ NMVOC\ by\ mass \cdot \frac{44}{12}$$

where percent carbon in NMVOC used for sectors Energy, IPPU (except category 2.D) and Waste is the default 60% given in IPCC 2006 Gl.

The indirect emissions from NMVOC for category 2.D Non-energy products from fuels and solvent use were estimated on the basis of the assumption that, for 1990-2014, the average percent carbon content is 80% by mass based on the 2006 IPCC Guidelines. This factor was used for the subcategories:

- Asphalt roofing
- Road paving

For the other subcategories of 2.D, it was assumed for the whole time period that the average carbon content is 60% by mass according to the 2006 IPCC Guidelines and this was used for the following NFR categories:

- Domestic solvent use including fungicides
- Coating applications
- Degreasing
- Dry cleaning
- Chemical products
- Printing
- Other solvent use.

9.4.2 Indirect N_2O emissions

The indirect N_2O emissions from atmospheric deposition of nitrogen other than agriculture and LULUCF sources are estimated based on the amount of nitrogen emitted in the country multiplied with an emission factor, assuming 1% (default) of the nitrogen in the emissions to be converted to N_2O. The calculation method is the IPCC default Tier 1. Indirect N_2O emissions were calculated using equation 7.1 (IPCC 2006, Vol. 1, Section 7.3.1.).

9.5 Uncertainties and time-series consistency

In the process of calculation of emission inventories, data provided by the operators of stationary sources of air pollution, statistic data of the Czech Statistical Office (data on fuel consumption, number of vehicles, number of livestock and area of cultivated land) and data from the Population and housing census which was conducted in 2011 (information on household heating) are used. Further, emission factors and other sources of data are applied.

The data, from which the inventory has been compiled, are of varying quality. Emissions of individual point sources set on the basis of measurements are determined with less uncertainty than the emissions calculated on the basis of statistical data. The uncertainty of the emissions from point sources is below 5% (e.g. emissions from large combustion sources), the uncertainty of emission data based on a sophisticated model (e.g. emissions from household heating and exhaust emissions from transport) ranges between 10–15%. The uncertainty of emissions calculated from statistical data and predefined emission factors is estimated according to the methodology of the EMEP/EEA air pollutant emission inventory guidebook and ranged from 50 up to 200% (e.g. emissions from the use of solvents, animal production and non-combustion emissions from transport).

9.6 Source-specific QA/QC and verification

The emission estimates are based on the activity data taken from the *Czech Informative Report (IIR), Submission under UNECE / CLRTAP Convention* and follow the recommendations and QA/QC procedures of IPCC 2006 Guidelines (IPCC 2006). Source specific QA/QC is conducted in line with the QA/QC plan (Tier 1) of the National Inventory System.

9.7 Source-specific recalculations, including changes made in response to the review process and impact on emission trend

The time series of indirect CO_2 and N_2O emissions were recalculated for the whole 1990-2014 time period in order to obtain more reliable data. Comparison of the total indirect emissions in CO_2 eq. reported in previous and current submissions can be seen in Fig. 9-9.

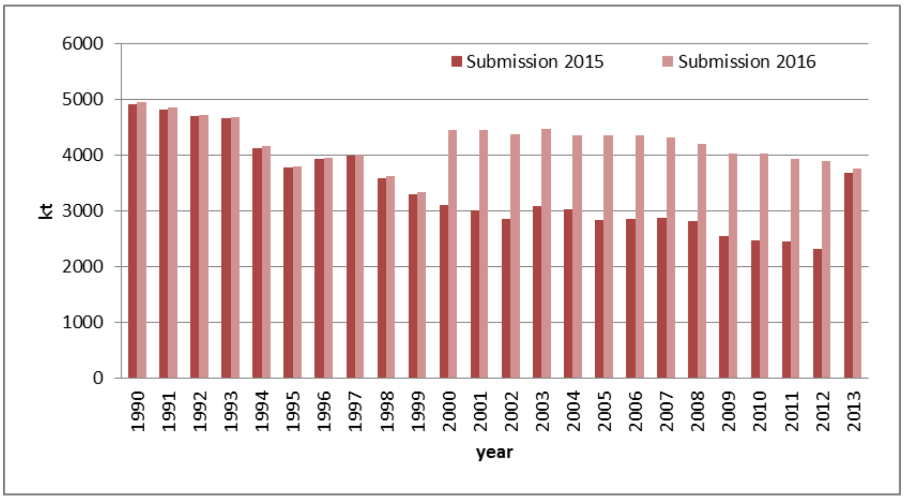


Fig. 9-9 Comparison of total indirect emissions in CO_2 eq. between previous and current submissions

Significant difference is observed from year 2000 on, due to newly included data for NH_3 emissions. In the previous submission only data for NH_3 emissions for year 2013 were available.

9.8 Source-specific planned improvements, including in response to the review process

Planned improvements for future submissions include: further investigation of NH_3 emissions for the time period between 1990 and 2000, and detailed examination of the indirect emissions produced in the individual categories.

10 Recalculations and improvements

The driving forces in applying recalculations in the Czech greenhouse gas inventory are provided by the implementation of the guidance given in the IPCC 2006 Guidelines (IPCC, 2006) and the recommendations from the UNFCCC inventory reviews. Recalculations of previously submitted inventory data are performed following the above-mentioned IPCC manuals only to improve the GHG inventory.

The driving forces in applying recalculations in the Czech greenhouse gas inventory are provided by the implementation of the guidance given in the IPCC *Good Practice Guidance* reports (IPCC, 2000; IPCC, 2003) and the recommendations from the UNFCCC inventory reviews.

Even though a QA/QC system helps to eliminate potential error sources, it is sometimes necessary to make some revisions (called recalculations) under the following circumstances:

- An emission source was not considered in the previous inventory.
- A source/data supplier has delivered new data. This could be because the previous data were only preliminary data (by estimation, extrapolation) or because the method of data collection has been improved.
- Some errors in data transfer or processing have been identified: wrong data, unit-conversion, software errors, etc.
- Methodological changes - when a new methodology must be applied to fulfil the reporting obligations for one of the following reasons:
    - to decrease uncertainties,
    - an emission source becomes a key source,
    - consistent input data needed for applying the methodology is no longer accessible,
    - input data for more detailed methodology is now available,
    - the methodology is no longer appropriate.

10.1 Explanations and justifications for recalculations, including in response to the review process

10.1.1 Recalculations performed in the submission 2011

10.1.1.1 Recalculation in sector 1 Energy

Recalculation of Road Transportation (1.A.3.b)

Recalculation of emissions from road transport was performed for all the greenhouse gases (CO_2, CH_4, N_2O) and for the 1990 - 1999 interval. For the sake of consistency of the time series, the recalculation was carried out according to the methodology used for the following years. Recalculation was based on obtaining new data on the vehicle fleet composition and emission characteristics. In addition, notation symbols “NE” for N_2O emissions from biomass, CNG and LPG from 1.A.3.b (Road Transport) were substituted by emission estimates of N_2O using relevant default EFs taken from the 2006 Guidelines (IPCC, 2006).

Recalculation in sector 1B Fugitive Emissions from Fuels (1.B.2.a)

During the centralised review in September 2010, the Expert review team (ERT) identified a potential problem in the incomplete reporting of category 1.B.2.a-ii (oil production). In this subcategory, the Czech Republic reported only CH_4 emissions from oil production, while CO_2 emissions and emissions of CO_2, CH_4 and N_2O from venting and flaring were not reported. Therefore, the Czech Republic prepared the resubmission of CRF (within 6 weeks) in order to respect this ERT finding. In this resubmission, the reporting of emissions from oil production was extended beginning in 1990 by incorporating CO_2 emissions from oil production and emissions of CO_2, CH_4 and N_2O from venting and flaring during oil production. Default EFs from the IPCC Good Practice Guidance (table 2.16, pages 2.86-2.87) were used.

10.1.1.2 Recalculation in sector 2 Industrial Processes

Recalculation of Soda Ash Use (2.A.4)

During the centralised review in September 2010, the Expert review team (ERT) identified a potential problem in the incomplete reporting of category 2.A.4 (soda ash use). ERT found that some amount of soda ash is used in the pulp and paper industry and it emits the corresponding amount of CO_2, which was not reported. Therefore, in its resubmission of CRF mentioned above, the Czech Republic supplemented this missing source of CO_2 starting in 2001 (the year of beginning of soda ash use). Activity data were taken from EU ETS and from consultations with the operator of the relevant plant. However, emissions of CO_2 from soda ash use in the pulp and paper industry are not very significant in the Czech Republic (less than 1 kt CO_2).

Recalculation of Mineral Products - Other (2.A.7.2)

CO_2 and CH_4 emissions were recalculated in sector 2A7.2 (Mineral products – other: bricks and ceramics) as the Czech Statistical Office has provided new and updated information about brick production for 2006 – 2008. 2.A.7.2 Brick and ceramics is not a significant category for CO_2 emissions (approximately 150 kt CO_2) and CH_4 emissions are even lower. The effect of recalculation of the CO_2 emissions is small and results in a decrease in emissions in 2006 – 2007 by approximately 1% CO_2 and an increase in 2008 by 8%.

Recalculation of Metal Production – Iron and Steel Production (2.C.1)

The recalculation in the period 2003 - 2008 was performed in the case of CO_2 emissions from 2C1 (Iron and steel production). The estimation of these emissions in the Czech Republic is based on the amount of coke consumed in blast furnaces. This amount (directly in TJ) was originally taken from the document provided by the Czech Statistical Office (CzSO) "Development of overall and specific consumption of fuels and energy in relation to product".

Now the other official document of CzSO "CzSO (2010): Energy Questionnaire - IEA/Eurostat (CZECH_COAL, CZECH_OIL, CZECH_GAS, CZECH_REN), Prague 2010" was used as a source of data on metallurgical coke consumed in blast furnaces. This approach, which is more consistent with that used for Energy sector since 2003, was recommended by experts from CzSO because of better accuracy and reliability of coke data. However, differences between both sources of data are not too significant: e.g. for 2003 the recalculated CO_2 emission is 1.2% lower than the original value, for 2008 the recalculated CO_2 emission is 3.8% lower than the original value and for 2009 the newly estimated CO_2 emission is 4.4% higher than would be the value obtained by the older approach.

10.1.1.3 Recalculation in sector 6 "Waste"

Recalculation of Solid Waste Disposal on Land – Managed Waste Disposal in Land (6.A.1) and Waste incineration - Other (6.C.2)

Based on a suggestion of the Expert Review Team (ERT) in the recent "In-country review" (October 2009, Prague), we recalculated whole time series (since 1990) in 6.C (Waste incineration) using a consistent approach and consistent data source for the whole series. Besides, due to rollback changes in the recovered LFG activity data, the two last years were recalculated (2007, 2008) in 6.A.1 category (Managed landfills).

10.1.2 Recalculation performed in the submission 2012

10.1.2.1 Recalculation in sector 1 Energy

Recalculation of 1.A Energy - stationary combustion

Expert review team (ERT) during In country review in August/September 2011 raised recommendation to prolong data series in subcategories 1.A.2.a – 1.A.2.f towards 1990. It was possible to use data given in IEA/OECD, Eurostat, UN Questionnaires (CzSO Questionnaires) till 1995. Previous data in Questionnaires are not sufficiently reliable. The ensure consistency of data used, the recalculation was performed for all categories in whole 1.A except of 1.A.3 – mobile combustion (i.e. 1.A.1, 1.A.2, 1.A.4, 1.A.5, 1.A.D, 1.A.3.e). In 1.A.1, 1.A.4, 1.A.5, 1.A.D and 1.A.3.e was recalculation carried out using data from CzSO Questionnaires since 1995. In 1.A.2 were CzSO Questionnaires data also used since 1995; for 1990-1994 were made expert estimates of data division according to other indicators (e.g. development of relevant branch of industry).

The Reference approach needed to be recalculated as well. It was two reasons for this recalculation – new calorific values for liquid fuels and use of CzSO Questionnaires data since 1995.

Recalculation in sector 1.A Energy – Transport (mobile combustion)

Expert review team (ERT) during In country review in August/September 2011 raised recommendation (ARR 2011, para 69) to analyse the data series in subcategories 1.A.3.a and 1.C.1.a, in particular in the category Jet Kerosene. First, the fuel consumption of Jet Kerosene was divided into domestic and international fuel consumption on the basis of passenger transport and transport of goods in 1990 – 2009. New values of fuel consumption resulted in recalculation of emissions for both of these categories.

Data in other categories of sector 1.A.3 were also recalculated. It was necessary to refine and harmonize some activity data over the entire time series (1990 – 2010) in cooperation with KONEKO and possibly IEA (CzSO Questionnaire). First, the net calorific values of the individual fuels were changed. Most of these values are available from KONEKO. Second, some discrepancies were found in the data for fuel consumption in 1995 – 2010. CDV harmonized the data on fuel consumption with CzSO, which provided these data.

Recalculation in sector 1.B Fugitive Emissions from Fuels (1.B.1 Solid Fuels) - Recalculation of CH_4 emissions from underground mining activities

By FCCC/ARR/2008/CZE was recommended to update CH_4 emission factor for underground mining activities. The team raised a request to Ostrava-Karviná, Ltd. to obtain relevant data. The data were available for 2000 – 2008. According to these data was developed new EF for CH_4. The recalculation was therefore made for 2000 – 2008. For data 2008 onwards is used average EF value from 2000 - 2008 EFs. The range of CH_4 emission decrease due to this recalculation is 23 - 40%.

Recalculation in sector 1.B Fugitive Emissions from Fuels (1.B.1 Solid Fuels) - Recalculation of CO_2 emissions from underground mining activities

ERT during ICR 2011 and FCCC/ARR/2010/CZE raised recommendation to provide estimates for CO_2 emissions from underground and surface mining. We put main focus on CO_2 emissions from underground mining. A special study was performed for CO_2 emission factor. The emission factor was recalculated for 1990 – 2009 and for years onwards was also recommended specific value.

10.1.2.2 Recalculation in sector 2 Industrial Processes

Recalculation of Metal Production – Iron and Steel Production (2.C.1)

In the 2012 submission, the recalculation explained in chapter *10.1.2.2* was extended for the 1995 – 2002 period. With the exception of 1995 and 1998, the differences in CO_2 emissions calculated from the two sources are less the 2%. Similarly as for the 2011 submission, these recalculations also were harmonized with recalculations performed in the Energy sector.

10.1.2.3 Recalculation in sector 4 Agriculture

During the in-country review in August/September 2011, the expert review team (ERT) identified as a potential problem the estimation of N_2O emissions from Manure management for dairy cattle. The revision of background information and Nex values for dairy cattle was requested. Already during the review, the Czech Republic introduced revised country-specific data for emission estimation using Tier 2 methods for Manure management of dairy cattle. This recalculation was submitted to ERT as resolved issue of the “Saturday paper” regarding the 2011 NIR submission.

The assessment review report (UNFCCC/ARR/2011/CZE) provided additional recommendations to improve the inventory estimates for Agriculture. Later other country-specific data for non-dairy cattle was obtained. Based on these recommendations and additional country-specific data, the following improvements were implemented in the 2012 submission:

1) Reallocation of sub-category "Suckling cows" from Dairy cattle to Non-dairy cattle
3) More accurate animal population data (not rounded up to thousands) reported (cattle, swine, sheep, poultry).
4) More accurate data for cattle population reported (not rounded to thousands) for the period since 2006.
5) Recalculation of N_2O emissions from Manure management using revised and complemented country-specific data: Nex values for cattle, manure type distribution (AWMS), protein in milk and protein in feed.
6) Tier 2 methods implemented for the emission estimation of Manure management for non-dairy cattle

Additionally, a new country-specific parameter on digestibility (DE, in%) was determined and implemented in the 2012 submission.

The “Saturday paper” recalculation led to increased emissions by about 14% relative to the older approach. Using the new country-specific data for the 2012 submission resulted in emissions that were lower by 1.3% as compared to 2011 submission. More detailed information about recalculation will be presented in the NIR 2012.

Recalculation in sector 4.A Enteric Fermentation

Reallocation of sub-category "Suckling cows" from Dairy cattle to Non-dairy cattle, use of more accurate numbers of cattle and applying new digestibility values resulted in changed emissions for the entire reporting period.

Recalculation in sector 4.B Manure Management (N_2O)

The estimation of N_2O emissions from Manure management for 1990-2010 was performed using the revised Nex from dairy and non-dairy cattle with the updated parameters (feed consumption, nitrogen feed intake and protein content of milk to estimate the amount of N retained in milk). The equations 10.32 and 10.33 (2006 IPCC) were used to revise Nex from dairy and non-dairy cattle, and to calculate the variables for nitrogen intake and nitrogen retained (milk production and growth). The results served as an input to the eq. 10.31.

The parameters for estimation of the revised Nex from dairy cattle were collected from literature and from personal communication with agricultural experts (protein in milk 3.3%, protein in feed (% in dry matter) 18%).

Country-specific data for the distribution of manure management practices across AWMS was taken from study Hons and Mudrik (2004) for the period 1990-1999 and for the period 2000-2010 was taken updated data from Kvapilík J. (author of Annual report of Czech cattle breeding from Institute of Animal Science Prague).

As mentioned in the “Response by the Czech Republic on Potential Problems and Further Questions from the ERT formulated in the course of the 2011 review of the greenhouse gas inventories of the Czech Republic submitted in 2011” the new country-specific parameters DE (digestibility, in%) for cattle was estimated based on existing publications. The average digestibility for cattle estimated based on available sources corresponds to the DE value around 70%. Dr. Pozdíšek (an agricultural expert from Research Institute for Cattle Breeding, Ltd., pers.com.) determined conservative average values of digestibility for three cattle categories (dairy cows, suckling cows and other cattle), which were applied for the N_2O emission estimation from Manure management.
Using the above changes, the N_2O emissions from Manure management were calculated with Tier 2 method for dairy and non-dairy cattle categories for the entire reporting period.

Recalculation in sector 4.D Agricultural soils (4.D.1.b, 4.D.2 and 4.D.3)

Given that the value of Nex for cattle was revised, it led to the increased N_2O emissions from:

1) animal manure applied to soils (4.D.1.b)
7) pasture, range and paddocks (4.D.2)
8) atmospheric deposition (4.D.3.1)
9) N lost through leaching and run-off (4.D.3.2)

Also these changes apply for the entire reporting period.

10.1.2.4 Recalculation in sector 5 LULUCF

Recalculation of LULUCF – Other (5.G)

New for the LULUCF sector in the Czech NIR 2012 was inclusion of emissions from lime application to Forest Land. Since the CRF Reporter does not allow inclusion of lime application under category 5.A Forest Land, the corresponding emissions are reported under 5.G Other. Information on lime application and the corresponding estimates of emissions are provided for the entire reporting period from 1990 to 2010. The annual emissions from lime application to Forest Land fluctuate irregularly from zero to 20.53 kt CO_2 eq. (in 2000). Hence, the effect of including these quantities in the total emission balance of the LULUCF sector is minimal. On an average, this represents an emission increase by 0.1% annually with the largest relative contribution detected in 2007 (0.43% of the reported emission total for LULUCF).

10.1.2.5 Recalculation in sector 6 Waste

First recalculation was minor changes in activity data in 6.A (amount of waste landfilled). This is regular recalculation since data that are used for previous year submission are most of time preliminary and data provider is always trying to improve data consistency.

Second change was based on continual request for country specific data on waste composition. We obtained and implemented country specific waste composition. This is major change mainly because country specific values increased overall DOC of waste in recent years. Last change is amount of LFG that is recovered for energy purposes. In 2007 started regular data collection of energetically used LFG by Ministry of Industry and Trade. They are trying to obtain consistent numbers and they regularly update their estimates while prolonging time line towards the base year. This change influenced decreased emissions in recent years and increased emissions in the middle of the 1990-2010 period. None of the above-mentioned changes influence emissions beyond 1997.

Recalculation/reallocation of Municipal Solid Waste category to Energy sector

Based on the suggestion of ICR, we moved former category 6.C.2 MSW incineration under 1.A.1.a. This shift is in compliance with the suggestion of the IPCC methodology. In addition to this shift, we quantified emissions of CO_2 from the biogenic part of incinerated MSW, which is now part of memo items. In terms of total emissions, this shift was emission-neutral.

Recalculation of Hazardous and Industrial Waste (activity data)

In previous submission (2011), we acknowledged that activity data used for estimation of incinerated H/I waste are underestimated. We gathered additional data and recalculated the whole time series where relevant. The changes do not go beyond 2002.

Recalculation of Hazardous and Industrial Waste (Split)

We split hazardous waste into biogenic and non-biogenic parts and they are now reported separately in the UNFCCC reporter. Total emissions are unchanged and we also estimated memo-item biogenic CO_2 for this category.

10.1.3 Recalculation performed in the submission 2014

10.1.3.1 Recalculation in sector 1.A Energy– stationary combustion

Expert review team (ERT) during Centralised review in September 2012 raised objection to using IPCC 2006 default emission factors instead of Revised 1996 Guidelines (IPCC, 1997) default emission factors in 1995-2010 period. This issue was identified as potential problem in Saturday paper. In following resubmission in October 2012 the recalculation of the whole sector 1.A Energy – stationary combustion was provide using Revised 1996 Guidelines (IPCC, 1997) default emission factors. Country specific emission factors are used for Coking Coal, Other Bituminous Coal, Brown Coal + Lignite and since this submission also for Natural Gas. For the rest of fuels (rest of Solid Fuels, Liquid Fuels and Biomass) were used default emission factors.

This recalculation also affected Reference Approach where emission factors were also revised.

10.1.3.2 Recalculation of gaseous fuel in 1.A Energy

Another improvement provided by the Czech Republic consists in new country specific CO_2 emission factor for Natural Gas. The extensive research was performed using data of Natural Gas composition provided by NET4GAS, Ltd. company. This research was part of project assigned by State Environmental Fund of the Czech Republic. Detailed description of the research is given in Annex 2.

Since this submission updated emission factor is used for all categories in 1.A Energy.

10.1.3.3 Recalculation/reallocation of solid fuels in sectors 1.A.1.c Energy - Manufacture of Solid Fuels and Other Energy Industries and 1.A.2 Energy- Manufacturing Industries and Construction

One of the improvements implemented by the Czech Republic considers reallocation of solid fuels and associated emissions between 1.A.1.c and 1.A.2. During QA/QC procedure Energy balance in these two sectors was compared with data provided by Czech Register of individual Sources and Emissions. This QA/QC discovered discrepancy in reporting of solid fuels in 1995-2010 period. There is one installation in CR for which solid fuels are in official statistics (CzSO Questionnaires) included in 1.A.2 autoproducers. The QA/QC procedure ascertained that this consumption of solid fuels should be included in 1.A.1.c category; in this submission solid fuels were reallocated. This reallocation affects consumption of solid fuels and associated emissions in 1.A.1.c category and in 1.A.2.a-1.A.2.f (autoproducers consumption).

10.1.3.4 Recalculation in sector 1.A.2.c Energy - Manufacturing Industries and Construction, Chemicals

The ESD review team discovered during ESD review (June 2012) double counting of naphtha. Part of the naphtha is used as feedstock and as liquid fuels in 1.A.2.c, but instead of taking 20%, we had incorrectly taken 70% (in 2005) or 80% (in 2008-2010) of the naphtha as oxidized. This issue is now addressed in this submission.

10.1.3.5 Recalculation in 1.A.3 Energy - Road Transportation - Diesel Oil

QC/QC procedures identified typographic error in this category - N_2O emissions, 2010. This issue has been rectified.

10.1.3.6 Recalculation in sector 1.A.4.b Energy - Other Sectors, Residential

Expert review team (ERT) during Centralized review in September 2012 raised recommendation to include emissions associated with charcoal use. This issue was noted as potential problem in Saturday paper. In following resubmission (October 2012) the CH_4 and N_2O emissions were included in this subcategory using FAOSTAT data and Revised 1996 Guidelines (IPCC, 1997) default emission factors. To ensure consistency in reporting of greenhouse gases in this submission are included also CO_2 emissions using country specific emission factor.

10.1.3.7 Recalculation in sector 1.A.D Energy - Feedstocks and non-energy use of fuels

In category 1.A.D 10 Other was necessary to provide recalculation for Other Oil (Solvents) in 2010 since in 3 Solvent and Other Product Use sector was performed recalculation due to ERT recommendation. Detailed information please see under description of sector 3 recalculations.

10.1.3.8 Recalculation in sector 1.B.1.b Energy – Fugitive Emissions from Solid Fuels, Solid Fuel Transformation

Expert review team (ERT) raised recommendation during Centralized review in September 2012 to include emissions associated with charcoal production, which was also identified as potential problem. In following resubmission the emissions were included in this subcategory using FAOSTAT data and Revised 1996 Guidelines (IPCC, 1997) default emission factors.

10.1.3.9 Recalculation in sector Cement Production (2.A.1)

In this submission the recalculation of CO_2 emissions was performed. In 2003-2005 period was discovered computational error, which was now corrected.

10.1.3.10 Recalculation in sector Soda Ash Use (2.A.4.2)

The activity data for this category were verified for 2009 and 2010, which introduced also recalculation of CO_2 emissions.

10.1.3.11 Recalculation in sector Other – Glass Production (2.A.7.1)

For 2005 was found the error in reported CO_2 emissions in this category. This discrepancy was corrected in this submission.

10.1.3.12 Recalculation in sector 2.F.3 Industrial Processes, Fire Extinguishers

Technical Expert Review Team (TERT) raised recommendation during ESD review in July 2012 to include split for 1st filled products/serviced products based on ratio recorded in previous years. The exact numbers were unknown for 2009 and 2010, but over previous period the ratio is very stable. This issue has been rectified.

10.1.3.13 Recalculation in sector 3 Solvent and Other Product Use

QC/QC procedures identified typographic errors in this sector – CO_2 emissions, 2010. This issue has been rectified.

10.1.3.14 Recalculation in sector 4 Agriculture

During the centralized review in September 2012, the expert review team (ERT) identified as a potential problem the estimation of N_2O Direct emissions from Agricultural soils. The ERT noted that: i) the Czech Republic has not included N-fixing forage crops such as alfalfa and clover in the calculations of N_2O emissions for the entire time series and ii) the Czech Republic has not included potatoes and sugarbeet crops produced in the country in the estimations of N_2O emissions from crop residues returned to soils for the entire time series. The revision of these emission categories was requested. The recalculation was submitted to ERT as a resolved issue of the “Saturday paper” regarding the 2012 NIR submission.

The ERT provided recommendations to improve the inventory estimates for Agriculture. Based on these recommendations and new obtained country-specific data, the following improvements were implemented in the 2013 submission:

1) N-fixing forage crops such as alfalfa and clover were included in the calculations of N_2O emissions for the entire time series and

10) Potatoes and sugarbeet crops produced in the country were included in the estimations of N_2O emissions from crop residues returned to soils for the entire time series

The “Saturday paper” recalculation led to increased emissions in 4.D.1 category (Direct emissions from agricultural soils) after recalculation by 6.9% in 2010. Using the above changes, the N_2O direct emissions from Agricultural soils were calculated with Tier 2 method for the entire reporting period.

10.1.3.15 Recalculation in sector 4.D Agricultural Soils (4.D.1.3, 4.D.1.4)

The estimation of N_2O Direct emissions from Agricultural soils for 1990-2010 was performed using the statistical crop production data and country-specific parameters.

Category 4.D.1.3

IPCC GPG was applied and available information on production of crops (alfalfa and clover) and national values were used to estimate N_2O emissions. The information of production comes from Czech Statistical Office (CzSO). The country-specific data of the fraction of nitrogen (FracNCRBF); and the fraction of dry matter content (FracDM) in aboveground biomass of forage crops were applied to the emission inventory. For the fraction of dry matter and fraction of nitrogen, the materials (results of research projects) of Faculty of Agronomy, South Bohemia University (Jeteloviny –internal/study material, www.zf.jcu.cz), were used.

The equation used to estimate direct N_2O emissions from Agricultural soils (N-fixing crops) has form

$$FBN = Crop * FracDM * FracNCRBF.$$

Category 4.D.1.4

N_2O Direct Soil Emissions from Crop Residue (potatoes and sugarbeet) were estimated applying the IPCC GPG and using available information on crop production. The source of information is Czech Statistical Office (CzSO). The default emission factors were used in accordance with the IPCC GPG methodology.

The equation 4.29 (Tier 1b, GPG IPCC 2000, page 4.59) of the IPCC GPG was used to estimate these emissions. The default N_2O emission factor for both crops (Table 4-17, IPCC 2000 GPG, page 4.60), the default values for the fractions of nitrogen in potatoes and sugarbeet (Table 4-16, IPCC 2000 GPG, page 4.58) and default fraction of crop residue that is removed from the field as crop (Table 4-17, IPCC 1997, Reference Manual, page 4.85) were used. The country- specific data for dry matter fraction was used: The value of FracDM for potatoes is based on study Cabajova, MU LF Brno (2009) and corresponds to other available sources. The value of FracDM for sugarbeet is based on study Blaha, CZU Praha (1986) and corresponds to other available sources. Both national parameters belong to interval of IPCC default values. The fraction of crop residue that is burned on the field equals zero.

10.1.3.16 Recalculation in sector 5 “LULUCF” (5.G)

No explicit recalculation was performed in this submission. However, the QC/QC procedures identified a typographic error in the category 5.A.1 Carbon stock change in living biomass, year 2010. Therefore, this issue was rectified.

10.1.4 Recalculation performed in the submission 2015

10.1.4.1 Recalculation in sector 1.A Energy (1.A excluding 1.A.3)

10.1.4.1.1 Recalculations due to response to the last review process

Recalculation of N_2O emissions in 1.A.1.b Petroleum Refining sector

As a response to the findings in Saturday paper provided by ERT from review process 2014, one recalculation in the Energy sector was performed. The mistake was caused during the transmission of the data into the CRF Reporter in the last submission. The correction was provided in 6 weeks after obtaining of the Saturday paper.

10.1.4.1.2 Recalculation *caused by implementation of IPCC 2006 Guidelines*

Change of the structure in the Sectoral approach

Sector **1.A.1.a Main Activity Electricity and Heat Production** is based on the IPCC 2006 Gl. split into three subsectors:

1.A.1.a.i	Electricity Generation
1.A.1.a.ii	Combined Heat and Power Generation (CHP)
1.A.1.a.iii	Heat Plants

Activity data and greenhouse gas emission estimates were in this submission reported in the subsector 1.A.1.a.i Electricity Generation since the differentiation between all three subsectors in the official data from CzSO is not considered to be reliable. The distribution of the data into all three subsectors is included in the current Improvement plan.

Sector **1.A.1.c Manufacture of Solid Fuels and Other Energy Industries** is based on the IPCC 2006 Gl. split into two subsectors:

1.A.1.c.i	Manufacture of Solid Fuels
1.A.1.c.ii	Other Energy Industries

Activity data and greenhouse gas emission estimates were in this submission reported in the subsector 1.A.1.c.i Manufacture of Solid Fuels since the differentiation between the subsectors in the official data from CzSO is not considered to be reliable. The distribution of the data into all three subsectors is included in the current Improvement plan.

The amount of subsectors in **1.A.2 Manufacturing Industries and Construction** increased from originally six (1.A.2.a till 1.A.2.f) to 13 (1.A.2.a till 1.A.2.m).

In the current submission was added just one subsector:

1.A.2.f	Non-Metallic Minerals

All other subsectors 1.A.2.g till 1.A.2.m were reported in one v subsector

1.A.2.g	Non-specified Industry

Validity of the data in official Energy balance provided by CzSO will be examined. The distribution of the data into all subsectors is included in the current Improvement plan.

Sector **1.A.4.c Agriculture/Forestry/Fishing** is based on the IPCC 2006 Gl. split into three subsectors:

1.A.4.c.i	Stationary
1.A.4.c.ii	Off-road Vehicles and Other Machinery

1.A.4.c.iii Fishing (mobile combustion)

Until now the activity data from mobile sources in Agriculture, Forestry and Fishing in the CR was reported in the sector 1.A.5. This division was used in order to differentiate the activity data from stationary combustion and from mobile combustion. In the new structure are used the sectors 1.A.4.c.i (original data for subsector 1.A.4.c) a 1.A.4.c.ii (original data were reported under 1.A.5.b Agriculture, Forestry and Fishing).

Sector **1.A.5 Non-Specified** is in the IPCC 2006 Gl. Split to

1.A.5.a Stationary
1.A.5.b Mobile

Subsector 1.A.5.a is not used, since all data about combustion processes were distributed in between the sectors 1.A.1 till 1.A.4. Subsector 1.A.5.b is further split into subsectors:

1.A.5.b.i Other mobile sources not included elsewhere
1.A.5.b.ii Agriculture and Forestry and Fishing

In the subsector 1.A.5.b.i are reported all emissions from the combustion in air transport, which are not included in 1.A.3. Subsector 1.A.5.b ii includes the sources not included in 1.A.4 subsector.

Described changes were performed in the whole time-series.

Change of emission and oxidation factors

IPCC 2006 Guidelines include updated emission factors for CO_2, CH_4 and N_2O. In case, where the country-specific emission factors are available, they are used for emission estimations. In other cases are used default emission factors.

Oxidation factors provided by IPCC 2006 Guidelines are equal to 1. Only in specific cases it allows to use country specific oxidation factors. Analysis of EU ETS data was performed in order to obtain country specific oxidation factors. This way country specific oxidation factors were estimated for Bituminous Coal, Coking Coal and Lignite. These country specific oxidation factors were used in the current inventory. In other cases are used default oxidation factors equal to 1.

Recalculation due to use of country specific conditions

The methodology for development of country specific CO_2 emission factors from different kind of fuels was drawn up. Country specific oxidation factors were determined for chosen solid fuels. For the transition of the data from CzSO for different gases (which are reported in TJ using GCV) were developed country specific ratios of GCV/NCV.

For CO_2 emission estimation were used this country specific approach in the whole time series in all sectors of stationary combustion. Methodology will be discussed in detail in the March submission of the NIR in relevant Annex.

Country specific CO_2 emission factors

In the current submission are used newly determined country specific emission factors for CO_2 emission estimation for Bituminous Coal, Coking Coal and Lignite, which were determined based on the elementary analyses of each kind of fuel. The methodology for determination of country specific emission factors as a relation to the NCV was drawn up.

Country specific oxidation factors for CO_2 computation

For each kind of coal (Bituminous Coal, Coking Coal, Lignite, Briquettes) were determined country specific oxidation factors based on the EU ETS data reported for 2010-2013. Recalculation was provided for listed fuels with country specific values. For the rest of the fuels was used oxidation factor equal to 1.

Country specific coefficient for the ratio between GCV and NCV for gaseous fuels

The recalculation of activity data determination for Natural Gas and derived gases was performed. These gases are in the official data from CzSO reported in TJ, which are calculated based in GCV. So far was used for the transition to TJ correspondent to NCV the ratio 1: 1.1. This approach was many times issued by ERT. Following the recommendations the data about composition of each gas was collected and also GCV and NCV based on the data were determined. Based on this data the specific ratio GCV/NCV for each gas was determined. This country specific ration was used for the activity data determination in the current submission.

Recalculations caused by changes in data and NCV in official CzSO data

Czech statistical office closely cooperates with national inventory system team and in its UNECE/IEA/OEXD Questionnaires it is reacting also for different requirements from the NIS team. Except of this every year the data are getting more accurate, also the data from the past years are often clarified and changed. Reallocations between different subsectors are also occurring. Based on the NIS team proposition were also some NCVs updated. Important change in the last data reporting (from CzSO) occurred in the consumption of liquid fuels.

All these changes are included in the whole recalculation of the Energy sector. The changes are reflected in the whole time series and for all kinds of fuels. It is necessary to point out, that currently all reported data are now in line with the official statistical data in energy balance of the Czech Republic which is processed in line with IEA methodology. So far in the 1990 – 1994 period was used data from the former energy balance of the Czech Republic. The most apparent changes occur in the differentiation between energy and non-energy use of fuels for liquid fuels. More precise differentiation between energy and non-energy use helped also for more precise allocation of non-energy use of liquid fuels to the IPPU sector.

In the official data are the fuels consumptions reported in kt, which means the requirement for the transition to TJ. In the last official CzSO data were also added still missing NCV, which allow also recalculation for the whole time series of NCV. Until now the missing NCV data were replacing by the average values.

It is possible to state, that this recalculation was so far the most important and huge since the GHG inventory is performed. The comparison of the values before and after recalculation was also performed. The comparison showed that despise quite significant changes for some kind of fuels and sectors, the whole fuel consumption and CO_2 and N_2O emissions didn't significantly change. CH_4 emissions indicate apparent changes, however this was caused by the apparent change in the emission factors.

10.1.4.2 Recalculation in sector 1.A.3 Energy – Road Transportation

10.1.4.2.1 Recalculation caused by implementation of IPCC 2006 Guidelines

Sector **1.A.3.b Road Transportation** is based on the IPCC 2006 Gl. split into five subsectors:

1.A.3.b.i	Cars
1.A.3.b.ii	Light Duty Trucks
1.A.3.b.iii	Heavy Duty Trucks and Buses
1.A.3.b.iv	Motorcycles
1.A.3.b.v	Other

Activity data and greenhouse gas emission estimates of subsector 1.A.3.b.ii Light Duty Trucks were in this submission included in the subsector 1.A.3.b.i Cars, because the differentiation between these two subsectors is not available. The distribution of the data into these two subsectors is included in the current Improvement plan.

10.1.4.3 Recalculation in sector 2 Industrial Processes and Product Use

10.1.4.3.1 *Recalculations due to response to the last review process*

No recalculations were needed after the last review.

10.1.4.3.2 *Recalculation caused by implementation of IPCC 2006 Guidelines*

2.A Mineral Industry

In the 2.A Mineral Industry subsector went through some reallocation issues. The subsector 2.A.3 doesn't include emissions from Limestone and Dolomite Use anymore, but includes the emissions from Glass Production (before included in the category 2.A.7.i). Category 2.A.4 includes now Other Process Uses of Carbonates and it is split into 4 subcategories

2.A.4.a	Ceramics (before included in 2.A.7.ii)
2.A.4.b	Other Uses of Soda Ash (before included in 2.A.4.ii)
2.A.4.c	Non Metallurgical Magnesia Production
2.A.4.d	Other (please specify).

The category 2.A.2 was recalculated in the 2010 - 2012 time series since new specific data were obtained. Further improvement is planned for the next submission and is included in the improvement plan. IPCC 2006 Gl. also include methodology for Glass production including emission factor and cullet ratio. Using these parameters were estimated emissions in 2.A.3 Glass Production sector.

2.B Chemical Industry

Chemical Industry is the sector with the biggest changes cause by the implementation of IPCC 2006 Gl. There are few new categories included.

Categories 2.B.1 Ammonia Production, 2.B.2 Nitric Acid Production and 2.B.3 Adipic Acid Production remained the same.

Category 2.B.4 now includes Caprolactam, Glyoxal and Glyoxylic Acid Production. Category 2.B.5 includes Carbide Production, 2.B.6 Titanium Dioxide Production, 2.B.7 Soda Ash Production. Category 2.B.8 Petrochemical and Carbon Black Production is split into categories:

2.B.8.a	Methanol
2.B.8.b	Ethylene
2.B.8.c	Ethylene Dichloride and Vinyl Chloride Monomer
2.B.8.d	Ethylene Oxide
2.B.8.e	Acrylonitrile
2.B.8.f	Carbon Black

Category 2.B.9 Fluorochemical Production is split into 2 subcategories and is not occurring in the Czech Republic. Last category in 2.B is category 2.B.10 Other, in which is included category Styrene production.

In case the process is occurring in the Czech Republic, the relevant emissions were estimated using methodology given by IPCC 2006 Gl.

2.C Metal Industry

New subcategories in the sector 2.C.1 Iron and Steel Production are 2.C.1.c Direct Reduced Iron and 2.C.1.e Pellet.

Categories 2.C.5 Lead Production and 2.C.6 Zinc Production are newly included in the IPCC 2006 Gl.

The emissions from limestone and dolomite use during the iron and steel production were included in the emission estimates in the category 2.C.1 Iron and Steel Production.

As a new source were included emissions from categories 2.C.5 Lead Production and 2.C.6 Zinc Production.

2.D Non-Energy Products from Fuels and Solvent Use

This category is newly included in the IPCC 2006 Gl. It includes use of fuels other than for combustion processes or for reducing agent in industry. This category is split into four subcategories

2.D.1 Lubricant Use
2.D Paraffin Wax Use
2.D.3 Other (please specify)

Category 2.D.3 Other is for the purposes of the Czech Republic's inventory split into categories 2.D.3.i Solvent Use and 2.D.3.ii Road paving with asphalt.

2.E Electronic Industry

Electronic Industry includes emissions of fluorinated carbons gases used predominantly for manufacturing of semiconductors. Subsector 2.E include sources from previous category 2.F.7 Semiconductor Manufacture and was furthermore extended for five more subcategories:

2.E.1 Integrated Circuit or Semiconductor
2.E.2 TFT Flat Panel Display
2.E.3 Photovoltaics
2.E.4 Heat Transfer Fluid
2.E.5 Other (please specify).

2.F Product Uses as Substitutes for Ozone Depleting Substances

This subsector has undergone a major changes caused by the implementation of IPCC 2006 Gl. One of the most important issues is that potential emissions are not reported anymore in addition to actual emissions. Moreover, the 2.F.7 Semiconductor Manufacturer category was reallocated to 2.E Electronic Industry. Also previous 2.F.8 Electrical Equipment and 2.F.9 Other (Sound-proof windows, Laboratory use) categories were reallocated in 2.G Other Product Manufacture and Use.

In the rest of the categories (2.F.1 to 2.F.5) there were only little changes such as an adjustment of category name or altering the classification of some subcategories.

2.G Other Product Manufacture and Use

As mentioned above, this new subsector introduce categories 2.G.1 Electrical Equipment, 2.G.2.c Soundproof Windows and 2.G.4 Laboratory (Experimental) use that have been reallocated from the previous subsector 2.F. This subsector includes also category 2.G.3 N_2O from Product Uses, which was previously reported under Solvents and Other Product Use.

10.1.4.4 Recalculation in sector 3 Agriculture

10.1.4.4.1 *Recalculations due to response to the last review process*

Recalculation of CH_4 emissions in 3.A Livestock/Manure Management sector

As a response to the findings in Saturday paper provided by ERT from the review process 2014, one recalculation in the Agriculture sector was performed. The discrepancy was caused by inconsistency of time-series data. One step input of change of grazing time data for cattle was utilized, where the slightly increasing trend of data was necessary. The correction was provided in 6 weeks after obtaining of the Saturday paper.

Recalculation caused by implementation of IPCC 2006 Guidelines

Sector 3.A Livestock is based on the IPCC 2006 Gl. split into three subsectors:

3.A.1 Enteric Fermentation
3.A.2 Manure Management

Activity data and greenhouse gas emission estimates are since this submission reported after new redistribution.

Sector 3.C Aggregate sources and non-CO_2 emissions sources on land is based on the IPCC 2006 Gl. split into ten subsectors, of which only four are reported under Agriculture sector in the Czech Republic:

3.C.3 Urea application
3.C.4 Direct N_2O Emissions from managed soils
3.C.5 Indirect N_2O Emissions from managed soils
3.C.6 Indirect N_2O Emissions from manure management

Activity data and greenhouse gas emission estimates were in this submission reported in mentioned sectors.

In the current submission some subsectors were added. Newly the emissions from urea application on agricultural land (3.C.3) and Indirect N_2O Emissions from manure management (3.C.6) were reported. The data of industry production of urea was applied to estimate emissions from 3.C.3 sector. To the sector 3.C.4 was added new source of emissions - direct application of sewage sludge to managed soils.

Described changes were performed in the time-series where the activity data are available.

Change of emission factors

IPCC 2006 Guidelines include updated emission factors for CH_4 and N_2O. In case there are country-specific emission factors available, they are used for emission estimation. In other cases are used default emission factors.

The emission factors provided by IPCC 2006 Guidelines for emission estimations from Manure Management (AWMS - EF3), Direct and Indirect emissions from managed soils (EF1 and EF5) were updated.

10.1.4.4.2 Recalculation due to use of country specific conditions

Country specific CH_4 and N_2O emission factors

Country-specific emission factors are applied if they are available. In Agriculture, the national specific emission factors are used in calculation of CH_4 and N_2O emissions from Enteric Fermentation and Manure Management (both in cattle category).

The changes in country-specific factors in time period 2007-2011 were performed and reported based on recalculation due to response to the last review process.

Recalculations caused by changes in data

Czech statistical office is the main source of national inventory system data. Annually, the data are getting more accurate, reallocations between different subsectors are also occurring. All these changes are included in the recalculations of the Agriculture sector. The changes are reflected in the whole time series.

It possible to state, that this recalculation was so far the most important and huge since the GHG inventory is performed. The comparison of the values before and after recalculation was also performed. The comparison showed that emissions significantly change. Although it was added to the inventory some sources, the reported emissions were due to the different methodology, incl. updated emission factors, reduced.

10.1.4.5 Recalculation in sector 4 LULUCF and KP LULUCF activities

10.1.4.5.1 *Recalculations due to response to the last review process*

No recalculations were needed after the last review.

10.1.4.5.2 Recalculation due to use of country specific conditions

No recalculations due to use of country specific conditions performed.

10.1.4.5.3 Recalculation caused by implementation of IPCC 2006 Guidelines

The methodologies and recommendations IPCC 2006 Guidelines were implemented gradually during previous inventory submissions. Any identified difference in reported emissions at the higher grouping level is due to changes in reporting structure and moving some emission categories to sector 3 – Agriculture.

The recalculations have been made due to adopting the new global warming potential values for CH_4 and N_2O (Decision 25/CP19). This concerns the emissions from burning and wildfires, as well as emissions from soils on land converted to cropland. Hence, these changes affect the estimates for the land use categories 4.A Forest land and 4B Cropland. Correspondingly, these changes were also implemented for estimates of Forest management activity under KP LULUCF reporting.

10.1.4.6 Recalculation in sector 5 Waste

10.1.4.6.1 *Recalculations due to response to the last review process*

Centralized review noted possible underestimation of N_2O emissions from 5.D Wastewater treatment and discharge due to under estimated amount of protein in consumed food. Whole category received updated data about protein consumption from FAOSTAT for whole time series 1990 - 2013. Average change in amount of GHG in source category was about 14% per year.

10.1.4.6.2 Recalculation due to use of country specific conditions

Category 5.A Solid waste disposal was recalculated, since new activity data, including data for recovered methane and amount of waste, became available. The difference is negligible.

10.1.4.6.3 Recalculation caused by implementation of IPCC 2006 Guidelines

Category 5.B Biological treatment of solid waste is newly included in the IPCC 2006 Gl. It is split into two subcategories:

5.B.1 Composting

5.B.2 Anaerobic digestion at Biogas facilities

Each subcategory is further split into two categories, dividing the emissions between MSW treatment and other waste treatment, respectively 5.B.1.a Municipal solid waste, 5.B.1.b Other, and 5.B.2.a Municipal solid waste, 5.B.2.b Other. Calculations were performed following the 2006 Gl. for the whole time period.

The implementation of 2006 GL. caused division of category 5.C Incineration and open burning of waste into two subcategories:

5.C.1 Incineration

5.C.2 Open burning of waste

In this submission in category 5.C.1 no recalculations were conducted. Category 5.C.2 is reported as not occurring in the Czech Republic.

10.1.5 Recalculations performed in the submission 2016

10.1.5.1 Recalculation in sector 1.A Energy (excluding 1.A.3)

10.1.5.1.1 New activity data

CzSO performed changes in the official energy balance data, which yielded to recalculations across whole 1A sector.

10.1.5.1.2 Reallocation of non-energy use of Natural Gas from 1.A.2.c to 2.B.10

The non-energy use of Natural Gas occurred in the official energy balance of the Czech Republic. This Natural Gas is used in chemical Industry. The relevant amount of Natural Gas was reallocated into sector 2.B.10 for 2008 – 2013. Prior to 2008 the official data of non-energy use of Natural Gas is not available.

10.1.5.2 Recalculation in sector 2 Industrial Processes and Product Use

10.1.5.2.1 Mineral Industry (2.A)

2.A.2 Lime production was recalculated in the 2010-2013 time series since new specific data were obtained.

The subcategory 2.A.4.a was also recalculated by using EU ETS data in the 2010-2014; 1990 – 2009 was calculated by using activity data provided by CzSO and country specific emission factor calculated from EU ETS data.

The subcategory 2.A.4.d Other (please specify) newly includes emissions from mineral wool production.

10.1.5.2.2 Chemical Industry (2.B.)

The subcategory 2.B.10 Other (please specify) includes two new subcategories Other non-energy use in chemical industry and Non selective catalytic reduction. Subcategory Other non-energy use in chemical industry includes emission from non-energy use of natural gas for hydrogen production by steam reforming. Activity data from this subcategory are presented in TJ. The CRF reporter does not allow switching unit from kt to TJ in this subcategory. Activity data for non-energy use of Natural Gas was reallocated from 1.A.2.c, where they were reported till last submission. Non selective catalytic reduction subcategory includes emissions from non-selective catalytic reduction used in Nitric Acid production technology.

10.1.5.2.3 Metal Industry (2.C)

For 2.C.2 Ferroalloys Production was obtained new updated activity data since 2008. Recalculation using these updated activity data was performed.

For 2.C.5 Lead Production was obtained new updated activity data since 2008. Recalculation using these updated activity data was performed.

For 2.C.6 Zinc Production was obtained new updated activity data since 2008. Recalculation using these updated activity data was performed.

10.1.5.2.4 Non-Energy Products from Fuels and Solvent Use (2.D)

New category 2.D.3 Other – Urea used as catalyst is included in the reporting. The default approach based on 2006 IPCC Gl. Vol. 2 was applied for emission estimation.

10.1.5.2.5 Electronic Industry (2.E)

Electronic Industry includes emissions of fluorinated carbons gases, SF_6 and NF_3 used predominantly for manufacturing of semiconductors. Subsector 2.E.1 Integrated Circuits or Semiconductors was recalculated including by-product emissions. In subsector 2.E.4 Heat Transfer Fluids the notation keys were changed to NE. Research of data for these issues is planned for future submissions.

10.1.5.2.6 Product Uses as Substitutes for Ozone Depleting Substances (2.F)

This subsector has undergone several recalculations due to use of new more reliable data. Based on the recommendations of TERT from the trial review historical data were revaluated. Due to acquiring of more reliable data following recalculations were made: relocation of HFC-23, HFC-32, HFC-143a and HFC-125 from 2.F.1.e (Mobile Air conditioning) to 2.F.1.a (Commercial refrigeration), further the error classification of HFC-245ca was corrected to HFC-245fa. These recalculations were consulted and verified by the independent F-gas expert.

Furthermore, the subcategory 2.F.3 Fire Protection was recalculated by changing life factor and lifetime according to IPCC 2006 Gl. The subcategory 2.F.5 Solvents (gas HFC-245fa) was recalculated due to new more reliable data.

10.1.5.2.7 Other Product Manufacture and Use

Research of data composition in the subsector 2.G.1 Electrical Equipment was conducted. Results of the research showed, that the emissions factor for HV switchgear (Table 8.3, 2006 IPCC Gl., Vol. 3-2) is more accurate for condition of the Czech Republic. Thus recalculation using emission factor for HV was performed in this submission.

Furthermore in the subcategory 2.G.4 Laboratory (Experimental) use recalculation for 2004-2006 were conducted using assumption of covering more than one year, since emissions are assumed to be continuous over the year (Eq. 8.23, 2006 IPCC Gl., Vol. 3-2).

10.1.5.3 Recalcualtions in sector 3 Agriculture

10.1.5.3.1 Recaulations caused by implementation of IPCC 2006 Guidelines

As a result of implementation of input parameters in accordance with 2006 Gl. IPCC, the recalculation of greenhouse gas emissions in some categories was performed for the entire reporting period.

3.A Enteric Fermentation

The emission factors for estimates of methane emissions from Enteric Fermentation of cattle (dairy and non-dairy) were recalculated following the revision of coefficient for calculating net energy for maintenance (Cfi) and cattle methane conversion factor (Ym). These new default parameters were applied according to 2006 IPCC Guidelines for the whole entire period. A cattle methane conversion factor Ym equals 0.065 was applied to the estimates from Table 10.12 (2006 Gl. IPCC) and coefficients Cfi for dairy and non-dairy cattle were applied from Table 10.4 (2006 Gl. IPCC). The mentioned changes generated new Gross Energy values (GE) and updated emission factors for estimation of methane emissions from Enteric Fermentation.

3.B Manure Management

The emission factors for estimation of CH_4 emissions for cattle category from Manure Management were recalculated following the adoption of Cfi and Ym parameters in accordance with 2006 Gl. IPCC. For CH_4 for manure management for pigs recalculated the CH_4 emission from pig manure, according to the 2006 Gl. IPCC, so it better fits the actual manure handling conditions in the Czech Republic. Instead of 3 kg/head/yr, a double value 6 kg/head/yr was used. Manure management CH_4 emission factors from Table 10A-9 for goats, horses and poultry were applied to the inventory. In case of poultry the default value (weighted average of types of breeding) was adjusted to the Czech conditions.

As a result of performed changes, the Nex values for cattle category were updated also. Due to application of the national Typical Animal Mass (TAM) for other than cattle categories (pig, sheep, goats, horses, poultry), the country-specific Nitrogen Excretion values (Nex) for the mentioned animals for the whole entire period were developed using by Equation 10.30 (2006 Gl. IPCC).

3.D N_2O Emissions from managed soils

The recalculation of nitrous oxide emissions from Manure applied to soils and Pasture, Range and Paddock were performed following the revision of input parameters of Livestock. Because some outputs from Manure Management category correspond to inputs for estimates of nitrous oxide emissions from soils, then the update of Manure Management outputs resulted to update of emissions from soils. The changes of direct emissions resulted to changes of indirect emissions, so the recalculation of indirect N_2O emissions from soils was also performed.

3.H Urea application

In this submission, the new activity data were obtained and applied to the inventory. The statistical production data were replaced by more precise data corresponding to the real consumption by Ministry of Agriculture. These data available for period 2000-2014 are based on the farmer´s fertilizer records. These data were used to recalculate the appropriate time-series (2000-2014).

10.1.5.4 Recalculations in sector 4 LULUCF and KP LULUCF Activities

10.1.5.4.1 Recalculations due to use of country specific conditions

LULUCF

The entire land-use assessment and land-use change identification system have been revised and significantly improved in collaboration with the data provider, the Czech Office for Surveying, Mapping and Cadastre (COSMC)., COSMC administers the database of "Aggregate areas of cadastral land categories" (AACLC). Newly in this inventory, the system uses within-year explicitly addressed changes between all pairs of the six land-use categories, based on 13 explicitly reported land use categories of the AACLC or derived therefrom at the level of each cadastral unit. This is qualitatively a better assessment of land use as compared to the previously required balancing of land use categories between two consecutive years. The improved system using explicitly addressed within-year land use changes is adopted since year 2004 until 2014. For land use change prior 2004 (technically since 1970), the previously adopted system is retained. The new revision included rectification of linking AACLC land use categories to IPCC land use categories. Specifically, the following changes have been implemented: i) the un-stocked cadastral forest land remains within 4A Forest land (previously transferred to Grassland) ii) the military areas are retained within the category of Settlements (previously treated as Grassland) and iii) Other land is no longer constant, but since 2004 it is treated identically as all other land use categories, i.e., conversions from and to this land use categories are explicitly expressed according to the newly revised system based on the official data from COSMC. These changes have been implemented across the entire data period (1970 to 2014) required for the mandatory reporting (1990 to 2014) of land use changes and associated assessment of carbon stock changes and GHG emissions to ensure full consistency of the LULUCF reporting. The above implemented changes resulted in revised estimates of all LULUCF categories besides 4G HWP.

4.A.2 Land converted to Forest land and Forest land converted to other LU categories

The assessment of dead organic matter (deadwood and litter) has been improved, using the newly available activity data of the CzechTerra landscape inventory (deadwood, litter) and National Forest Inventory (deadwood). These changes concern category 4.A and all sub-categories involving land use conversion from or to Forest land.

4.B.1 Cropland remaining Cropland and 4.C.1 Grassland remaining Grassland

Soil carbon stock change estimation has been revised for the categories 4.B.1 and 4.C.1, following the recommendations of the recent review and owing to the newly available data on management of agricultural soil.

4.G Harvested Wood Products (HWP)

The approach B was newly used for the estimates of HWP contribution in the category 4.G HWP (approach A was used in NIR 2015).

Table 4(IV) – Indirect N_20 emissions

Updated estimates of Indirect emissions from atmospheric deposition of N volatized from managed soils, rectifying the previous calculation.

KP LULUCF

Further improvement and revision of land use representation and land use change identification system as described for the section of LULUCF above also applies for the areas of KP LULUCF activities. There have been rectified based on the new data from COSMC. These changes concern areas of AR, D and FM activities

AR, D – revised estimates of deadwood and litter based on the newly available activity as described in the section of LULUCF for land use change categories involving Forest land

10.1.5.5 Recalculations in sector 5 Waste

10.1.5.5.1 Recalculations due to use of country specific conditions

Biological Treatment of Solid Waste

Considering the 9th Corrigenda for the 2006 IPCC Guidelines from July 2015, recalculation for the whole time series in category 5.B were performed, using the provided emission factors for N_2O and CH_4.

Waste incineration

Waste incineration for non-energy purposes was recalculated to harmonise activity data from ISOH. New data are more internally consistent with other source categories from waste sector.

Wastewater treatment

Domestic wastewater treatment was recalculated to better cover country specific condition. Tier 1 approach was modified with country specific data about methane generation from sludge.

Industrial wastewater treatment was recalculated for year 2000 by using improved activity data for this year.

10.2 Implications for emission levels

Tab. 10-1 Implications on emission levels on example on 2013 emission levels

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Previous submission (CO_2 eq., kt)	Latest submission (CO_2 eq., kt)	Difference (CO_2 eq., kt)	Difference %	Impact of recalculation on total emissions excl. LULUCF%	Impact of recalculation on total emissions incl.LULUCF %
Total National Emissions and Removals	120 402.15	120 473.44	71.28	0.06%	0.06%	0%
1. Energy	100 876.57	100 760.48	-116.09	-0.12%	-0.10%	0%
A. Fuel combustion activities	96 887.22	96 771.43	-115.79	-0.12%	-0.10%	0%
1. Energy industries	55 919.61	56 004.99	85.37	0.15%	0.07%	0%
2. Manufacturing industries and construction	11 017.60	11 110.37	92.78	0.84%	0.08%	0%
3. Transport	16 649.55	16 649.55	0.00	0.00%	0.00%	0%
4. Other sectors	12 991.03	12 697.10	-293.93	-2.26%	-0.25%	0%
5. Other	309.43	309.43	0.00	0.00%	0.00%	0%
B. Fugitive Emissions from Fuels	3 989.34	3 989.04	-0.30	-0.01%	0.00%	0%
1. Solid fuels	3 354.91	3 354.61	-0.30	-0.01%	0.00%	0%
2. Oil and natural gas	634.43	634.43	0.00	0.00%	0.00%	NA
C. CO_2 transport and storage	NO	NO	NA	NA	NA	0%
2. Industrial processes and product use	14 122.69	14 598.63	475.94	3.37%	0.41%	0%
A. Mineral industry	2 156.01	2 394.38	238.37	11.06%	0.21%	0%
B. Chemical industry	1 878.80	2 093.56	214.76	11.43%	0.19%	0%
C. Metal industry	7 058.16	7 045.16	-13.01	-0.18%	-0.01%	0%
D. Non-energy products from fuels and solvent use	100.80	117.04	16.24	16.11%	0.01%	0%
G. Other product manufacture and use	239.92	304.32	64.40	26.84%	-0.05%	0%
H. Other	NO	NO	NA	NA	NA	-6%
3. Agriculture	7 263.34	8 040.63	777.30	10.70%	0.61%	1%
A. Enteric fermentation	2 412.48	2 758.52	346.05	14.34%	0.27%	0%
B. Manure management	1 758.86	2 009.52	250.66	14.25%	0.20%	0%
C. Rice cultivation	NO	NO	NA	NA	NA	NA
D. Agricultural soils	2 955.69	3 011.40	55.71	1.88%	0.04%	0%
E. Prescribed burning of savannahs	NO	NO	NA	NA	NA	NA
F. Field burning of agricultural residues	NO	NO	NA	NA	NA	NA
G. Liming	135.50	135.50	0.00	0.00%	0.00%	0%
H. Urea application	0.81	125.69	124.88	15481.30%	0.10%	0%
I. Other carbon-containing fertilizer	NO	NO	NA	NA	NA	NA
J. Other	NO	NO	NA	NA	NA	NA
4. Land use, land-use change and forestry (net)	-6 741.78	-7 916.34	-1,174.57	17.42%	-0.91%	-1%
A. Forestland	-7 403.47	-7 372.83	30.64	-0.41%	0.02%	0%
B. Cropland	74.50	19.81	-54.69	-73.41%	-0.04%	0%
C. Grassland	-322.01	-592.02	-270.01	83.85%	-0.21%	0%
D. Wetlands	29.38	31.41	2.03	6.90%	0.00%	0%
E. Settlements	83.16	88.56	5.41	6.50%	0.00%	0%
F. Other land	NO	41.53	NA	NA	NA	NA
G. Harvested wood products	791.82	-133.96	-925.78	-116.92%	-0.72%	-1%
H. Other	NO	NO	NA	NA	NA	NA
5. Waste	4 881.34	4 990.04	108.70	2.23%	0.08%	0%
A. Solid waste disposal	3 324.45	3 363.89	39.44	1.19%	0.03%	0%
B. Biological treatment of solid waste	585.17	577.12	-8.04	-1.37%	-0.01%	0%
C. Incineration and open burning of waste	178.86	132.44	-46.42	-25.95%	-0.04%	0%
D. Waste water treatment and discharge	792.86	916.59	123.72	15.60%	0.10%	0%
E. Other	NO	NO	NA	NA	NA	NA
6. Other (As specified in summary 1.A)	NA	NA	NA	NA	NA	NA
Memo items:						
International bunkers	860.43	860.43	0.00	0.00%	0.00%	0%
Aviation	860.43	860.43	0.00	0.00%	0.00%	0%
Navigation	NO	NO	NA	NA	NA	NA
Multilateral operations	NO	NO	NA	NA	NA	0%
CO_2 emissions from biomass	12 716.68	12 795.33	78.65	0.62%	0.07%	NO
CO_2 captured	NO	NO	NO	NO	NO	0%
Long-term storage of C in waste disposal sites	10 416.85	10 440.98	24.13	0.23%	0.02%	-1%
Indirect N_2O	2 412.90	1 427.92	-984.98	-40.82%	-0.85%	0%
Indirect CO_2	2 248.99	2 346.95	97.97	4.36%	0.08%	0%

10.3 Implications for emission trends, including time-series consistency

10.3.1 Implications for emission trend and time-series consistency of CO_2

The influence of the recalculations for the emission trend of CO_2 are illustrated on Fig. 10-1. Both curves are following the same pattern. The CO_2 emissions are lower on average by 0.23%, through the whole time period.

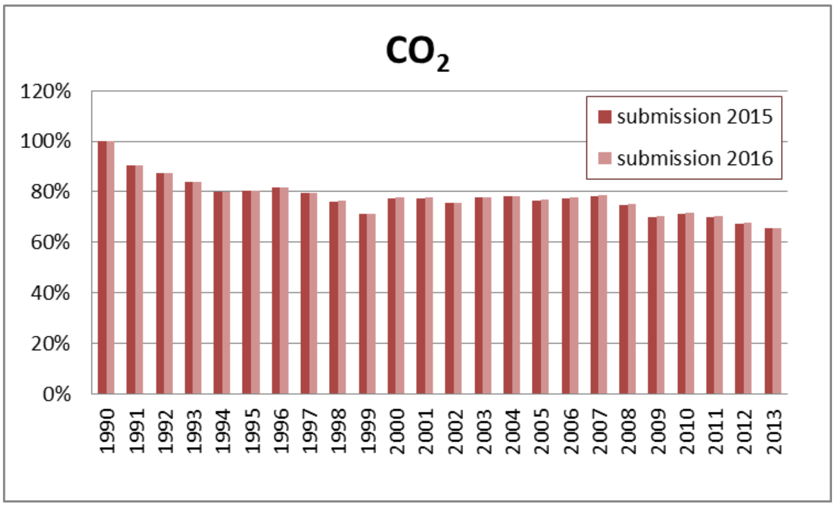


Fig. 10-1 Difference in trends of CO_2 emissions in index form, between the submissions 2015 and 2016, due to recalculations (1990 = 100%)

10.3.2 Implications for emission trend and time-series consistency of CH_4

The influence of the recalculations for the emission trend of CH_4 are illustrated on Fig. 10-2. Both curves are following the same pattern. The CH_4 emission trend is higher on average by 0.03%, through the whole time period.

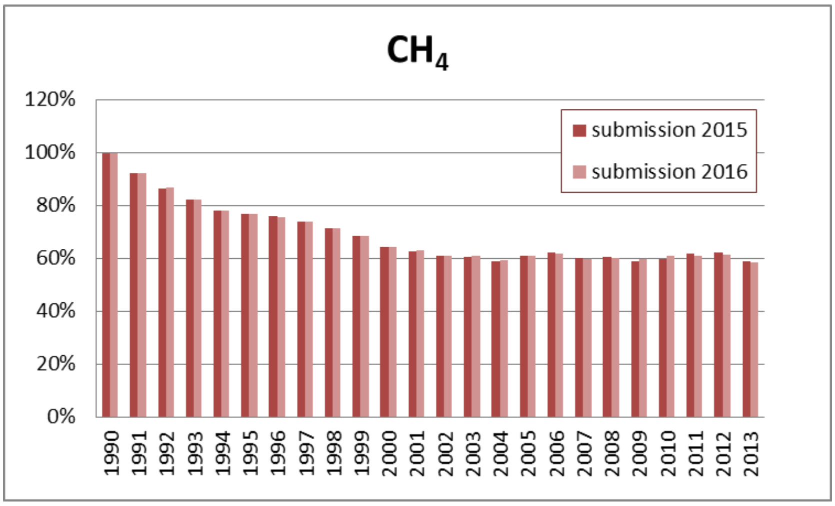


Fig. 10-2 Difference in trends of CH_4 emissions in index form, between the submissions 2015 and 2016, due to recalculations (1990 = 100%)

10.3.3 Implications for emission trend and time-series consistency of N_2O

The influence of the recalculations for the emission trend of N_2O are illustrated on Fig. 10-3. Both curves are following the same pattern. The N_2O emission trend is higher on average 0.72%, through the whole time period.

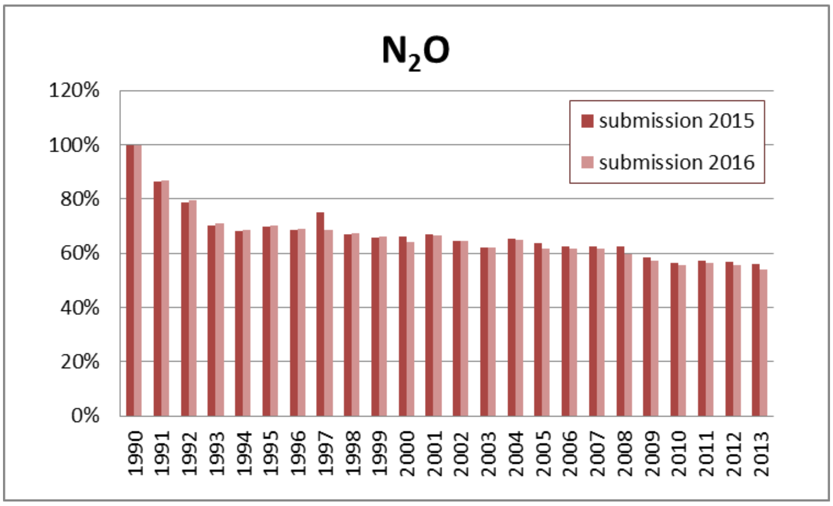


Fig. 10-3 Difference in trends of N_2O emissions in index form, between the submissions 2015 and 2016, due to recalculations (1990 = 100%)

10.3.4 Implications for emission trends and time-series consistency of F-gases and SF_6

The influence of the recalculations for the emission trend of HFCs are illustrated on Fig. 10-4. Both curves are following the same pattern.

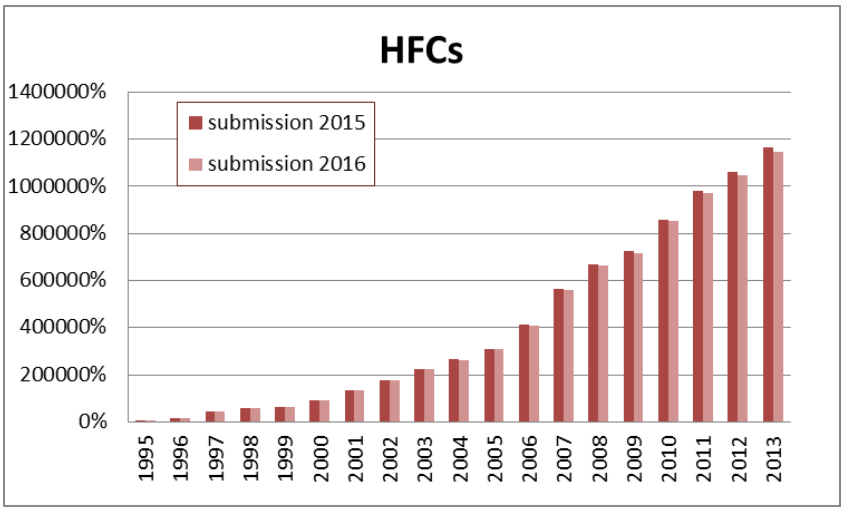


Fig. 10-4 Difference in trends of HFCs emissions in index form, between submission 2015 and 2016, due to recalculations (1990 = 100%)

The influence of the recalculations for the emission trend of PFCs are illustrated on Fig. 10-5. Both curves are following the same pattern.

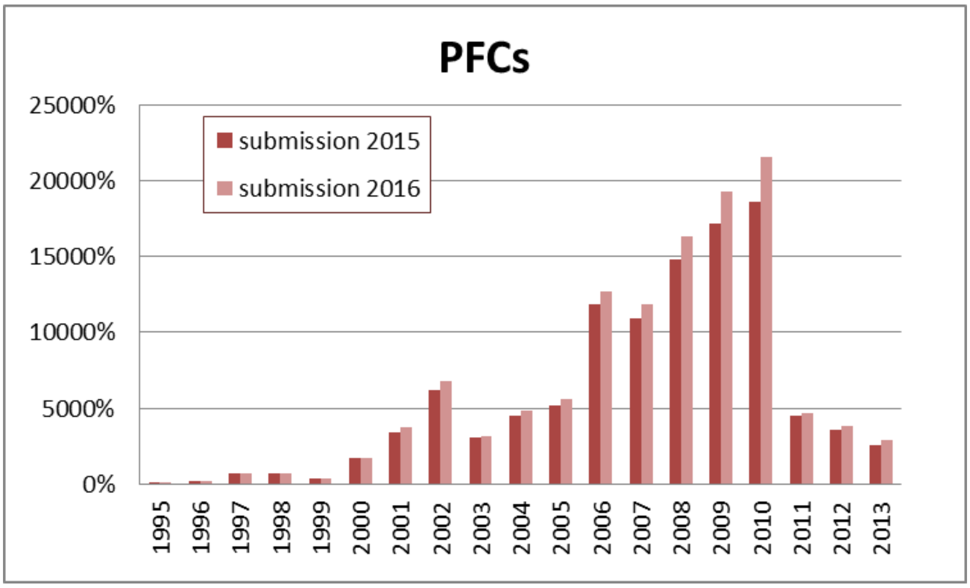


Fig. 10-5 Difference in trends of PFCs emissions in index form, between submission 2015 and 2016, due to recalculations (1990 = 100%)

The influence of the recalculations for the emission trend of SF_6 are illustrated on Fig. 10-6. Both curves are following the same pattern.

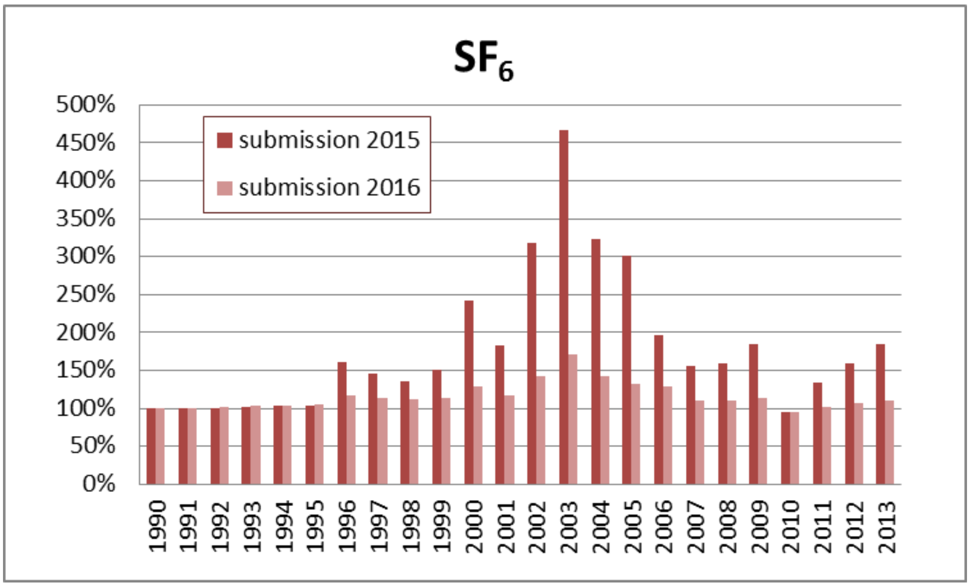


Fig. 10-6 Difference in trends of SF_6 emissions in index form, between submission 2015 and 2016, due to recalculations (1990 = 100%)

10.3.5 Implications for emission trends and time-series consistency of total emissions

The influence of the recalculations for the emission trend of total emissions, including LULUCF are illustrated on Fig. 10-7. Both curves are following the same pattern. The total emissions including LULUCF in trend is lower on average by 0.59% through the whole time period.

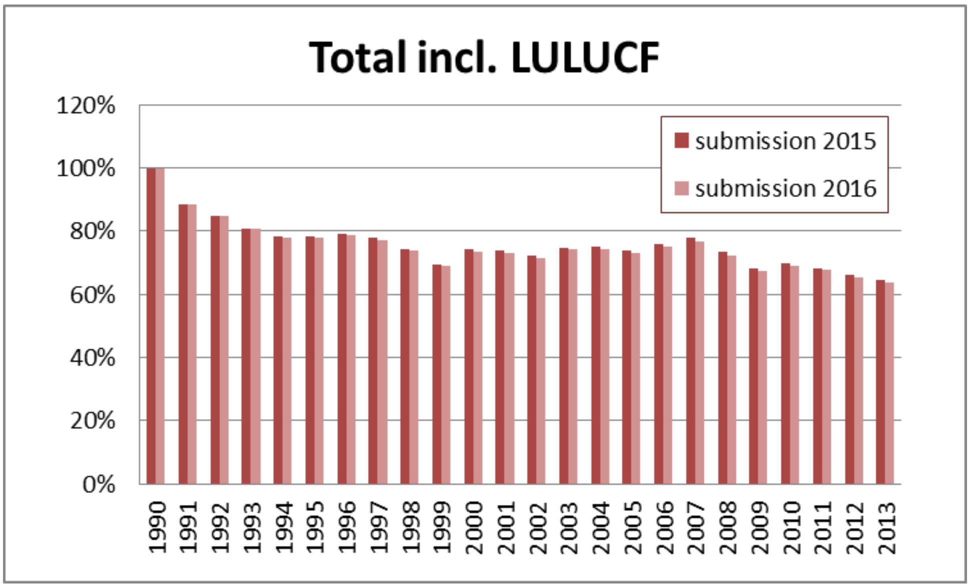


Fig. 10-7 Difference in trends of total emissions including LULUCF in index form, between submission 2015 and 2016, due to recalculations (1990 = 100%)

The influence of the recalculations for the emission trend of total emissions, excluding LULUCF are illustrated on Fig. 10-8. Both curves are following the same pattern. The total emissions excluding LULUCF in trend is higher on average by 0.07% through the whole time period.

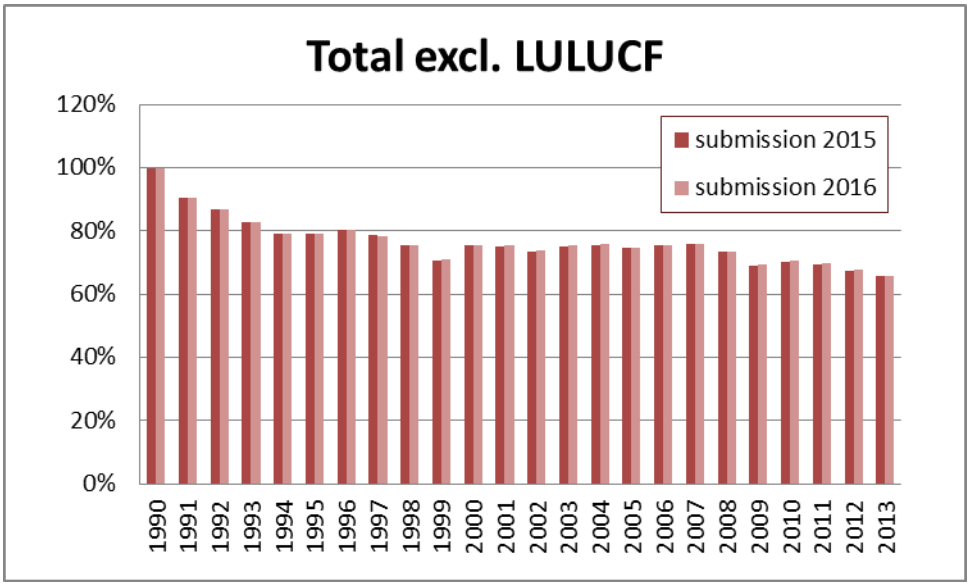


Fig. 10-8 Difference in trends of total emissions including LULUCF in index form, between submission 2015 and 2016, due to recalculations (1990 = 100%)

10.4 Planned improvements, including in response to the review process

Each year, the Czech inventory team analyses the findings of ERT (the Expert Review Team) and attempts to improve the quality of the inventory by implementation of the relevant recommendations.

An overview of previous findings and the relevant follow up by the Czech Republic was given in the previous NIRs (CHMI, 2012, 2013, 2014). In this report, attention is focused on the two last reviews.

In September 2010, the Czech Republic was subjected to a centralised review in Bonn. However, the relevant draft of the ARR 2010 was submitted from UNFCCC rather late, only on 17 February 2011, at the time when this report (2011 submission) was being written. The final version was issued only on 28 March 2011. Therefore it was not possible to implement most of the ERT recommendations.

During the centralised review in September 2010, the Expert Review Team (ERT) identified a potential problem in the incomplete reporting of category 1.B.2.a.ii (Oil Production). In this subcategory, the Czech Republic reported only CH_4 emissions from oil production, while CO_2 emissions and emissions of CO_2, CH_4 and N_2O from venting and flaring were not reported. Therefore, the Czech Republic prepared the resubmission of CRF (within 6 weeks) in order to respect this ERT finding. In addition, ERT highlighted the necessity for full implementation of the QA/QC plan, better harmonization of information given in NIR and in CRF, improvement of time series consistency (mainly in Energy and Waste) and correct use of the notation key in CRF Tables.

In September 2011 (ARR 2011), the Czech Republic was subjected to the In-country-review in Prague. During the review, ERT identified the following “potential problem” in Agriculture: emissions of N_2O from Manure management – 4.B.1 (even though this category was not identified as a Key Category). ERT claimed that the default factor used causes underestimation of the reported N_2O emission from Manure management. This potential problem was successfully resolved in time (during a 6 week period).

In addition, ERT reiterated some recommendations from previous reviews regarding e.g. updating and replenishment of the QA/QC plan including refinement of the existing archiving system, development of an improvement plan and increasing stress on implementation for higher Tier methods for Key Categories.

Work on an updated QA/QC plan has been completed (see Chapter 1); the improvement plan, which includes also gradual implementation of higher Tiers, is presented in this chapter, together with an overview of the main improvements implemented so far in comparison with the 2011 submission.

Sector Chapters 3 to 8 contain current suggestions for improvements in the individual sectors as well as detailed explanations of how the ERT recommendations are specifically taken into account.

In September 2012, the Czech Republic was subjected to the centralised review in Bonn. During the review ERT identified the “potential problem” regarding following categories:

1) CO_2 emissions from 1.A Stationary Combustion

11) CO_2, CH_4 and N_2O emissions from 1.A.3.a Civil Aviation

12) CH_4 and N_2O emissions from 1.A.4.b Residential

13) CH_4 emissions from 1.B.1.b Solid Fuel Transformation

14) N_2O emissions from 4.D.1.3 N-fixing crops

15) N_2O emissions from 4.D.1.4 Crop residue

16) CH_4 emissions from 6.A Solid Waste Disposal

17) CH_4 and N_2O emissions from 6.C Waste Incineration.

Issues 1), 3) – 6) were fully accepted by the Czech team and recalculated according to ERT instructions in time (during a 6 week period). Brief description of these recalculations is given above (Reporting under 3.1(e)). After resubmission the national GHG emissions total was by 365.5 kt (i.e. 0.27% of total GHG emissions) higher.

Other issues 2), 7), 8) were carefully considered and were solved (without recalculation) by the Czech team by more transparent and more detailed explanation of the adequacy of used methods. Finally, ERT considered the whole “potential problem” as resolved.

In September 2013, the Czech Republic was subjected to the centralised review in Bonn. During the review ERT identified following potential problems:

1) Relevant background information and a descriptive summary of the revisions made by the Czech Republic in its 2013 inventory submission, in particular in the year 2011 with respect to HFC, PFC and SF_6 emissions from consumption of halocarbons and SF_6 and N_2O emissions from domestic and commercial wastewater handling (human sewage);

18) A complete resubmission of the 2013 CRF tables, reflecting the revised estimates;

19) Party’s revision of the calculation of the commitment period reserve, based on the recalculated emissions reported for 2011, if the calculation of the commitment period reserve is based on the inventory and not the assigned amount.

All issues were accepted and the revised estimates were submitted in time.

Unfortunately, the relevant draft of the ARR has not been made available before official submission of this report. Therefore, it was not possible to take into account in this submission (15 March 2014) possible finding of ERT except those mentioned in the Saturday paper.

Overview of all actual recalculations (compared with the April’s 2013 submission) are given above (Chapter 10.2)

10.4.1 Overview of implemented improvements in the 2016 submission

The following table summarises the main changes and that were performed in 2016 (2014) submissions in comparison with previous submissions. Since there was no review held in 2015, most of changes were implemented from Party’s initiative to improve the inventory.

Last review was held in September 2013, when the Czech Republic was subjected to the centralised review in Bonn. However, the relevant draft of the ARR 2013 was not submitted so far. Therefore possible improvements based on ARR 2013 will be addressed only in the 2015 submission (except findings formulated in “Saturday paper” as potential problems that were resolved in time – resubmission in October 2013).

For changes in methodological descriptions please see Tab. 10-2.

Tab. 10-2 Table of implemented improvements in the 2016 submission

Topic/Category, gas	Description of the change	Reason (motive) of the change	Reference to NIR or CRF Table
Sector: General issues			
QA/QC	Improved and updated QA/QC plan	Improvement suggested by Party	NIR, chapter 1.5 NIR, chapters 3 – 8
Improvement plan	Updated Improvement plan	ARR 2010, para 16, para 37a ARR 2011,. para 32,33	NIR, chapter 10.3.2
Archiving	Revised archiving routines	ARR 2010, para 34, 38b ARR 2011, para 48	NIR, chapter 1.3.3

Topic/Category, gas	Description of the change	Reason (motive) of the change	Reference to NIR or CRF Table
Sector: Energy – emissions from combustion			
1.A	Reallocation of non-energy use of Natural Gas	Improvement suggested by Party	NIR, chapter 3.2.12.5
Sector: Industrial processes and Other Product Use			
2.A.2	Updated country specific emission factor	Improvement suggested by Party	NIR, chapter 4.2
2.A.4.a	Updated country specific emission factor for 1990-2009 and implementation of EU ETS emission factor for 2010-2014	Improvement suggested by Party	NIR, chapter 4.2
2.A.4.d	Including emissions from mineral wool production and flue-gas desulphurisation.	Improvement suggested by Party	NIR, chapter 4.2
2.B.10	Including specify two new subcategories	Improvement suggested by Party	NIR, chapter 4.2
2.E.1	Including emissions from by-products	Improvement suggested by Party	NIR, chapter 4.6
2.F.1	Relocation of HFC-23, HFC-32, HFC-143a and HFC-125	Based on the consultations with external experts	NIR, chapter 4.7
2.F.3	Changing life factor and lifetime according to IPCC 2006 Gl	Improvement suggested by Party	NIR, chapter 4.7
2.G.1	Corection of emission factor.	Based on the consultations with external experts	NIR, chapter 4.8
Sector: Agriculture			
3.A, CH_4	Implementation of updated emission parameters and factors (Cfi, Ym)	Initial checks	NIR, chapter 5.2.
3.B, CH_4	Implementation of updated emission parameters and factors (VS for cattle, pig manure)	Initial checks	NIR, chapter 5.2
3.B, N_2O	Implementation of updated emission parameters and factors (Nex for other animals)	Initial checks	NIR, chapter 5.2
3.D, N_2O	Updated based on the recalculations in 3A and 3B categories	Improvements suggested by Party	NIR, chapter 5.4
3.H, CO_2	Updated the activity data of Urea application in time period 2000-2014 (data MA)	Improvements suggested by Party	NIR, chapter 5.8
Sector: LULUCF			
4.A – 4.F	Updated land-use areas based on new data from COSMC and linked revision of the land-use representation and land use change identification system	Improvements suggested by Party	NIR, chapters 6.2, 6.3
4.B, 4.C	Updated methods to estimate emissions from soils in 4B1 and 4C1 land use categories	Improvements suggested by recent reviews and Party	NIR, chapter 6.5, 6.6
4.G	Updated methodology for HWP	Improvement arising from new LULUCF reporting requirements	NIR, chapter 6.10
Unassigned	Updated estimates of Indirect emissions from atmospheric deposition of N volatized from managed soils under Table 4(IV)	Improvement arising from new LULUCF reporting requirements	NIR, chapter 6.5
Sector: Waste			
5.C	Updated data source for 5.C	Improvement suggested by Party	NIR, chapter 7
5.D	Updated methodology for subsector 5.D.1	Improvement suggested by Party	NIR, chapter 7

Tab. 10-3 Methodological descriptions in submission 2016

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
Total (Net Emissions)			More detailed information for each recalculation is provided in Table 10-1 and in relevant Chapters of NIR
1. Energy		√	
A. Fuel Combustion (Sectoral Approach)		√	
1. Energy Industries			
2. Manufacturing Industries and Construction	√	√	
3. Transport			
4. Other Sectors			
5. Other			
B. Fugitive Emissions from Fuels			
1. Solid Fuels			
2. Oil and Natural Gas and Other emissions from Energy Production			
C. CO_2 transport and storage			
2. Industrial Processes	√	√	
A. Mineral Industry	√	√	
B. Chemical Industry	√	√	
C. Metal Industry		√	
D. Non-energy Products from Fuels and Solvent Use		√	
E. Electronics Industry	√	√	
F. Product Uses as Substitutes for ODS	√	√	
G. Other Product Manufacture and Use	√	√	
3. Agriculture		√	
A. Enteric Fermentation		√	
B. Manure Management		√	
C. Rice Cultivation	NO	NO	
D. Agricultural Soils		√	
E. Prescribed Burning of Savannas	NO	NO	
F. Field Burning of Agricultural Residues	NO	NO	
G. Liming			
H. Urea Application		√	
I. Other Carbon-containing Fertilizers	NO	NO	
J. Other	NO	NO	
4. Land Use, Land-Use Change and Forestry	√	√	
A. Forest Land		√	
B. Cropland	√	√	
C. Grassland	√	√	
D. Wetlands		√	
E. Settlements		√	
F. Other Land	√	√	
G. Harvested Wood Products	√	√	
H. Other			
5. Waste	√	√	
A. Solid Waste Disposal			
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)	NO	NO	

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
KP LULUCF	Not reported in this submission	Not reported in this submission	
Article 3.3 activities			
Afforestation/reforestation		√	
Deforestation		√	
Article 3.4 activities			
Forest management		√	
Cropland management (if elected)			
Grazing land management (if elected)			
Revegetation (if elected)			
Wetland drainage and rewetting (if elected)			
HWP	Newly reported	Newly reported	
Memo Items:			
International Bunkers			
Aviation			
Marine			
Multilateral Operations			
CO_2 Emissions from Biomass			
CO_2 Captured			
Long-term storage of C in waste disposal sites			
Indirect N_2O			
NIR Chapter	**DESCRIPTION**		**REFERENCE**
	Please tick where the latest NIR includes major changes		**If ticked please provide some more detailed information**
Chapter 1.2 Institutional arrangements			
Chapter 1.6 QA/QC plan	√		

10.4.2 Improvement plan

Provisional Improvement plan was included in the NIR already last year and in this submission was updated and supplemented. This plan is in accordance with the recommendation of the international Expert Review Team (ERT) and concentrates particularly on introduction the more sophisticated procedures of the higher Tiers. These procedures employ country-specific emission factors and other parameters required for determining greenhouse gas emissions. However, it is rather difficult to obtain the data required for these purposes, especially at the present time, when only limited funds are available for the national inventory. Thus, it is planned to introduce the procedures of the higher Tiers gradually, over a longer time interval. In accordance with the IPCC methodology, emphasis is simultaneously put on Key categories. The following table gives the anticipated timetable for introduction of these procedures. As announced in the last submission, the country-specific emission factor for estimating CO_2 emissions from combustion of Natural Gas has been determined (please see Annex 2). These factors were already employed in this submission (see Chapter 3).

In addition to the planned introduction of the procedures of the higher Tiers in the individual sectors, the Improvement plan also includes a more general aspect. For instance last year have been revised uncertainty estimates. A substantial improvement in this respect has already appeared in this submission (see Chapter 1).

Furthermore Improvement Plan also includes using of EU ETS data for the purposes of national inventory. Substantial effort is put into implementation of this issue. In this submission EU ETS data were used for emission estimates in some subcategories in 2.A Mineral Product (e.g. 2.A.1 Cement Production). EU ETS data would be useful tool for QA/QC procedures also in Energy sector.

With the implementation of this issue could help also MS assistance project (Assistance to MS with KP Reporting) which is now under operation. Issue of implementation of EU ETS data was raised by the Czech Republic. Another issues concerning Energy and IP sector were raised in this assistance project.

Tab. 10-4 Plan of improvements for key categories

Sector	Key Categories (KC)	GHG	% *) GHG	Type of KC	Present situation	Planned improvement	For submission
General	Uncertainty estimates				Research of uncertainties held in 2012	Improvement of uncertainty estimates	2018
General	KC analysis				KC estimated using Tier 1	KC analysis using Tier 2	2017
1.A.1.a.i	Public electricity and heat production	AD			Activity data reported under 1.A.1.a.i	Distribution of fuel consumption in each subsector of 1.A.1.a	2017
1.A.1.b	Petroleum Refining	AD			Activity data fluctuation in 1993 till 1995	Research and possibly update of activity data for 1993 - 1995	2017
1.A.2.a	Iron and steel	AD			Consumption of coke oven gas is all reported under 1.A.2.a	Obtaining of data of Coke Oven Gas delivery to other facilities than the main metallurgical installations; possible reallocation of activity data based on this research	2017
1.A	1A.3.b Transport - Road Transportation	CO_2	13.05	LA,TA	Activity data for PC and LDT are reported together	Split activity data for PC and LDT to their own categories	2018
1.A.4.a	Commertial/Institutional	AD			Activity data fluctuation in 1991 till 1995	Detailed research of data at the beginning of 90s is planned for the future submissions	2017
1.A	Stationary combustion - Liquid fules	CO_2	15.48	LA,TA	Default Emission factors	Detailed research of carbon contained in liquid fuels and consequent development of country specific emission factors	2017
1.A.1.a	Stationary Combustion - Solid Fuels	CH_4	0.15	TA	Defaul EF	Country specific emission factors (measurement of concentrations in the flues gases of significatn sources)	2019-2020
1.A.1.a	Stationary Combustion - Liquid Fuels	N_2O	0.55	LA,TA	Defaul EF	Country specific emission factors	after 2020
2.B.2	2.B.2 Nitric Acid Production	N_2O	0.21	TA	Tier 2	Implementation of EU ETS data	2017, 2018
2.B.8	2.B.8. Petrochemical and carbon black production	CO_2	0.88	LA, TA	Tier 1	Country specific EFs for steam cracking ethylene production for CO_2 emissions	2017, 2018
2.F.1	2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	AD	2.26	LA,TA	Tier 1 - AD obtained from Custom Authorities	New source of AD	2018
3	3.A Enteric Fermentation	CH_4	2.28	LA,TA	Tier 2	Update of initial zoo-technical data	2017
3	3.B Manure Management	CH_4	0.62	LA,TA	Tier 2	Update of initial zoo-technical data	2017

Sector	Key Categories (KC)	GHG	% *) GHG	Type of KC	Present situation	Planned improvement	For submission
3	3.B Manure Management	N_2O	1.06	LA,TA	Tier 2	Update of initial zoo-technical data	2017
3	3.D.1 Agricultural Soils, Direct Emissions	N_2O	1.94	LA,TA	Tier 2	Apply country-specific parameters for crops	2017
3	3.D.2 Agricultural Soils, Indirect Emissions	N_2O	0.64	LA	Tier 1	Verification of activity data for leaching (FracLEACH)	2018
3	3.G Liming	CO_2		TA	Tier 1	Obtaining detailed data of aerial liming	2017
4	4.A.1 Forest Land remaining Forest Land	CO_2 N_2O CH_4		LA,TA	Tier 3	Further revision of EFs on carbon content in wood according to the latest scientific evidence	2017
5	5.B.2 Anaerobic digestion	CH_4			CS, D	Review current leakages EF used	2017
5	5.C.2 Open burning of waste	CO_2			Tier 1	Research methodology on fires and open burning of waste	2017
5	5.D Waste water treatment	CH_4	0.59	LA	Tier 1	Review of method, streamlining of worksheets, critical data review	2017

Part 2: Supplementary Information Required under Article 7, paragraph 1

11 KP LULUCF

This chapter includes information required under KP LULUCF reporting for NIR submission in 2015 and 2016.

11.1 General Information

The information provided in this chapter follows the requirements set in "Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol" (Annex to decision 15/CMP.1, FCCC/KP/CMP/2005/8/Add.2) and "Information on land use, land-use change and forestry activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol in annual greenhouse gas inventories" (Annex II to decision 2/CMP.8, FCCC/KP/CMP/2012/13/Add.1).

This is the first report on KP LULUCF activities under the second commitment period of the Kyoto Protocol (further denoted as 2CP), as the CRF Reporter software provided by UNFCCC became operational only early in 2016.

11.1.1 Definition of forest and any other criteria

For reporting LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol, forest is defined as land with tree crown cover over at least 30% (or equivalent stocking density) and an area of more than 0.05 hectares. Trees should reach a minimum height of 2 meters at maturity. Tree rows less than 20 meters wide are not considered to form a forest.

In the Czech Republic, forests are strongly affected by forest management and the long forestry tradition. Hence, most of the forests should be considered as planted forest, whereas natural forests correspond to only a small fraction of the forest area. This area is under a specific protection and conservation regime based on the categories of Act 114/1992 Col. These categories include forests of different degree of naturalness, ranging from near-natural, natural and virgin forests. Only the latter two categories can be considered as natural and covered 29.1 ha as of 2014 (MZF 2015). All other forest area in the country (ca. 2.67 Mha) is then covered by dominantly planted forest, which is to a various degree affected by forest management interventions.

11.1.2 Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

In addition to the mandatory activities of Afforestation/Reforestation (further denoted as AR) and Deforestation (D) under Article 3, paragraph 3, of the Kyoto Protocol, the Czech Republic elected the optional activity of Forest Management (FM) under Article 3.4 of the Kyoto Protocol to be included in the accounting for the first commitment period. For 2CP, these activities (AR, D and FM) are mandatory, while the remaining KP LULUCF activities are neither elected nor reported by the Czech Republic. The accounting for KP LULUCF activities will be performed for the entire 2CP at its end.

11.1.3 Implementation and application of activities and elected activities under Article 3.3 and Article 3.4

Due to the close links imposed between the emission inventory under the Convention and under the Kyoto Protocol, most of the methodological approaches are applicable identically for the emission estimates of KP LULUCF activities and for those reported for the LULUCF sector under the Convention. Hence, reference is frequently made to the corresponding methodologies described in Chapter 6 (LULUCF) of the NIR 2016 text, while additional and specific information related to KP LULUCF activities is highlighted here.

The conceptual linkage between the AR, D and FM activities and the reporting based on land use categories under the Convention is as follows:

- **AR activity may represent the following types of land-use conversions:**
  - 4.A.2.1. Cropland converted to Forest Land
  - 4.A.2.2. Grassland converted to Forest Land
  - 4.A.2.3. Wetlands converted to Forest Land
  - 4.A.2.4. Settlements converted to Forest Land
  - 4.A.2.5. Other Land converted to Forest Land

- **D activity may represent the following situations:**
  - 4.B.2.1. Forest land converted to Cropland
  - 4.C.2.1. Forest land converted to Grassland
  - 4.D.2.1. Forest land converted to Wetlands
  - 4.E.2.1. Forest land converted to Settlements
  - 4.F.2.1. Forest land converted to Other Land

- **FM activities relate to emissions and removals correspondingly as described in category 4.A.1 Forest land remaining Forest land**

In this way, AR activities generally always represent land-use conversion from a land-use category other than Forest Land to the land use category of Forest Land. Similarly, D is an activity when Forest Land is converted to other types of land-use, as shown above. These links are retained consistently for the entire reporting period, similarly as for the adopted methodology. This ensures consistent treatment of the activity data and methodologies across 2CP, as well as for the reporting period under the Convention, i.e., since 1990, and in some applicable instances since 1969. Other details can be found below.

11.1.4 Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently employed in determining how land was classified.

Since only one activity of the listed Article 3.4 activities is reported by the Czech Republic, no precedence conditions and/or hierarchy among Article 3.4 activities are applicable.

11.2 Land-related information

11.2.1 Spatial assessment unit used for determining the area of the units of land under Article 3.3

Land areas associated with LULUCF activities are identified within a geographic boundary encompassing units of land or land subject to multiple activities under article 3.3 and 3.4 activities (i.e. reporting method 1, IPCC 2014). Considering the small area of the country and its specific conditions, there is no applicable stratification that would justify reporting for smaller than a country-level unit. 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 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. The system is exclusively based on the annually updated data on land use from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) at the level of approximately 13 thousand individual cadastral units (Fig. 11.1). For this submission, the land use representation and land use change identification system was further refined as described in Chapter 6.2. Specifically for 2014, the areas of AR and D were estimated at the level of 13 054 cadastral units. The mean area of these units that enter the analysis of land-use changes within each of them is 6.04 km^2. The cadastral information on particular land-use categories has a resolution of m^2. The minimum assessment unit for land-use change detection is 0.05 ha. This is linked to the spatial parameters of the forest definition employed in the Czech Republic.

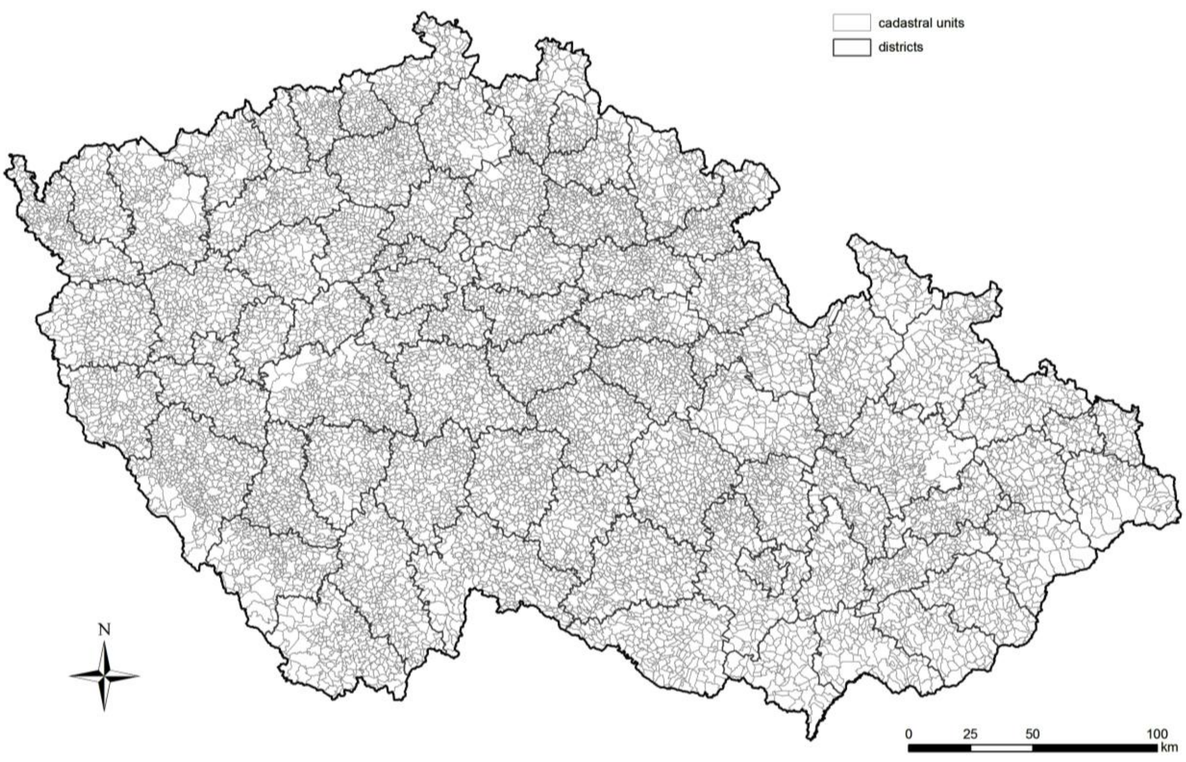


Fig. 11.1: The spatial detail of the land use representation and land-use change identification system used for detecting land use change associated with ARD activities. In 2014, the areas of ARD were estimated at the level of 13 054 individual cadastral units.

11.2.2 Methodology used to develop the land transition matrix

The land use representation and land-use change identification system was created in several steps, namely 1) source data assembly 2) linking land-use definitions 3) identification of land-use change 4) complementing time-series. These steps are described in detailed in Section 6.2 above. This results in a system of consistent representation of land areas, ranking as Reporting Method 1 of GPG for LULUCF (IPCC, 2014), having the attributes of both Approach 2 and Approach 3 and permitting accounting for all mandatory land-use transitions in annual time steps.

Tab. 11-1 The identified land-use change from Cropland (C), Grassland (G), Wetlands (W), Settlements (S) and Other Land (O) to Forest Land (F), categorized as AR (kha/year) and land use change from F to land use categories C, G, W, S and O, which represent D (kha/year).

Year	Afforestation/Reforestation (AR, kha/year)						Deforestation (D, kha/year)					
	C to F	G to F	W to F	S to F	O to F	Total	F to C	F to G	F to W	F to S	F to O	Total
1990	0.50	0.36	0.00	0.02	0.00	0.88	0.03	0.08	0.01	0.28	0.00	0.40
1991	1.14	0.01	0.00	0.02	0.00	1.17	0.01	0.65	0.06	0.13	0.00	0.84
1992	0.15	0.05	0.01	0.02	0.00	0.23	0.03	0.20	0.02	0.21	0.00	0.47
1993	0.09	0.11	0.02	0.19	0.00	0.41	0.19	0.07	0.02	0.57	0.00	0.85
1994	0.26	0.29	0.12	0.90	0.00	1.56	0.13	0.08	0.01	0.40	0.00	0.62
1995	0.38	0.35	0.00	0.50	0.00	1.24	0.14	0.07	0.02	0.29	0.00	0.51
1996	0.74	0.41	0.03	0.59	0.00	1.77	0.18	0.32	0.02	0.38	0.00	0.90
1997	0.30	0.44	0.05	0.97	0.00	1.76	0.21	0.17	0.03	0.38	0.00	0.79
1998	0.46	0.67	0.09	2.28	0.00	3.51	0.38	0.39	0.05	0.56	0.00	1.38
1999	0.31	0.40	0.04	0.81	0.00	1.56	0.21	0.08	0.06	0.62	0.00	0.96
2000	0.51	0.54	0.08	2.40	0.00	3.52	0.13	0.14	0.06	0.39	0.00	0.72
2001	0.43	0.49	0.04	1.22	0.00	2.17	0.07	0.10	0.02	0.33	0.00	0.52
2002	0.34	0.77	0.04	3.55	0.00	4.71	0.04	0.07	0.08	0.33	0.00	0.52
2003	0.68	0.60	0.03	0.76	0.00	2.07	0.08	0.13	0.05	0.52	0.00	0.77
2004	0.66	0.80	0.07	0.52	0.26	2.30	0.10	0.07	0.02	0.51	0.02	0.72
2005	0.75	0.93	0.01	0.53	0.19	2.42	0.09	0.09	0.03	0.47	0.03	0.70
2006	1.03	0.62	0.04	0.39	0.18	2.25	0.07	0.04	0.03	0.36	0.01	0.52
2007	0.82	0.56	0.02	0.85	0.30	2.54	0.05	0.07	0.03	0.29	0.04	0.46
2008	0.67	0.49	0.08	0.87	0.22	2.33	0.11	0.05	0.03	0.29	0.02	0.50
2009	0.71	0.67	0.10	0.83	0.41	2.71	0.08	0.12	0.03	0.32	0.01	0.56
2010	1.01	0.63	0.14	0.71	0.45	2.94	0.11	0.09	0.06	0.36	0.02	0.63
2011	0.71	0.62	0.10	0.94	0.69	3.06	0.27	0.18	0.08	0.33	0.02	0.88
2012	0.74	0.70	0.05	0.78	0.35	2.62	0.07	0.11	0.04	0.26	0.04	0.51
2013	0.69	0.57	0.04	0.71	0.45	2.47	0.09	0.07	0.06	0.24	0.11	0.58
2014	0.67	0.43	0.05	1.84	0.28	3.27	0.08	0.09	0.04	0.35	0.02	0.57

The identified annual land use changes among the major land use categories as defined in the Czech emission inventory are shown Tab. 11-1. The mean area of AR activities reached 2.2 kha per year during the 1990 to 2014 period, corresponding to a cumulative area of 55.5 kha. For the same period, the mean area of D reached 0.7 kha per year, which amounts to 16.9 kha for the entire period. The difference between AR and D corresponds to the net increment of cadastral forest land as shown in Fig. 6-4 above.

Although the system of land-use representation and land-use identification is basically identical for both KP-reporting and Convention reporting, there are some notable differences that have implications for the reported areas of KP activities (Tab. 11-2). These differences are imposed by the specific requirements for the reporting of LULUCF activities under the Kyoto protocol, namely:

i) AR activities that qualify under KP accounting are only those commenced since 1990

ii) AR land must be traced under KP reporting, i.e., it never enters the land registered under FM activity.

To handle this issue in the KP LULUCF reporting, two additional technical sub-categories were introduced for FM reporting. One is “Forest land remaining Forest land in KP reporting”, while the second is “Residual afforested land from before 1990 (in conversion status)”. The entire land qualified as the area under FM activity represents the sum of these two categories.

Tab. 11-2: The forest areas of subcategories by four major tree species (Beech, Oak, Pine, Spruce) and the temporary unstocked areas (clearcut, CA), which altogether form the category 4A1 of the Convention reporting. Although not explicitly labelled in this table, until 2009 4A1 was identical with the category of Forest Land remaining Forest Land (FLRFL) used in the KP reporting of FM. 4A2 represents Land converted to Forest land, remaining in conversion status for a period of 20 years. 4A1 and 4A2 form the entire category 4A Forest Land used in the Convention reporting. Residual afforestation (RA) represents the fraction of AR areas afforested prior 1990, which forms part of the FM area (FM = FLRFL+RA), while the AR since 1990 (Art. 3.3) is treated separately and shown in Tab. 11-1 above

Year	Convention and KP LULUCF reporting categories and their areas (kha) since 1990									
	Beech	Oak	Pine	Spruce	CA	4A2	4A	FLRFL	RA	FM
1990	380.9	156.0	466.2	1539.2	40.6	46.6	2629.5	2582.9	45.7	2628.6
1991	384.0	156.6	466.1	1535.0	40.7	46.9	2629.3	2582.4	44.8	2627.2
1992	387.4	157.7	464.7	1534.7	41.9	42.5	2629.1	2586.5	40.3	2626.8
1993	390.0	158.4	462.9	1533.9	41.4	41.9	2628.6	2586.7	39.2	2625.9
1994	393.9	158.6	461.5	1537.3	39.8	38.3	2629.5	2591.1	34.0	2625.1
1995	397.2	159.2	461.6	1537.7	38.9	35.4	2630.1	2594.6	29.9	2624.5
1996	399.9	160.9	460.8	1536.4	38.1	34.7	2631.0	2596.1	27.5	2623.6
1997	403.3	160.9	460.3	1537.3	36.0	33.8	2631.8	2597.8	24.8	2622.6
1998	409.9	161.3	462.9	1532.5	33.7	33.3	2633.8	2600.3	20.8	2621.0
1999	412.7	163.3	458.9	1537.6	32.2	29.5	2634.5	2604.7	15.4	2620.1
2000	417.0	165.3	457.5	1536.6	31.0	29.6	2637.3	2607.4	12.0	2619.4
2001	422.2	166.5	456.2	1535.7	29.8	28.5	2639.2	2610.4	8.7	2619.1
2002	428.1	168.0	454.1	1531.5	28.3	32.7	2643.1	2610.1	8.3	2618.3
2003	435.5	169.6	452.7	1525.2	27.0	33.9	2644.2	2610.0	7.4	2617.4
2004	441.1	170.4	450.3	1521.5	26.8	35.5	2645.7	2610.1	6.6	2616.7
2005	447.3	171.1	448.8	1517.5	26.3	36.3	2647.4	2610.9	5.0	2616.0
2006	451.7	173.0	446.8	1514.1	25.9	37.4	2649.1	2611.5	3.9	2615.5
2007	457.6	174.2	444.8	1509.9	26.1	38.6	2651.2	2612.5	2.5	2615.0
2008	464.6	176.6	442.9	1502.3	27.1	39.5	2653.0	2613.4	1.1	2614.5
2009	471.0	177.8	440.9	1496.7	27.6	41.1	2655.2	2613.9	0.0	2613.9
2010	475.2	179.7	439.4	1490.7	28.1	43.2	2657.4	2613.1	0.0	2613.1
2011	479.8	181.8	437.0	1484.8	29.1	45.0	2659.8	2612.6	0.0	2612.6
2012	485.6	183.4	435.4	1477.6	30.0	47.4	2661.9	2612.0	0.0	2612.0
2013	492.2	185.1	433.8	1469.9	30.5	49.5	2663.7	2611.4	0.0	2611.4
2014	500.4	185.1	431.0	1461.3	33.1	51.2	2666.4	2610.8	0.0	2610.8

The Czech inventory system adopts the 20-year default period for preserving lands under conversion status as recommended by IPCC (2006). Therefore, the areas of the sub-category Forest land remaining Forest land in KP reporting are equal to the areas in the category 4A1 under Convention reporting until 2009. In KP reporting, the entire area of FM must additionally include the fraction of land afforested prior 1990, which is represented by the second introduced sub-category, i.e., “Residual afforested land from before 1990 (i.e., in conversion status)”, which is abbreviated as RA in Tab. 11-2.

Since the reported year 2010, the area of FLRFL became equal to FM and the area of RA became zero. At the same time, the FM area became smaller than that reported under 4A1 under the Convention reporting (4A1 is not explicitly shown in Tab. 11-2, but it is equal to 4A - 4A2) and hence also the areas of the individual species groups differ under the Convention and KP reporting. This is due to the fact that forest area loss from FM due to D activities is not compensated by any residual areas of formerly (prior 1990) afforested land, and because AR, similarly to D, remain treated separately from FM even after 20 years.[10]

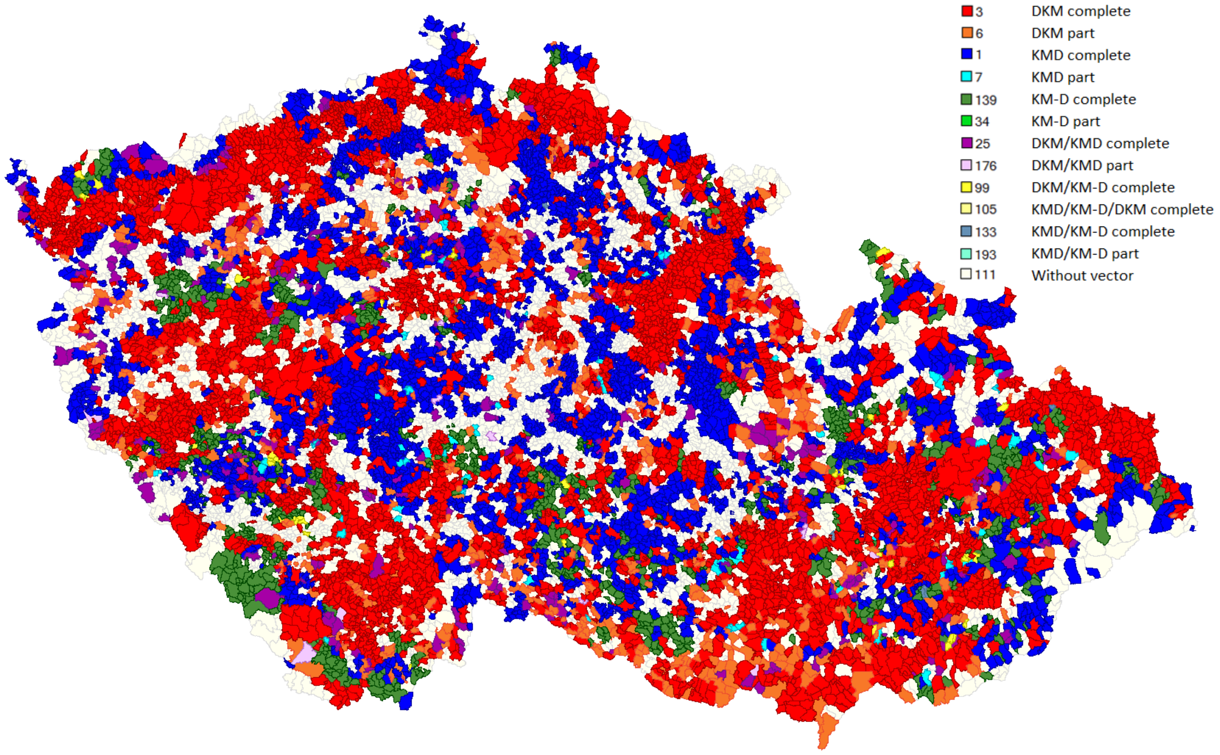


Fig. 11.2: The ongoing digitalization of the Czech cadastral land use information with units identified by categories of source map origin, coordination system and scale (DKM, KMD, KM-D and their combination) and completeness labelled by individual colours. Based on the information of COSMC as of 2013.

The system of land use, land-use representation and land-use change identification as currently implemented in this inventory represents the most advanced approach achievable within the conditions in the country. It should be understood that it is basically a bottom-up system using detailed information at the level of individual cadastral units (n=13 054 as of 2014). The information as reported in the CRF tables represents sum-up values of the individual cadastral units, involving 10 land use types of the original categorization and the time span from 1969 to 2014. It should also be noted the reconciled official land use information of COSMC undergoes continuous updating and accuracy improvement due to the progressing digitalization of the original maps. The resulting digital maps are distinguished by the source information and its coordination system. As also noted in section 6.2 of the NIR text (see also Footnote 3), the LULUCF inventory consults the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) on the issues related to the information on land areas in the Czech Republic. To illustrate the process of ongoing digitalization of cadastral maps in the county, we include the map of the

[10] It should be stressed that although fully solved in the Czech LULUCF and KP LULUCF inventory, the seemingly similar but different treatment of forest land areas under Convention and KP reporting is unfortunate and unnecessarily complex.

recent (as of 2013) state of the art in this process (Fig. 11.2, based on COSMC). It gives an overview of the national cadastral system under the process of digitalization, with different categories by source map origin, coordination system, scale and completeness labelled by individual colours. Evidently, this gradual digitalization leads to rectified area information on individual cadastral parcels, units and therefore also on the entire country. This also explains the nature of the ongoing area rectifications in the official reports on areas of land and land use categories in the country.

11.2.3 Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

The KP LULUCF reporting of the Czech Republic is based on the annually updated data from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) at the level of about 13 thousands individual cadastral units (Fig. 11-1), which represent the Czech cadastral system. At that level, land use change is identifiable, using the standard identification codes and names of the Czech cadastral system and COSMC.

The spatial resolution of the adopted land-use representation and land-use change identification system is depicted in Figs. 11-3 and 11-4, which show the identified units with AR and D activities, respectively, in 2014.

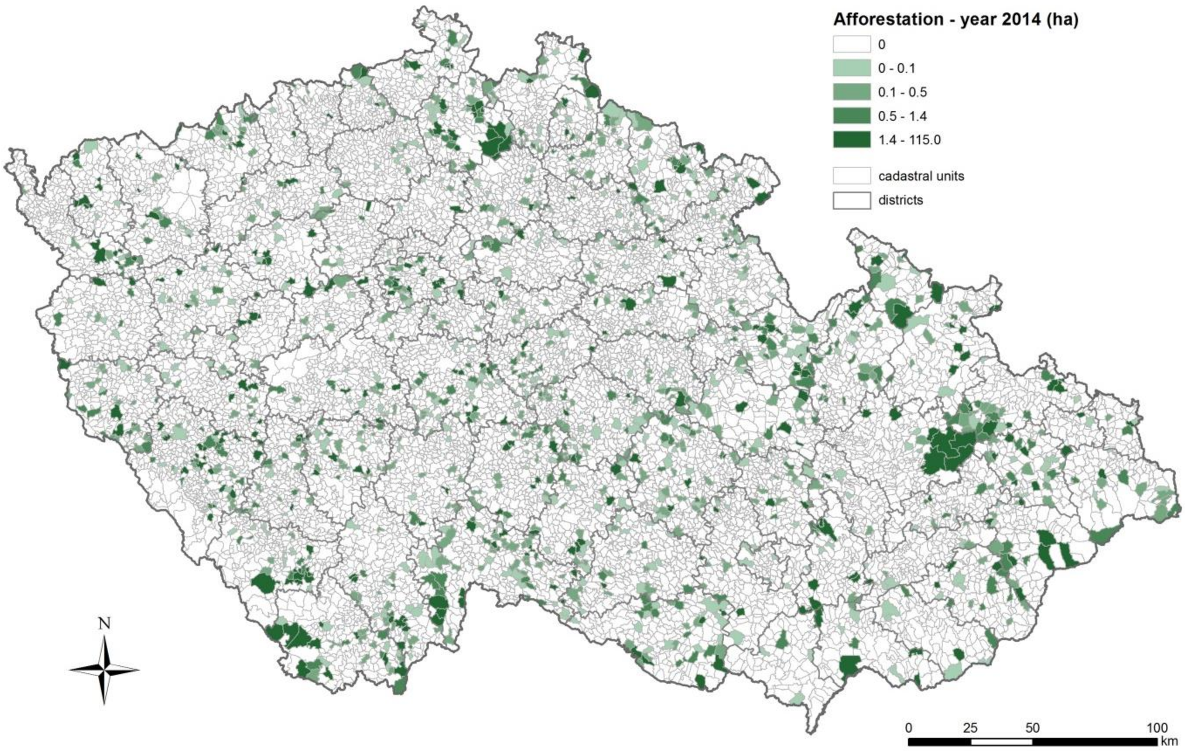


Fig. 11-3: The cadastral units with identified afforestation (AR) activities in 2014.

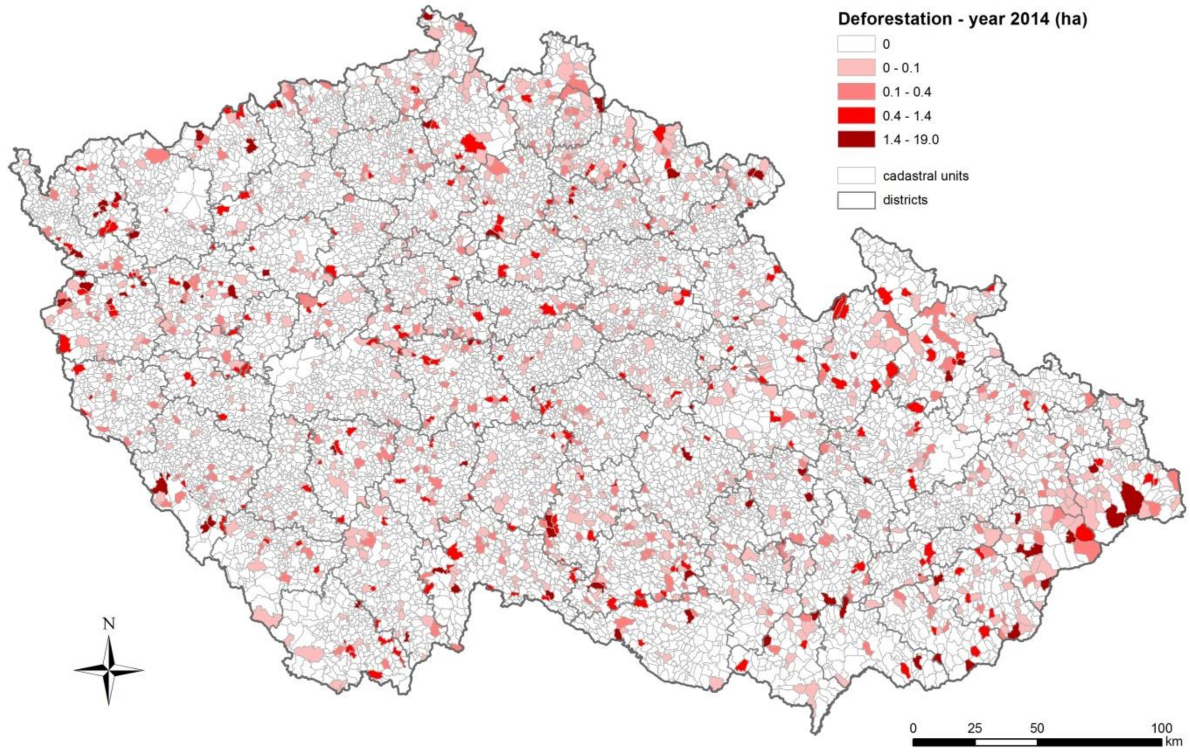


Fig. 11. 4: The cadastral units with identified deforestation (D) activities in 2014.

11.3 Activity-specific information

11.3.1 Methods for carbon stock change and GHG emission and removal estimates

11.3.1.1 Description of the methodologies and the underlying assumptions used

Due to efforts to link the emission inventory under the Convention and that under the Kyoto Protocol, most of the methodological approaches are applicable identically for the KP LULUCF activities and the relevant LULUCF categories under the Convention reporting. These are described in detail in Chapter 6 (LULUCF) of the 2016 NIR submission. Hence, reference is often made to these methodologies, while additional and specific information related to Kyoto Protocol LULUCF activities is highlighted here.

For AR activities, the applicable methodology of IPCC (2006) for estimating emissions and removals is given in Section 4.3. Correspondingly, the emissions due to D were estimated based on the guidance given in Chapters 5.3, 6.3, 7.3, 8.3 and 9.3. For specific details on the approaches employed, country-specific activity data and factors, Chapter 6 of the NIR 2016 submission should be consulted.

In the KP LULUCF reporting., the emissions and/or removals of CO_2 are quantified for changes in five ecosystem carbon pools, namely above-ground biomass, below-ground biomass, dead wood, litter and soil organic matter. Additionally, the CO_2 emission contribution is estimated for Harvested wood Products (HWP), which may also concern AR and D activities.

Changes in above-ground biomass carbon pool were estimated primarily on the basis of forest taxation data in Forest Management Plans (further denoted as FMP), disaggregated in line with the country-specific approaches at the level of the four major tree species groups, namely beech, oak, pine and spruce (Chapter 6.4 of NIR 2016).

Since the estimates of biomass carbon stock change on Forest Land under the Convention involve one default coefficient for the root/shoot ratio (*R*; 0.20) and the equations of the default method involving multiplicative members, the attributing of carbon stock change to the below- and above-ground components, required for the reporting under Kyoto Protocol, was determined solely by *R*.

The carbon stock change in dead organic matter, i.e., deadwood and litter carbon pools for AR and D activities, was estimated similarly as described for the corresponding LULUCF categories in Chapters 6.4.2.2 and 6.5.2.2 of NIR 2016. This method uses the latest activity data obtained from the statistical inventory programs available in the country. The only difference between the LULUCF and KP LULUCF approaches is the different area associated with these carbon stock changes under the two reporting bodies. Mineral soil carbon stock estimation follows the methodology of soil carbon stock change estimation resulting from land use change among the land use categories of Forest Land, Cropland and Grassland, based on the interpreted soil carbon stock maps (Section 6.4.2.2, NIR 2016). Complementarily, for sub-categories involving Wetland, Settlements and Other Land, "NA" was entered in association with the soil carbon pool, as no adopted applicable methodology is listed for this pool in IPCC (2006) for the symmetric types of land-use conversion events.

For the FM activity, which resembles category 4A1 Forest Land remaining Forest Land, the Tier 1 methodology assumption of the IPCC Guidelines (IPCC, 2006) of no significant change in the deadwood carbon pool was adopted under UNFCCC Reporting. Since Tier 1 methodology does not meet the requirements of KP LULUCF reporting, justification for using this assumption under FM activity reporting is provided in Section 11.3.1.2. Note also that there is a common misunderstanding of what Tier 1 reporting means in terms of using the appropriate notation keys. In our case, the notation key "R" is used in order to distinguish a deliberate consideration of Tier 1 assumption as compared to "NE" (not estimated). NE inherently implies that the Tier 1 assumption cannot be considered and a carbon pool under this notation may actually represent a significant source or sink of emissions, which is not the case in this inventory. More information on the deadwood carbon pool considerations under FM is therefore provided in Section 11.3.1.2, which justifies our inexplicit reporting of the deadwood carbon pool. It should also be noted that the assumptions for carbon stock change of deadwood for FM activity will probably be revised using Tier 2 or Tier 3 methodology estimation based on the results of the recently conducted CzechTerra statistical landscape inventory in the Czech Republic.

In contrast, the carbon stock change of the soil carbon pool under FM was not estimated and the "NE" notation key is used. This implicitly also applies to the litter carbon pool, which is included in the soil carbon pool for the reasons noted above in the section on AR and D reporting, as well as due to the YASSO soil model concept, which is used for justification when omitting these carbon pools in Section 11.3.1.2 below.

Additional greenhouse gases (CO_2, CH_4 and N_2O) are reported from biomass burning. Burning is explicitly confined to the activity of FM and thus matches the corresponding estimates under the Convention for the land-use category 4A1 Forest Land remaining Forest Land. The emissions are estimated identically as described in Section 6.4.2.1 of the NIR 2016 text.

There are no N_2O emissions from N-fertilization and soil drainage, which are therefore not applicable for the reporting period. On the contrary, N_2O emissions are reported for deforestation of Forest land that is converted to Cropland. This estimation is identical to that reported under the Convention and described in NIR 2016, Section 6.5.2.2 for land use category 4.B.2.1.

The estimates for the emission contribution from changes in Harvested Wood Products (HWP) are also newly included in this inventory submission. The methodology and activity data are basically identical to those employed for HWP estimates under the Convention, which is described in Chapter 6.10. The adopted approach also includes information on emissions to HWP changes attributable to areas of D, which are methodologically treated differently (instant oxidation) compared to HWP attributable to FM (first order decay by product sub-categories; Approach B1).

11.3.1.2 Justification for omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

First, justification is provided for the deadwood carbon pool under FM, which is currently reported using the Tier 1 assumption that the time average values of this pool will remain constant with inputs balanced by outputs (IPCC 2006). As this is inadequate under KP LULUCF reporting, we use the following argumentation supporting the assumption that the deadwood carbon pool does not represent a source of emissions. We use both reasoning based on sound knowledge of probable system responses and empirical data.

The reasoning is based on the long term trend of increasing growing stock in our country, which is also demonstrated for the reporting period under the Convention (cf. Chapter 6 of NIR text). On large temporal and spatial scales, the amount of deadwood is roughly proportional to the growing stock. Since the growing stock has been steadily increasing during the reporting period in the forests of this country, there is basically the same trend as for deadwood volume. An increasing pool of deadwood volume basically means removals of emissions (fixing carbon). In other words, this pool is not a source of emissions.

The statistically representative empirical data that were recently acquired in the Czech Republic offer additional support for this trend. Specifically, information on the dead wood pool is available from two independent statistical inventories. One is the National Forest Inventory (NFI), whose first and so far the only cycle was performed during 2001-2004. This inventory includes about several thousand sample plots covering the entire forest area in the country. The results of this inventory campaign were published by the Forest Management Institute, Brandýs n. Labem (FMI), in 2007 and also included information on deadwood (FMI 2007). The second data source is the ongoing project of the National landscape inventory (CzechTerra - adaptation of landscape carbon reservoirs in the context of global change), a project funded by the Ministry of the Environment (SP/2d1/93/07). CzechTerra conducted its first field sampling during 2008 and 2009 (www.czechterra.cz). This project also contains a statistically representative assessment of the deadwood pool in forests applicable at a country level. Since both NFI and CzechTerra use an identical assessment method for lying deadwood volume, a straightforward comparison can be performed to assess the trend of lying dead wood pool change in Czech forests during very recent years. It can be assumed that NFI sampling represents the year 2003, while CzechTerra sampling represents the year 2009. Lying deadwood volume is estimated for four classes of decay stages, which are summarized in Table 11-3 below.

Tab. 11-3 Mean volume of lying deadwood on forest land by decay classes as estimated by the NFI and CzechTerra inventory programs. The unit is mil. m^3 and the parentheses show the 95% confidence interval.

Campaign Decay stage	NFI – ref. year 2003	CzechTerra – ref. year 2009
Wood is hard	7.47 (7.02 - 7.93)	9.54 (7.58 – 11.5)
Soft periphery, centre hard	3.75 (3.48 - 4.02)	5.10 (2.81 – 7.38)
Hard periphery, centre soft	0.82 (0.73 - 0.90)	1.28 (0.72 – 1.85)
Totally soft/rotten	6.28 (5.98 - 6.59)	4.79 (3.84 – 5.74)

The volume of deadwood estimated by the CzechTerra campaign, representing the situation as of 2009, is larger for most of the decay stage classes compared to the estimates by NFI conducted for 2003. To envisage this trend more clearly, deadwood volume can be converted into biomass and carbon quantities as the product of the wood volume, density weighted by the mean growing stock volume of major tree species, reduction coefficients applicable to individual decomposition categories and wood carbon fraction as given in Section 11.3.1.1 above. The result of this recalculation is shown in Table 11-4.

Tab. 11-4 Carbon stock held in lying deadwood on forest land by decay classes as estimated by the NFI and CzechTerra inventory programs. The unit is mil. t C.

Campaign Decay stage	NFI – ref. year 2003	CzechTerra – ref. year 2009
Wood is hard	1.29	1.65
Soft periphery, centre hard	0.65	0.88
Hard periphery, centre soft	0.09	0.14
Totally soft/rotten	0.27	0.21
Total quantity	2.30	2.88

To interpret the estimates shown in Table 11-4, we see that the total carbon content held in deadwood increased from 2.30 mil. t C in 2003 to 2.88 mil. t C in 2009. The difference is 0.58 mil. t C accumulated during the period of 6 years. Thus, the annual accumulation of carbon held in deadwood was 0.096 mil. t C, which represents a CO_2 sink of -0.35 mil. t CO_2/year.

To conclude, the above quantitative assessment from the two country-level statistical inventory programs (with identical methodology to obtain deadwood volume estimates by decay classes) demonstrates that the deadwood carbon pool is currently not a source of emissions under the conditions in the Czech Republic. However, it is planned that both the data and the underlying assumptions for deadwood carbon pool estimation will be further examined to explore the possibility of its specific accounting also under FM activity. This is already planned for the next, i.e., 2017 NIR inventory submission.

Secondly, we provide justification for omitting the soil carbon pool (and inherently the litter carbon pool) from the reporting under FM activity. Here it is also assumed that, under the conditions of current forestry practices at the country level, forest soils do not represent a net source of CO_2 emissions. Justification for this approach is based on the targeted peer-reviewed modelling analysis performed for the actual circumstances of FM in the country (Cienciala et al., 2008b). It uses the well-established YASSO soil model (Liski et al., 2003, 2005) in combination with the similarly well-known and established EFISCEN forest scenario model (e.g., Karjalainen et al., 2002) and the actual data for forest biomass, growth performance and growing conditions in the country. The analysis shows that, under the adopted sustainable forest management practices implemented in the Czech Republic, the forest soil carbon pool (including litter) does not decrease, i.e., it is not a net source of emissions. The study contains further details on the country-specific model application, definition of scenarios and results related to both biomass and soil carbon pools, including the probable effect of changing climatic conditions. It also contains a discussion that elucidates the aspect of the YASSO model concept of litter input and aggregated output for litter/organic and mineral soil layers and its justification, as well as the reasoning with respect to the Kyoto protocol LULUCF reporting requirements. There is a wealth of literature on YASSO model applications that can be further consulted (www.environment.fi/syke/yasso).

To conclude, the forest soil carbon pool and inherently the litter carbon pool under current forest management practices and growth trends can be assumed not to be a source of emissions. The underlying assumptions will be further verified.

11.3.1.3 Information on whether or not indirect and natural GHG emissions and removals have been factored out

The indirect and natural GHG emissions and removals were not factored out.

11.3.1.4 Changes in data and methods since the previous submission (recalculations)

This inventory includes changes in activity data in areas, which were further improved for this inventory. Also, new activity data were used for litter and deadwood carbon stock estimates for AR and D activities. Finally, the emission contribution of HWP is newly included. All these changes required recalculation of emission estimates for the entire reporting period and the currently reported estimates are herewith revised compared to those in the previous submission.

11.3.1.5 Uncertainty estimates

The uncertainty estimates were prepared following the methodological guidance of GPG for LULUCF (IPCC, 2003) and IPCC (2006), which is described in Chapter 6.4.3. It includes the noted issue of combining uncertainties that is considered questionable when uncertainties associated with removals and emissions are to be combined, which may result in a denominator close to or equal to zero (which is not admissible). Since the last revision introduced in the NIR 2012, no other changes have been implemented for the uncertainty estimation in the follow-up NIR submissions.

In 2014, the estimated overall uncertainty for AR activities was 39.6%. The overall uncertainty for D was 62.5%. For FM the overall uncertainty equalled 18.9%.

11.3.1.6 Information on other methodological aspects

Despite efforts to make the reporting of KP LULUCF activities correspond to that under the Convention, there are some aspects that make direct comparison difficult. Specifically for FM, a direct comparison with the emission estimates of related category 4.A.1 under the Convention reporting will reveal some differences. There are several aspects to be considered when comparing the quantitative estimates of these categories, which relate to different treatment of land areas, i.e., differences in land-based and activity reporting (see Chapter 11.2.2 above).

11.3.1.7 The year of the onset of an activity, if after 2013

Not applicable.

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 directly human-induced

The annually updated cadastral information from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz) 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 and individual years.

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 Czech 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 permanent cadastral change of land use from Forest Land to other categories of land use.

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.

Any deforestation in terms of land use change requires an official administrative decision. Hence, no permanent loss of forest cover may occur prior this approval, which is reflected in cadastral land use. The above also implies that there is no afforestation occurring on previously deforested land through an administrative decision. A temporary loss of forest cover up to an area of 1 ha may occur as part of forest management operations on Forest land (units of land subject to *FM*), which is, however, not qualified as deforestation in terms of Art. 3.3. KP LULUCF activity.

11.4.4 Information related to natural disturbances provision under Art. 3.3

The Czech emission inventory of KP LULUCF activities does not employ any provision for natural disturbances for the accounting in 2CP and therefore no additional specific information on this issue is provided.

11.4.5 Information on Harvested wood products under Art. 3.3

The estimates of HWP emission contribution relate to Activities under Art. 3.3. Specifically, the emission estimation discerns the contribution of D to the total HWP produced and consumed domestically in order to apply direct oxidation for the associated emissions (IPCC 2014). The share of HWP originating from D is estimated on the basis of an area-based share of land under D and FM for the individual reporting years. This share reached 0.02% in both 1990 and 2014, with a maximum of 0.05% in 1998. The mean value for the entire reporting period was 0.03%. As no HWP is assumed to originate from AR activities due to inadequate tree age, 99.98% of HWP products employed for first order decay estimation of HWP emission contribution originates from the areas under FM.

11.4.6 Information on estimated emissions and removals of activities under Art. 3.3

In 2014, the estimated removals from AR activities reached -550 Gg CO_2 eq. The estimated emissions from D equalled 231 Gg CO_2 eq. The details can be found in the corresponding CRF Tables of KP LULUCF.

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

The Czech Republic adopted the broad definition (FCCC/CP/2001/13/Add.1; IPCC 2014) of FM. It reads "Forest management is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner." This decision implies that the entire forest area in the country is subject to FM interventions, as guided by the Forestry Act (No. 289/1995 Coll.).

11.5.2 Information relating to Cropland Management, Grazing Land Management and Revegetation, if elected, for the base year

Not applicable for the Czech Republic.

11.5.3 Information relating to Forest Management

As noted in Section 11.5.1 above, the practice of *FM* is generally guided by the Forestry Act (No. 289/1995 Coll.).

11.5.3.1 Conversion of natural forest to planted forest

The extent of natural forest in the Czech Republic was 29.1 ha as of 2014 (MZF 2015), representing about 0.001% of the forest area in the country. The remnants of natural forest in the country are extremely valuable and under the most strict conservation and protection regime. Hence, no conversion of natural forest to planted forest is permitted and has not occurred under the conditions of the country during the reporting period since 1990.

11.5.3.2 Forest Management Reference Level (FMRL)

FMRL applicable for the Czech Republic was prepared by the Joint Research Centre of the European Commission (JRC), based on elaboration of the results of independent EU modeling groups, coordinated by the International Institute for Applied Systems Analysis (IIASA), assisted by the JRC and funded by the European Commission Directorate General of Climate Action (DG CLIM). The adopted value of FMRL with emissions/removals from HWP using the first order decay functions is 4 686 Gg CO_2 eq. A detailed description of the FMRL can be found on https://unfccc.int/bodies/awg-kp/items/5896.php (revised submission of the Czech Republic from 13 September 2011).

11.5.3.3 Technical Corrections of FMRL

No technical correction has been applied to FMRL applicable for the Czech Republic.

11.5.3.4 Information related to the natural disturbance provision under Art. 3.4

The Czech emission inventory of KP LULUCF activities does not apply any provision for natural disturbances for the accounting in 2CP and therefore no additional specific information on this issue is provided here.

11.5.3.5 Information on Harvested Wood Products under Art. 3.4

The estimates of the HWP emission contribution are predominantly related to activity of FM under Art. 3.4. The contribution of Art. 3.3 activities to HWP is discerned on the basis of the area-based share of land under D and FM for individual reporting years as described in Chapter 11.4.5. The share applicable to FM represents 99.98%, for which the first order decay estimation of the HWP emission contribution is used in accordance with IPCC (2014). The specific methodological details related to HWP under FM are described in Chapter 11.5.5 below.

11.5.4 Information on estimated emissions and removals of Forest Management activity under Art. 3.4

In 2014, the estimated removals from *FM* (without HWP contribution) reached -6 188 Gg CO_2 eq. The details can be found in the corresponding CRF Tables of KP LULUCF.

11.5.5 Information on methodology and estimated emission contribution from HWP

The activity and methodology data applicable to estimation of emission contribution from HWP are described in Chapter 6.10 of the current NIR submission. Estimation of the HWP contribution is treated identically under the Convention and KP LULUCF; therefore all details, including source category description, methodological issues, uncertainties and time series consistency, QA/QC and verification as described in Chapter 6.10 of NIR are also fully applicable for KP reporting. Other details can be found in the corresponding CRF tables.

In 2014, the estimated emission contribution from HWP reached -94.1 Gg CO_2 eq. The estimates for the entire reporting period since 1990 can be found in the corresponding CRF Tables of KP LULUCF.

11.6 Other information

11.6.1 Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

As stated in CRF KP-LULUCF table "NIR-3", one key category was identified among the KP LULUCF activities, namely FM. Similarly to its associated LULUCF category 4.A.1 Forest land remaining Forest land, it was identified by level assessment. No other activity was identified as key in this NIR submission.

11.7 Information relating to Article 6

No LULUCF joint implementation project under Art. 6 concerns the Czech Republic.

12 Information on accounting of Kyoto units

12.1 Information related to NIR submission in 2015

12.1.1 Background information

The information from the national registry on the issue, acquisition, holding, transfer, cancellation, withdrawal and carryover of assigned amount units, removal units, emission reduction units and certified emission reductions in the period from 1st of January 2014 to 31st of December 2014 is provided in standard electronic format in Annex A5. 6 of the NIR submitted in November 2015.

12.1.2 Summary of information reported in the SEF tables

The total number of AAUs in the registry at the end of the year 2014 corresponded to 683,186,585 t CO_2 eq., of which 348,536,263 units were in the Party holding account, 334,650,295 in the retirement account and 27 in other cancellation accounts.

The number of ERUs in registry corresponded to 14,006 t CO_2 eq., in the party holding account and 18,735,943 in the retirement account.

The CER units in the registry corresponded to 19,888,351 t CO_2 eq., of which 5,750 units were in the party holding account, 19,874,444 in the retirement account and 8,157 in other cancellation accounts.

There were no RMUs, t-CERs or l-CERs and no units in the Article 3.3/3.4 net source cancellation accounts and the t-CER and l-CER replacement accounts.

The total amount of units in the registry corresponded to 721,824,885 t CO_2 eq.

The Czech Republic's assigned amount equals 789,859,031 t CO_2 eq.

12.1.3 Discrepancies and notifications

No CDM notifications and non-replacements occurred in 2014.

No invalid units exist as at 31 December 2014.

No discrepant transactions occurred in 2014.

12.1.4 Publicly accessible information

Non-confidential information in accordance with decision 13/CMP.1, annex, chapter II.E, paragraphs 44–48, is provided in the Public Reports section of the registry website at:

https://ets-registry.webgate.ec.europa.eu/euregistry/CZ/public/reports/publicReports.xhtml

12.1.5 Calculation of the commitment period reserve (CPR)

Each Party included in Annex I shall maintain, in its national registry, a commitment period reserve which should not drop below 90 per cent of the Party's assigned amount calculated pursuant to Article 3, paragraphs 7 and 8, of the Kyoto Protocol, or 100 percent of five times the most recently reviewed inventory, whichever is lowest.

In the case of the Czech Republic, the relevant size of the Commitment Period Reserve is five times the most recent inventory (2013), which is calculated below[11].

5 x 127,143,93 = 635,719,651 tonnes CO_2 eq.

12.2 Information related to NIR submission in 2016

12.2.1 Background information

The information from the national registry on the issue, acquisition, holding, transfer, cancellation, withdrawal and carryover of assigned amount units, removal units, emission reduction units and certified emission reductions in the period from 1st of January 2015 to 31st of December 2015 is provided in standard electronic format in Annex A5. 6.

12.2.2 Summary of information reported in the SEF tables

The total number of AAUs in the registry at the end of the year 2015 corresponded to 675,079,362 t CO_2 eq., of which 48,272,014 units were in the Party holding account, 15,675 in the Entity holding accounts, 626,791,646 in the retirement account and 27 in other cancellation accounts.

The number of ERUs in registry corresponded to 2 t CO_2 eq. in the Entity holding accounts and 25,128,765 in the retirement account.

The CER units in the registry corresponded to 21,668,877 t CO_2 eq., of which 14,843 units were in the Entity holding accounts, 21,645,426 in the retirement account and 8,608 in other cancellation accounts.

The number of RMU units in the Article 3.3/3.4 net source cancellation accounts corresponded to 854,212 and there were 6,584,129 RMU units in the retirement account. There were no t-CERs or l-CERs and no units in the t-CER and l-CER replacement accounts.

The total amount of units in the registry corresponded to 729,315,347 t CO_2 eq.

The Czech Republic's assigned amount equals 789,859,031 t CO_2 eq.

12.2.3 Discrepancies and notifications

No CDM notifications and non-replacements occurred in 2015.

[11] *For CPR calculation used Czech Republic's total CO_2 equivalent emissions without LULUCF in 2013 (source: CZE-2015-2013.xls, Table10s6, cell: Z18).*

No invalid units exist as at 31 December 2015.

No discrepant transactions occurred in 2015.

12.2.4 Publicly accessible information

Non-confidential information in accordance with decision 13/CMP.1, annex, chapter II.E, paragraphs 44–48, is provided in the Public Reports section of the registry website at:

https://ets-registry.webgate.ec.europa.eu/euregistry/CZ/public/reports/publicReports.xhtml

12.2.5 Calculation of the commitment period reserve (CPR)

The commitment period reserve equals the lower of either 90% of a Party's assigned amount pursuant to Article 3(7bis), (8) and (8bis) or 100% of its most recently reviewed inventory, multiplied by 8.

For the purposes of the joint fulfilment, the commitment period reserve applies to the EU, its Member States and Iceland individually.

The calculations of the commitment period reserve for The Netherlands are follows.

Approach 1: 90 % of assigned amount results in:

0.90 x 520,515,203 = 495,463,682.7 tonnes of CO_2eq.

Approach 2: 100 % of most recently reviewed inventory, taken the 2016 submission as the most recently reviewed inventory, multiplied by 8 results in:

123,650,696 x 8 = 989,205, 565 tonnes of CO_2eq.

The commitment period reserve consequently amount to **495,463,682.7** tonnes of carbon dioxide equivalent.

13 Information on changes in National System

13.1 Information related to NIR submission in 2015

There Czech national inventory system has undergone major staffing changes.

- The role of coordinator of national inventory process was transferred to Ing. Eva Krtková, who has been part of the national inventory team for 6 years already
- Ing. Ondřej Miňovský is no longer part of the team of the Czech national inventory system
- Ing. Martin Beck has been hired as new sectoral expert to support inventory in Industrial processes and product use sector
- Denitsa Troeva Grozeva, MSc. has been hired to support national inventory team in scope of QA/QC process and Waste sector

The National Inventory Team also obtained higher funding from Ministry of Environment, which is further improving the cooperation with sectoral experts and sectoral institutions. Since 2015 the contracts with relevant sectoral institution were signed for four years. Since previous years the contracts were signed only for one year this step means significant strengthening of National System.

No other significant changes were made and the main pillars of the national inventory system declared in the Czech Republic’s Initial Report under the Kyoto Protocol are operational and running.

13.2 Information related to NIR submission in 2016

Since last year the National Inventory Team obtained higher funding from Ministry of Environment, which is further improving the cooperation with sectoral experts and sectoral institutions. Since 2015 the contracts with relevant sectoral institution were signed for four years. Since previous years the contracts were signed only for one year this step means significant strengthening of National System.

There are no staffing changes in Czech National Inventory Team.

No other significant changes were made and the main pillars of the national inventory system declared in the Czech Republic’s Initial Report under the Kyoto Protocol are operational and running.

14 Information on Changes in National Registry

14.1 Information related to NIR submission in 2015

14.1.1 Previous Review Recommendations

In document FCCC/ARR/2014/CZE ERT requested the Party to include non-confidential up-to-date holding and transaction information in its publicly available information. The non-confidential holding and transaction information was made available at the registry website:

https://ets-registry.webgate.ec.europa.eu/euregistry/CZ/public/reports/publicReports.xhtml

14.1.2 Changes to National Registry

The following changes to the national registry of the Czech Republic have therefore occurred in 2014:

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	Registry administrators Ms Zuzana Stašková and Ms Helena Hůlová are on their maternity leaves. There are 2 new registry administrators in the team: • Mr Martin Štandera, email MStandera@ote-cr.cz, tel. +420 296 579 329 and • Ms Andrea Macková, email AMackova@ote-cr.cz, tel. +420 296 579 332.
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	An updated diagram of the database structure is attached as Annex A. Versions of the CSEUR released after 6.1.7.1 (the production version at the time of the last Chapter 14 submission) introduced 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. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.1.7.1 of the national registry were limited and only affected EU ETS functionality. However, 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 (see Annex B). Annex H testing was carried out in February 2015 and the test report is attached as Annex H. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	Publicly available information is on the address: https://ets-registry.webgate.ec.europa.eu/euregistry/CZ/public/reports/publicReports.xhtml There are reports: • Account Information (Paragraph 45) • Joint Implementation Project Information (Paragraph 46) • Unit Holding and Transaction Information (Paragraph 47) • Entities Authorised to hold Units (Paragraph 48)
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 6.1.7.1 of the national registry were limited and only affected EU ETS functionality. 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; the report is attached as Annex B. Annex H testing was carried out in February 2015 and the test report is attached as Annex H.

14.2 Information related to NIR submission in 2016

14.2.1 Previous Review Recommendations

In document FCCC/ARR/2014/CZE ERT requested the Party to include non-confidential up-to-date holding and transaction information in its publicly available information. The non-confidential holding and transaction information was made available at the registry website:

https://ets-registry.webgate.ec.europa.eu/euregistry/CZ/public/reports/publicReports.xhtml

14.2.2 Changes to National Registry

The following changes to the national registry of the Czech Republic have therefore occurred in 2015:

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	None
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There was no change to the database structure as it pertains to KP functionality in 2015. Versions of the CSEUR released after 6.3.3.2 (the production version at the time of the last Chapter 14 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 disaster recovery plan was submitted in 2012 as part of the Union Registry-ITL connection process. The database model is provided in Annex A. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex B. 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 (see Annex B). Annex H testing was carried out in February 2016 and the test report is attached as Annex H. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex B. 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; the report is attached as Annex B. Annex H testing was carried out in February 2016 and the test report is attached as Annex H.

15 Information on Minimization of Adverse Impact in Accordance with Art. 3, para 14

15.1 Information related to NIR submission in 2015

The Czech Republic strives to implement its Kyoto commitments in a way, which minimizes adverse impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention. The impact of mitigation actions on overall objectives of sustainable development is also given due consideration. As there is no common methodology for reporting of possible adverse impacts on developing country Parties, the information provided is based on the expert judgment of the Ministry of the Environment of the Czech Republic. More information on EU wide policies is available in chapter 15 of the Annual European Union greenhouse gas inventory 1990–2012 and inventory report 2014 and will be also provided in the European Union submission for the year 2015. The table below summarizes how the Party gives priority to selected actions, identified in paragraph 24 of the Annex to Decision 15/CMP.1.

Tab 15-1 Actions implementation by party as identified in paragraph 24 of the Annex to Decision 15/CMP.1

Action	Implementation by the Party
(a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities.	The ongoing liberalization of energy market is in line with EU policies and directives. No significant market distortions have been identified. Consumption taxes for electricity and fossil fuels were harmonized recently. The main instrument addressing externalities is the emission trading under the EU ETS. Introduction of new instruments is subject to economic modelling and regulatory impact assessment. The introduction of carbon tax was proposed and discussed but the government decided to wait for the outcome of proposal for EU wide harmonisation.
(b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies.	No subsidies for environmentally unsound and unsafe technologies have been identified.
(c) Cooperating in the technological development of non-energy uses of fossil fuels and supporting developing country Parties to this end.	The Czech Republic does not take part in any such activity.
(d) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort.	Advanced low-carbon technologies are currently not a priority area in the Czech Republic's research, development and innovation system. Research and development is focused on improving efficiency of currently available technologies. In 2009 and 2010 the project "Towards geological storage of CO_2 in the Czech Republic" (TOGEOS) was carried out. Resullts were published in article: D.G. Hatzignatiou, F. Riis, R. Berenblyum, V. Hladik, R. Lojka, J. Francu, Screening and evaluation of a saline aquifer for CO_2 storage: Central Bohemian Basin, Czech Republic, International Journal of Greenhouse Gas Control, Volume 5, Issue 6, November 2011. There is currently no ongoing or CCS programme or demonstration project in the Czech Republic. On 31st March 2014 the first open call for applications to fund individual projects within the Programme CZ08 "Pilot Studies and Surveys on CCS Technology (Carbon Capture and Storage)" under the so called Norway Grants.
(e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve	The Czech Republic supports technology and capacity development through development assistance. Example of such activities is a project for modernization of powering and control of power plant block connected with establishment of a technical training centre at the University in Ulan Bator, Mongolia.

the environmental efficiency of these activities.	
(f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.	The Czech Republic is cooperating in several bilateral development assistance projects focusing on reduction of fossil fuels dependence and development of renewable energy sources, inter alia: - Increasing energy independence of remote regions in Georgia with solar thermal and photovoltaic systems - Construction of biomass heating plant and heat distribution network in Bosnia and Herzegovina - Development of biogas and photovoltaic energy sources in rural areas of Vietnam - Subsidizing biodigesters construction in rural areas of Cambodia to stimulate the emerging market All of the above mentioned projects are being implemented in the period 2011 – 2013.

15.2 Information related to NIR submission in 2016

The Czech Republic strives to implement its Kyoto commitments in a way, which minimizes adverse impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention. The impact of mitigation actions on overall objectives of sustainable development is also given due consideration. As there is no common methodology for reporting of possible adverse impacts on developing country Parties, the information provided is based on the expert judgment of the Ministry of the Environment of the Czech Republic. More information on EU wide policies is available in chapter 15 of the Annual European Union greenhouse gas inventory 1990–2013 and inventory report 2015 and will be updated in the European Union submission for the year 2016. The table below summarizes how the Party gives priority to selected actions, identified in paragraph 24 of the Annex to Decision 15/CMP.1.

Tab 15-2 Actions implementation by party as identified in paragraph 24 of the Annex to Decision 15/CMP.1

Action	Implementation by the Party
(a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities.	The ongoing liberalization of energy market is in line with EU policies and directives. No significant market distortions have been identified. Consumption taxes for electricity and fossil fuels were harmonized recently. The main instrument addressing externalities is the emission trading under the EU ETS. Introduction of new instruments is subject to economic modelling and regulatory impact assessment. The introduction of carbon tax was proposed and discussed but the government decided to wait for the outcome of proposal for EU wide harmonisation.
(b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies.	No subsidies for environmentally unsound and unsafe technologies have been identified.
(c) Cooperating in the technological development of non-energy uses of fossil fuels and supporting developing country Parties to this end.	The Czech Republic does not take part in any such activity.
(d) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort.	There is currently no ongoing or CCS programme or demonstration project in the Czech Republic. On 31st March 2014 the first open call for applications to fund individual projects within the Programme CZ08 “Pilot Studies and Surveys on CCS Technology (Carbon Capture and Storage)” under the so called Norway Grants. In 2015 4 projects were approved in the first call of the the Programme CZ08. These projects focus on pilot CCS technologies for coal fired power plants, sharing of knowledge and experience, research of high temperature CO_2 sorption from flue gas using carbonate loop and finally preparation of a pilot CCS project in the Czech Republic.
(e) Strengthening the capacity of developing country Parties identified in Article 4,	The Czech Republic supports technology and capacity development through development assistance. Example of such activities is a project for

paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities.	modernization of powering and control of power plant block connected with establishment of a technical training centre at the University in Ulan Bator, Mongolia. Over the years 2014 – 2016, new project will engage in a thorough modernisation of the thermal power plants plant's operation.
(f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.	The Czech Republic is cooperating in several bilateral development assistance projects focusing on reduction of fossil fuels dependence and development of renewable energy sources, inter alia: - Increasing Exploitation of renewable geothermal energy in the municipality of Doboj, Bosnia and Herzegovina - Utilization of central heating systems, including use of renewable sources of energy in Bosnia and Herzegovina and Serbia - Developing sustainable, market-driven biogas and solar energy solutions for rural communities in Cambodia - Implementing solar tracking techniques to improve parabolic solar cooker effectiveness in Namibia The previously reported development assistance projects have been successfully implemented in the period 2010 – 2013. Some of the new projects for the implementing period 2014 – 2016 are building on these results.

16 Other Information

No other information submitted in 2014.

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Abbreviations

AACLC	Aggregate areas of cadastral land categories
APL	Association of Industrial Distilleries (Asociace průmyslových lihovarů)
ARR	Annual Review Report
AVNH	Association of Coatings Producers (Asociace výrobců nátěrových hmot)
AWMS	Animal Waste Management System
BOD	Biochemical Oxygen Demand
CAPPO	Czech Association of the Petroleum Industry (Česká asociace petrolejářského průmyslu a obchodu)
CCA	Czech Cement Association
CDV	Transport Research Centre (Centrum dopravního výzkumu)
CGA	Czech Gas Association
CNG	Compressed Natural Gas
COD	Chemical Oxygen Demand
COP	Conference of Parties
COSMC	Czech Office for Surveying, Mapping and Cadastre
COŽP UK	Centrum pro otázky životního prostředí Univerzity Karlovy
CUEC	Charles University Environment Center
CULS	Czech University of Life Sciences
CzechTerra	Czech Landscape Inventory
ČPS	Czech Gas Association (Český plynárenský svaz)
DOC	Degradable Organic Carbon
EEA	European Environmental Agency
EIG	Emission Inventory Guidebook
ERT	Expert Review Team
ETS	Emission Trading Scheme
FAO	Food and Agriculture Organization
FMI	Forest Management Institute, Brandýs nad Labem
FMP	Forest Management Plans
FOD (model)	First Order Decay (model)
GHG	Greenhouse Gas
HDV	Heavy Duty Vehicle
HWP	Harwested Wood Products
CHMI	Czech Hydrometeorological Institute
IEA	International Energy Agency
IFER	Institute of Forest Ecosystem Research (Ústav pro výzkum lesních ekosystémů)
IGU	International Gas Union
IPCC	Intergovernmental Panel of Climate Change
IPR	Integrated Pollution Register
ISPOP	Integrated system of mandatory reporting (Integrovaný systém plnění ohlašovacích povinností)
KP LULUCF	LULUCF activities under Kyoto Protocol
LDV	Light Duty Vehicle
LPG	Liquid Petroleum Gas
LPIS	Land Parcel Identification System,
LTO	Landing/Taking-off
LULUCF	Land Use, Land-Use Change and Forestry

MA	Ministry of Agriculture
MCF	Methane Correction Factor
MIT	Ministry of Industry and Trade
MoE	Ministry of Environment
MSW	Municipal Solid Waste
NACE	Nomenclature Classification of Economic Activities
NIR	National Inventory Report
NIS	National Inventory System (National system under Kyoto protocol, Art. 5)
OKD, a.s.	Ostrava – Karvina Mines (Ostravsko karvinské doly, a.s.)
OTE	Electricity Market Operator (Operátor trhu s elektřinou, a.s.)
PC	Passenger Car
QA/QC	Quality Assurance/Quality Control
RA	Reference Approach
REZZO	Register of Emissions and Sources of Air Pollution (Registr emisí a zdrojů znečišťování ovzduší)
SA	Sectoral Approach
SWDS	Solid Waste Disposal Sites
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nation Framework Convention on Climate Change
ÚVVP	Institute for Research and Use of Fuels (Ústav pro výzkum a využití paliv)
VŠCHT	Institute of Chemical Technology (Vysoká škola chemicko technologická)

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Annexes to the National Inventory Report

Annex 1 Key Categories

Key Categories were estimated using IPCC 2006 Gl. approach 1 including and excluding LULUCF. Tables A1-1 till A1-4 followed the approach in Tables 4.2 and 4.3 of the IPCC 2006 Gl.

Tab. A1- 1 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 2014 – Level Assessment including LULUCF

IPCC Source Categories	GHG	Latest Year Emission or Removal Estimate (kt)	ABS Latest Year Emission or Removal Estimate (kt)	LA,%	Cumulative Total (LA,%)
1.A Stationary Combustion - Solid Fuels	CO_2	55 609.34	55 609.34	37.24	37.24
1.A Stationary Combustion - Liquid Fuels	CO_2	19 121.96	19 121.96	12.81	50.05
1.A.3.b Transport - Road Transportation	CO_2	16 117.13	16 117.13	10.79	60.84
1.A Stationary Combustion - Gaseous Fuels	CO_2	13 719.29	13 719.29	9.19	70.03
4.A.1 Forest Land remaining Forest Land	CO_2	-6 907.74	6 907.74	4.63	74.66
2.C.1 Iron and Steel Production	CO_2	6 498.79	6 498.79	4.35	79.01
5.A Solid Waste Disposal on Land	CH_4	3 330.79	3 330.79	2.23	81.24
1.B.1.a Coal Mining and Handling	CH_4	3 129.84	3 129.84	2.10	83.34
3.A Enteric Fermentation	CH_4	2 817.27	2 817.27	1.89	85.23
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	2796.90	2 796.90	1.87	87.10
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	2397.43	2 397.43	1.61	88.70
2.A.1 Cement Production	CO_2	1482.00	1 482.00	0.99	89.70
3.B Manure Management	N_2O	1312.02	1 312.02	0.88	90.58
2.B.8 Petrochemical and carbon black production	CO_2	1080.92	1 080.92	0.72	91.30
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	784.92	784.92	0.53	91.83
3.B Manure Management	CH_4	768.19	768.19	0.51	92.34
5.D Wastewater treatment and discharge	CH_4	731.05	731.05	0.49	92.83
2.B.1 Ammonia Production	CO_2	689.05	689.05	0.46	93.29
1.A Stationary Combustion - Liquid Fuels	N_2O	673.47	673.47	0.45	93.74
2.A.2 Lime Production	CO_2	629.04	629.04	0.42	94.16
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	625.48	625.48	0.42	94.58
5.B Biological treatment of solid waste	CH_4	617.79	617.79	0.41	95.00
1.A.3.b Transport - Road Transportation	N_2O	610.49	610.49	0.41	95.40
2.C.2 Ferroalloys Production	CH_4	502.72	502.72	0.34	95.74
4.A.2 Land converted to Forest Land	CO_2	-482.21	482.21	0.32	96.06
1.A Stationary Combustion - Biomass	CH_4	414.21	414.21	0.28	96.34
1.A Stationary Combustion - Other fuels - MSW	CO_2	349.80	349.80	0.23	96.58
2.A.4 Other process uses of carbonates	CO_2	320.51	320.51	0.21	96.79
1.A Stationary Combustion - Other fuels - 1A2	CO_2	301.59	301.59	0.20	96.99
4.C.2 Land converted to Grassland	CO_2	-295.18	295.18	0.20	97.19
4.C.1 Grassland remaining Grassland	CO_2	-273.92	273.92	0.18	97.37
1.A.3.c Transport - Railways	CO_2	273.78	273.78	0.18	97.56
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	260.37	260.37	0.17	97.73
2.B.2 Nitric Acid Production	N_2O	255.62	255.62	0.17	97.90
1.A Stationary Combustion - Solid Fuels	N_2O	226.17	226.17	0.15	98.05
2.G.3 N_2O from product uses	N_2O	223.50	223.50	0.15	98.20
2.B.10 Other	CO_2	219.52	219.52	0.15	98.35
5.D Wastewater treatment and discharge	N_2O	204.00	204.00	0.14	98.49
1.B.1.a Coal Mining and Handling	CO_2	196.83	196.83	0.13	98.62
1.A Stationary Combustion - Solid Fuels	CH_4	186.20	186.20	0.12	98.74
3.G Liming	CO_2	150.29	150.29	0.10	98.84
5.C Incineration and open burning of waste	CO_2	131.74	131.74	0.09	98.93
4.E.2 Land converted to Settlements	CO_2	127.60	127.60	0.09	99.02
1.A Stationary Combustion - Biomass	N_2O	114.05	114.05	0.08	99.09
2.A.3 Glass Production	CO_2	111.93	111.93	0.07	99.17
4.G Harvested wood products	CO_2	-94.13	94.13	0.06	99.23
2.D.1 Lubricant Use	CO_2	92.55	92.55	0.06	99.29
4.B.2 Land converted to Cropland	CO_2	88.11	88.11	0.06	99.35
1.A.3.e Transport - Other Transportation	CO_2	83.72	83.72	0.06	99.41
4.B.1 Cropland remaining Cropland	CO_2	-76.00	76.00	0.05	99.46

IPCC Source Categories	GHG	Latest Year Emission or Removal Estimate (kt)	ABS Latest Year Emission or Removal Estimate (kt)	LA,%	Cumulative Total (LA,%)
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	75.56	75.56	0.05	99.51
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.05	99.56
4.A.1 Forest Land remaining Forest Land	CH_4	73.31	73.31	0.05	99.61
1.A.5.b Other mobile sources not included elsewhere	CO_2	71.21	71.21	0.05	99.66
3.H Urea application	CO_2	57.03	57.03	0.04	99.70
2.C.2 Ferroalloys Production	CO_2	56.72	56.72	0.04	99.73
2.B.8 Petrochemical and carbon black production	CH_4	53.22	53.22	0.04	99.77
5.B Biological treatment of solid waste	N_2O	36.50	36.50	0.02	99.79
1.A.3.c Transport - Railways	N_2O	31.49	31.49	0.02	99.82
4.D.2. Land converted to Wetlands	CO_2	26.76	26.76	0.02	99.83
2.C.5 Lead Production	CO_2	24.10	24.10	0.02	99.85
1.A.3.b Transport - Road Transportation	CH_4	23.33	23.33	0.02	99.87
1.A Stationary Combustion - Liquid Fuels	CH_4	22.54	22.54	0.02	99.88
2.F.3 Fire Protection (CO_2 eq.)	HFC	20.88	20.88	0.01	99.89
1.A Stationary Combustion - Gaseous Fuels	CH_4	17.72	17.72	0.01	99.91
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	17.20	17.20	0.01	99.92
2.D.3 Urea used as catalyst	CO_2	17.02	17.02	0.01	99.93
2.C.1 Iron and Steel Production	CH_4	10.09	10.09	0.01	99.94
1.A.3.d Transport - Domestic navigation	CO_2	9.55	9.55	0.01	99.94
4.F.2 Land converted to Other Land	CO_2	8.55	8.55	0.01	99.95
2.F.4 Aerosols (CO_2 eq.)	HFC	8.11	8.11	0.01	99.95
1.A Stationary Combustion - Gaseous Fuels	N_2O	7.39	7.39	0.00	99.96
2.D.2 Paraffin Wax Use	CO_2	7.07	7.07	0.00	99.96
1.A.3.a Transport - Domestic Aviation	CO_2	7.02	7.02	0.00	99.97
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	6.72	6.72	0.00	99.97
4.A.1 Forest Land remaining Forest Land	N_2O	6.01	6.01	0.00	99.98
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	4.85	4.85	0.00	99.98
1.B.1.b. Solid Fuel Transformation	CH_4	4.50	4.50	0.00	99.98
1.A Stationary Combustion - Other fuels - MSW	N_2O	3.74	3.74	0.00	99.98
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	3.26	3.26	0.00	99.99
1.A.5.b Other mobile sources not included elsewhere	N_2O	3.04	3.04	0.00	99.99
2.F.2 Foam Blowing (CO_2 eq.)	HFC	2.64	2.64	0.00	99.99
5.C Incineration and open burning of waste	N_2O	2.39	2.39	0.00	99.99
1.A.3 Transport - Biomass	N_2O	2.37	2.37	0.00	99.99
2.E.1 Integrated Circuit or Semiconductor	NF_3	2.35	2.35	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	HFC	1.86	1.86	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	N_2O	1.35	1.35	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	CH_4	0.81	0.81	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.63	0.63	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.49	0.49	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.38	0.38	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.36	0.36	0.00	100.00
2.C.6 Zinc Production	CO_2	0.29	0.29	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.08	0.08	0.00	100.00
1.A.3.a Transport - Domestic Aviation	N_2O	0.06	0.06	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	0.05	0.05	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.05	0.05	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.04	0.04	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.03	0.03	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.03	0.03	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.02	0.02	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.00	0.00	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0	0.00	0.00	100
2.F.5 Solvents (CO_2 eq.)	PFC	0	0	0	100
4.B.2. Land converted to Cropland	N_2O	0	0	0	100
	Total	**133 054.08**	**149 312.44**	**100.00**	

Tab. A1- 2 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 2014 – Trend Assessment including LULUCF

IPCC Source Categories	GHG	Base Year Estimate (kt)	Current Year Estimate (kt)	Trend Assessment	% contribution to Trend	Cumulative total of contribution to trend
1.A Stationary Combustion - Solid Fuels	CO_2	110 822.55	55 609.34	0.10	27.74	27.74
1.A.3.b Transport - Road Transportation	CO_2	6 176.54	16 117.13	0.06	16.91	44.65
1.A Stationary Combustion - Gaseous Fuels	CO_2	11 195.61	13 719.29	0.06	15.87	60.52
1.A Stationary Combustion - Liquid Fuels	CO_2	22 219.95	19 121.96	0.02	5.74	66.26
3.B Manure Management	N_2O	3 309.60	1 312.02	0.02	4.69	70.95
1.B.1.a Coal Mining and Handling	CH_4	9 119.12	3 129.84	0.02	4.33	75.29
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.21	2 796.90	0.01	3.97	79.25
5.A Solid Waste Disposal on Land	CH_4	1 979.27	3 330.79	0.01	2.82	82.07
3.B Manure Management	CH_4	1 772.43	768.19	0.01	2.51	84.58
3.A Enteric Fermentation	CH_4	5 754.89	2 817.27	0.01	1.54	86.12
4.A.1 Forest Land remaining Forest Land	CO_2	-4 644.62	-6 907.74	0.00	1.09	87.21
5.D Wastewater treatment and discharge	CH_4	1 138.23	731.05	0.00	1.04	88.25
3.G Liming	CO_2	1 177.82	150.29	0.00	0.92	89.17
1.A Stationary Combustion - Solid Fuels	CH_4	1 212.44	186.20	0.00	0.90	90.07
2.B.8 Petrochemical and carbon black production	CO_2	792.47	1 080.92	0.00	0.77	90.84
1.A.3.b Transport - Road Transportation	N_2O	136.73	610.49	0.00	0.73	91.58
2.C.2 Ferroalloys Production	CH_4	0.01	502.72	0.00	0.71	92.29
1.A Stationary Combustion - Liquid Fuels	N_2O	262.57	673.47	0.00	0.70	92.99
2.B.2 Nitric Acid Production	N_2O	1 050.29	255.62	0.00	0.65	93.64
1.A Stationary Combustion - Other fuels - MSW	CO_2	36.53	349.80	0.00	0.46	94.10
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	3 991.85	2 397.43	0.00	0.44	94.54
1.A Stationary Combustion - Other fuels - 1A2	CO_2	0.00	301.59	0.00	0.43	94.97
2.A.2 Lime Production	CO_2	1 336.65	629.04	0.00	0.39	95.36
1.A Stationary Combustion - Biomass	CH_4	264.76	414.21	0.00	0.38	95.74
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.00	260.37	0.00	0.37	96.11
2.A.4 Other process uses of carbonates	CO_2	109.15	320.51	0.00	0.35	96.46
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	1 500.79	784.92	0.00	0.33	96.79
2.A.1 Cement Production	CO_2	2 489.18	1 482.00	0.00	0.29	97.08
5.D Wastewater treatment and discharge	N_2O	234.18	204.00	0.00	0.29	97.37
1.A.3.c Transport - Railways	CO_2	653.86	273.78	0.00	0.24	97.61
5.C Incineration and open burning of waste	CO_2	23.15	131.74	0.00	0.16	97.77
1.B.1.a Coal Mining and Handling	CO_2	456.24	196.83	0.00	0.16	97.93
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	1 079.91	625.48	0.00	0.15	98.09
4.C.2 Land converted to Grassland	CO_2	-145.34	-295.18	0.00	0.15	98.23
4.G Harvested wood products	CO_2	-1 712.95	-94.13	0.00	0.13	98.36
1.A.3.a Transport - Domestic Aviation	CO_2	139.44	7.02	0.00	0.12	98.49
2.G.3 N_2O from product uses	N_2O	206.22	223.50	0.00	0.12	98.61
1.A.3.e Transport - Other Transportation	CO_2	5.42	83.72	0.00	0.11	98.72
1.A Stationary Combustion - Solid Fuels	N_2O	450.92	226.17	0.00	0.11	98.83
4.B.1 Cropland remaining Cropland	CO_2	-2.28	-76.00	0.00	0.10	98.94
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.00	71.21	0.00	0.10	99.04
4.E.2 Land converted to Settlements	CO_2	85.09	127.60	0.00	0.10	99.14
1.A Stationary Combustion - Biomass	N_2O	58.76	114.05	0.00	0.08	99.22
4.A.2 Land converted to Forest Land	CO_2	-321.25	-482.21	0.00	0.08	99.30
2.C.2 Ferroalloys Production	CO_2	0.00	56.72	0.00	0.08	99.38
2.C.1 Iron and Steel Production	CO_2	9 642.54	6 498.79	0.00	0.06	99.44
1.A.3.d Transport - Domestic navigation	CO_2	56.61	9.55	0.00	0.04	99.48
2.B.8 Petrochemical and carbon black production	CH_4	36.17	53.22	0.00	0.04	99.52
2.A.3 Glass Production	CO_2	123.66	111.93	0.00	0.04	99.56
2.C.5 Lead Production	CO_2	10.40	24.10	0.00	0.03	99.60
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.00	0.03	99.63
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.00	20.88	0.00	0.03	99.66
1.A.3.c Transport - Railways	N_2O	75.21	31.49	0.00	0.03	99.69
1.A Stationary Combustion - Liquid Fuels	CH_4	60.16	22.54	0.00	0.03	99.71
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	85.22	75.56	0.00	0.03	99.74
2.D.3 Urea used as catalyst	CO_2	0.00	17.02	0.00	0.02	99.76
2.B.1 Ammonia Production	CO_2	990.80	689.05	0.00	0.02	99.79
3.H Urea application	CO_2	108.53	57.03	0.00	0.02	99.81
2.D.1 Lubricant Use	CO_2	116.13	92.55	0.00	0.02	99.83
1.A Stationary Combustion - Gaseous Fuels	CH_4	12.79	17.72	0.00	0.02	99.85
4.D.2. Land converted to Wetlands	CO_2	21.51	26.76	0.00	0.02	99.87
4.B.2 Land converted to Cropland	CO_2	113.99	88.11	0.00	0.02	99.88
4.F.2 Land converted to Other Land	CO_2	0.00	8.55	0.00	0.01	99.89
2.F.4 Aerosols (CO_2 eq.)	HFC	0.00	8.11	0.00	0.01	99.91

IPCC Source Categories	GHG	Base Year Estimate (kt)	Current Year Estimate (kt)	Trend Assessment	% contribution to Trend	Cumulative total of contribution to trend
2.D.2 Paraffin Wax Use	CO_2	9.43	7.07	0.00	0.01	99.92
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	6.72	0.00	0.01	99.93
4.A.1 Forest Land remaining Forest Land	CH_4	117.30	73.31	0.00	0.01	99.93
1.A Stationary Combustion - Gaseous Fuels	N_2O	6.12	7.39	0.00	0.01	99.94
4.B.2. Land converted to Cropland	N_2O	8.91	0.00	0.00	0.01	99.95
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	0.00	4.85	0.00	0.01	99.96
1.B.1.b. Solid Fuel Transformation	CH_4	0.75	4.50	0.00	0.01	99.96
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.39	3.74	0.00	0.00	99.97
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	3.04	0.00	0.00	99.97
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.00	2.64	0.00	0.00	99.98
5.C Incineration and open burning of waste	N_2O	0.42	2.39	0.00	0.00	99.98
1.A.3 Transport - Biomass	N_2O	0.00	2.37	0.00	0.00	99.98
2.E.1 Integrated Circuit or Semiconductor	NF_3	0.00	2.35	0.00	0.00	99.99
1.A.3.b Transport - Road Transportation	CH_4	37.50	23.33	0.00	0.00	99.99
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	2.20	0.05	0.00	0.00	99.99
1.A Stationary Combustion - Other fuels - 1A2	N_2O	0.00	1.35	0.00	0.00	99.99
1.A Stationary Combustion - Other fuels - 1A2	CH_4	0.00	0.81	0.00	0.00	100.00
1.A.3.a Transport - Domestic Aviation	N_2O	1.19	0.06	0.00	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.00	0.63	0.00	0.00	100.00
4.A.1 Forest Land remaining Forest Land	N_2O	9.61	6.01	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.00	0.49	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.00	0.36	0.00	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.92	0.38	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.46	0.08	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.13	0.02	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.05	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.04	0.00	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.00	0.03	0.00	0.00	100.00
2.C.1 Iron and Steel Production	CH_4	14.84	10.09	0.00	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.01	0.03	0.00	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.02	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.00	0.00	0.00	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	0.00	100.00
2.B.10 Other	CO_2	0.00	219.52	0.00	0.00	100.00
2.C.6 Zinc Production	CO_2	0.00	0.29	0.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	0.00	17.20	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	HFC	0.00	1.86	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.00	3.26	0.00	0.00	100.00
4.C.1 Grassland remaining Grassland	CO_2	0	-273.921004	0	0	100
5.B Biological treatment of solid waste	CH_4	0	617.7943	0	0	100
5.B Biological treatment of solid waste	N_2O	0	36.49973136	0	0	100
	Total	**196 154.79**	**133 054.08**	**0.3596**	**100.00**	

Tab. A1- 3 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 2014 – Level Assessment excluding LULUCF

IPCC Source Categories	GHG	Latest Year Emission or Removal Estimate (kt)	ABS Latest Year Emission or Removal Estimate (kt)	LA,%	Cumulative Total (LA)
1.A Stationary Combustion - Solid Fuels	CO_2	55 609.34	55 609.34	39.48	39.48
1.A Stationary Combustion - Liquid Fuels	CO_2	19 121.96	19 121.96	13.58	53.06
1.A.3.b Transport - Road Transportation	CO_2	16 117.13	16 117.13	11.44	64.50
1.A Stationary Combustion - Gaseous Fuels	CO_2	13 719.29	13 719.29	9.74	74.24
2.C.1 Iron and Steel Production	CO_2	6 498.79	6 498.79	4.61	78.85
5.A Solid Waste Disposal on Land	CH_4	3 330.79	3 330.79	2.36	81.22
1.B.1.a Coal Mining and Handling	CH_4	3 129.84	3 129.84	2.22	83.44
3.A Enteric Fermentation	CH_4	2 817.27	2 817.27	2.00	85.44
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	2 796.90	2 796.90	1.99	87.43
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	2 397.43	2 397.43	1.70	89.13
2.A.1 Cement Production	CO_2	1 482.00	1 482.00	1.05	90.18
3.B Manure Management	N_2O	1 312.02	1 312.02	0.93	91.11
2.B.8 Petrochemical and carbon black production	CO_2	1 080.92	1 080.92	0.77	91.88
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	784.92	784.92	0.56	92.44
3.B Manure Management	CH_4	768.19	768.19	0.55	92.98
5.D Wastewater treatment and discharge	CH_4	731.05	731.05	0.52	93.50
2.B.1 Ammonia Production	CO_2	689.05	689.05	0.49	93.99
1.A Stationary Combustion - Liquid Fuels	N_2O	673.47	673.47	0.48	94.47
2.A.2 Lime Production	CO_2	629.04	629.04	0.45	94.91
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	625.48	625.48	0.44	95.36
5.B Biological treatment of solid waste	CH_4	617.79	617.79	0.44	95.80
1.A.3.b Transport - Road Transportation	N_2O	610.49	610.49	0.43	96.23
2.C.2 Ferroalloys Production	CH_4	502.72	502.72	0.36	96.59
1.A Stationary Combustion - Biomass	CH_4	414.21	414.21	0.29	96.88
1.A Stationary Combustion - Other fuels - MSW	CO_2	349.80	349.80	0.25	97.13
2.A.4 Other process uses of carbonates	CO_2	320.51	320.51	0.23	97.36
1.A Stationary Combustion - Other fuels - 1A2	CO_2	301.59	301.59	0.21	97.57
1.A.3.c Transport - Railways	CO_2	273.78	273.78	0.19	97.77
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	260.37	260.37	0.18	97.95
2.B.2 Nitric Acid Production	N_2O	255.62	255.62	0.18	98.13
1.A Stationary Combustion - Solid Fuels	N_2O	226.17	226.17	0.16	98.29
2.G.3 N_2O from product uses	N_2O	223.50	223.50	0.16	98.45
2.B.10 Other	CO_2	219.52	219.52	0.16	98.61
5.D Wastewater treatment and discharge	N_2O	204.00	204.00	0.14	98.75
1.B.1.a Coal Mining and Handling	CO_2	196.83	196.83	0.14	98.89
1.A Stationary Combustion - Solid Fuels	CH_4	186.20	186.20	0.13	99.02
3.G Liming	CO_2	150.29	150.29	0.11	99.13
5.C Incineration and open burning of waste	CO_2	131.74	131.74	0.09	99.22
1.A Stationary Combustion - Biomass	N_2O	114.05	114.05	0.08	99.31
2.A.3 Glass Production	CO_2	111.93	111.93	0.08	99.38
2.D.1 Lubricant Use	CO_2	92.55	92.55	0.07	99.45
1.A.3.e Transport - Other Transportation	CO_2	83.72	83.72	0.06	99.51
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	75.56	75.56	0.05	99.56
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.05	99.62
1.A.5.b Other mobile sources not included elsewhere	CO_2	71.21	71.21	0.05	99.67
3.H Urea application	CO_2	57.03	57.03	0.04	99.71
2.C.2 Ferroalloys Production	CO_2	56.72	56.72	0.04	99.75
2.B.8 Petrochemical and carbon black production	CH_4	53.22	53.22	0.04	99.79
5.B Biological treatment of solid waste	N_2O	36.50	36.50	0.03	99.81
1.A.3.c Transport - Railways	N_2O	31.49	31.49	0.02	99.83
2.C.5 Lead Production	CO_2	24.10	24.10	0.02	99.85
1.A.3.b Transport - Road Transportation	CH_4	23.33	23.33	0.02	99.87
1.A Stationary Combustion - Liquid Fuels	CH_4	22.54	22.54	0.02	99.88
2.F.3 Fire Protection (CO_2 eq.)	HFC	20.88	20.88	0.01	99.90
1.A Stationary Combustion - Gaseous Fuels	CH_4	17.72	17.72	0.01	99.91
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	17.20	17.20	0.01	99.92
2.D.3 Urea used as catalyst	CO_2	17.02	17.02	0.01	99.93
2.C.1 Iron and Steel Production	CH_4	10.09	10.09	0.01	99.94
1.A.3.d Transport - Domestic navigation	CO_2	9.55	9.55	0.01	99.95
2.F.4 Aerosols (CO_2 eq.)	HFC	8.11	8.11	0.01	99.95
1.A Stationary Combustion - Gaseous Fuels	N_2O	7.39	7.39	0.01	99.96
2.D.2 Paraffin Wax Use	CO_2	7.07	7.07	0.01	99.96
1.A.3.a Transport - Domestic Aviation	CO_2	7.02	7.02	0.00	99.97
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	6.72	6.72	0.00	99.97
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	4.85	4.85	0.00	99.98

IPCC Source Categories	GHG	Latest Year Emission or Removal Estimate (kt)	ABS Latest Year Emission or Removal Estimate (kt)	LA,%	Cumulative Total (LA)
1.B.1.b. Solid Fuel Transformation	CH_4	4.50	4.50	0.00	99.98
1.A Stationary Combustion - Other fuels - MSW	N_2O	3.74	3.74	0.00	99.98
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	3.26	3.26	0.00	99.99
1.A.5.b Other mobile sources not included elsewhere	N_2O	3.04	3.04	0.00	99.99
2.F.2 Foam Blowing (CO_2 eq.)	HFC	2.64	2.64	0.00	99.99
5.C Incineration and open burning of waste	N_2O	2.39	2.39	0.00	99.99
1.A.3 Transport - Biomass	N_2O	2.37	2.37	0.00	99.99
2.E.1 Integrated Circuit or Semiconductor	NF_3	2.35	2.35	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	HFC	1.86	1.86	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	N_2O	1.35	1.35	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	CH_4	0.81	0.81	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.63	0.63	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.49	0.49	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.38	0.38	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.36	0.36	0.00	100.00
2.C.6 Zinc Production	CO_2	0.29	0.29	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.08	0.08	0.00	100.00
1.A.3.a Transport - Domestic Aviation	N_2O	0.06	0.06	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	0.05	0.05	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.05	0.05	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.04	0.04	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.03	0.03	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.03	0.03	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.02	0.02	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.00	0.00	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
	Total	**140 852.92**	**140 852.92**	**100.00**	

Tab. A1- 4 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 2014 – Trend Assessment excluding LULUCF

IPCC Source Categories	GHG	Base Year Estimate	Current Year Estimate	Trend Assessment	% contribution to Trend	Cumulative total of contribution to trend
1.A Stationary Combustion - Solid Fuels	CO_2	110822.55	55609.34	0.11	30.05	30.05
1.A.3.b Transport - Road Transportation	CO_2	6176.54	16117.13	0.06	16.58	46.63
1.A Stationary Combustion - Gaseous Fuels	CO_2	11195.61	13719.29	0.06	15.70	62.33
1.A Stationary Combustion - Liquid Fuels	CO_2	22219.95	19121.96	0.02	5.16	67.49
3.B Manure Management	N_2O	3309.60	1312.02	0.02	4.64	72.13
1.B.1.a Coal Mining and Handling	CH_4	9119.12	3129.84	0.02	4.50	76.63
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.21	2796.90	0.01	3.92	80.55
5.A Solid Waste Disposal on Land	CH_4	1979.27	3330.79	0.01	2.74	83.30
3.B Manure Management	CH_4	1772.43	768.19	0.01	2.49	85.78
3.A Enteric Fermentation	CH_4	5754.89	2817.27	0.01	1.66	87.44
5.D Wastewater treatment and discharge	CH_4	1138.23	731.05	0.00	1.03	88.47
3.G Liming	CO_2	1177.82	150.29	0.00	0.94	89.40
1.A Stationary Combustion - Solid Fuels	CH_4	1212.44	186.20	0.00	0.92	90.33
2.B.8 Petrochemical and carbon black production	CO_2	792.47	1080.92	0.00	0.74	91.07
1.A.3.b Transport - Road Transportation	N_2O	136.73	610.49	0.00	0.72	91.79
2.C.2 Ferroalloys Production	CH_4	0.01	502.72	0.00	0.71	92.50
1.A Stationary Combustion - Liquid Fuels	N_2O	262.57	673.47	0.00	0.69	93.18
2.B.2 Nitric Acid Production	N_2O	1050.29	255.62	0.00	0.67	93.85
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	3991.85	2397.43	0.00	0.53	94.38
1.A Stationary Combustion - Other fuels - MSW	CO_2	36.53	349.80	0.00	0.45	94.83
1.A Stationary Combustion - Other fuels - 1A2	CO_2	0.00	301.59	0.00	0.42	95.26
2.A.2 Lime Production	CO_2	1336.65	629.04	0.00	0.42	95.68
1.A Stationary Combustion - Biomass	CH_4	264.76	414.21	0.00	0.37	96.05
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.00	260.37	0.00	0.37	96.41
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	1500.79	784.92	0.00	0.36	96.78
2.A.1 Cement Production	CO_2	2489.18	1482.00	0.00	0.35	97.13
2.A.4 Other process uses of carbonates	CO_2	109.15	320.51	0.00	0.34	97.47
2.C.1 Iron and Steel Production	CO_2	9642.54	6498.79	0.00	0.29	97.75
5.D Wastewater treatment and discharge	N_2O	234.18	204.00	0.00	0.29	98.04
1.A.3.c Transport - Railways	CO_2	653.86	273.78	0.00	0.25	98.29
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	1079.91	625.48	0.00	0.18	98.47
1.B.1.a Coal Mining and Handling	CO_2	456.24	196.83	0.00	0.17	98.64
5.C Incineration and open burning of waste	CO_2	23.15	131.74	0.00	0.16	98.80
1.A.3.a Transport - Domestic Aviation	CO_2	139.44	7.02	0.00	0.13	98.93
1.A Stationary Combustion - Solid Fuels	N_2O	450.92	226.17	0.00	0.12	99.05
2.G.3 N_2O from product uses	N_2O	206.22	223.50	0.00	0.11	99.16
1.A.3.e Transport - Other Transportation	CO_2	5.42	83.72	0.00	0.11	99.27
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.00	71.21	0.00	0.10	99.37
1.A Stationary Combustion - Biomass	N_2O	58.76	114.05	0.00	0.08	99.46
2.C.2 Ferroalloys Production	CO_2	0.00	56.72	0.00	0.08	99.54
1.A.3.d Transport - Domestic navigation	CO_2	56.61	9.55	0.00	0.04	99.58
2.B.8 Petrochemical and carbon black production	CH_4	36.17	53.22	0.00	0.04	99.62
2.A.3 Glass Production	CO_2	123.66	111.93	0.00	0.04	99.65
2.C.5 Lead Production	CO_2	10.40	24.10	0.00	0.03	99.69
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.00	0.03	99.72
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.00	20.88	0.00	0.03	99.75
1.A.3.c Transport - Railways	N_2O	75.21	31.49	0.00	0.03	99.78
1.A Stationary Combustion - Liquid Fuels	CH_4	60.16	22.54	0.00	0.03	99.80
3.H Urea application	CO_2	108.53	57.03	0.00	0.03	99.83
2.D.3 Urea used as catalyst	CO_2	0.00	17.02	0.00	0.02	99.85
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	85.22	75.56	0.00	0.02	99.88
1.A Stationary Combustion - Gaseous Fuels	CH_4	12.79	17.72	0.00	0.02	99.90
2.D.1 Lubricant Use	CO_2	116.13	92.55	0.00	0.02	99.91
2.F.4 Aerosols (CO_2 eq.)	HFC	0.00	8.11	0.00	0.01	99.92
2.D.2 Paraffin Wax Use	CO_2	9.43	7.07	0.00	0.01	99.93
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	6.72	0.00	0.01	99.94
1.A Stationary Combustion - Gaseous Fuels	N_2O	6.12	7.39	0.00	0.01	99.95
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	0.00	4.85	0.00	0.01	99.96
1.B.1.b. Solid Fuel Transformation	CH_4	0.75	4.50	0.00	0.01	99.96
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.39	3.74	0.00	0.00	99.97
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	3.04	0.00	0.00	99.97

IPCC Source Categories	GHG	Base Year Estimate	Current Year Estimate	Trend Assessment	% contribution to Trend	Cumulative total of contribution to trend
1.A.3.b Transport - Road Transportation	CH_4	37.50	23.33	0.00	0.00	99.98
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.00	2.64	0.00	0.00	99.98
5.C Incineration and open burning of waste	N_2O	0.42	2.39	0.00	0.00	99.98
1.A.3 Transport - Biomass	N_2O	0.00	2.37	0.00	0.00	99.99
2.E.1 Integrated Circuit or Semiconductor	NF_3	0.00	2.35	0.00	0.00	99.99
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	2.20	0.05	0.00	0.00	99.99
1.A Stationary Combustion - Other fuels - 1A2	N_2O	0.00	1.35	0.00	0.00	99.99
1.A Stationary Combustion - Other fuels - 1A2	CH_4	0.00	0.81	0.00	0.00	100.00
1.A.3.a Transport - Domestic Aviation	N_2O	1.19	0.06	0.00	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.00	0.63	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.00	0.49	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.00	0.36	0.00	0.00	100.00
2.B.1 Ammonia Production	CO_2	990.80	689.05	0.00	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.92	0.38	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.46	0.08	0.00	0.00	100.00
2.C.1 Iron and Steel Production	CH_4	14.84	10.09	0.00	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.13	0.02	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.05	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.04	0.00	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.00	0.03	0.00	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.01	0.03	0.00	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.02	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.00	0.00	0.00	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	0.00	100.00
2.B.10 Other	CO_2	0.00	219.52	0.00	0.00	100.00
2.C.6 Zinc Production	CO_2	0.00	0.29	0.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	0.00	17.20	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	HFC	0.00	1.86	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	0.00	100.00
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.00	3.26	0.00	0.00	100.00
5.B Biological treatment of solid waste	CH_4	0.00	617.79	0.00	0.00	100.00
5.B Biological treatment of solid waste	N_2O	0.00	36.50	0.00	0.00	100.00
	Total	**202624.82**	**140852.92**	**0.35**	**100.00**	

Tab. A1- 5 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 1990 – Level Assessment including LULUCF

IPCC Source Categories	GHG	Base Year Estimate	Base Year Estimate (Abs)	Level Assessment	Cumulative Total (LA)
1.A Stationary Combustion - Solid Fuels	CO_2	110 822.55	110 822.55	52.82	52.82
1.A Stationary Combustion - Liquid Fuels	CO_2	22 219.95	22 219.95	10.59	63.41
1.A Stationary Combustion - Gaseous Fuels	CO_2	11 195.61	11 195.61	5.34	68.75
2.C.1 Iron and Steel Production	CO_2	9 642.54	9 642.54	4.60	73.34
1.B.1.a Coal Mining and Handling	CH_4	9 119.12	9 119.12	4.35	77.69
1.A.3.b Transport - Road Transportation	CO_2	6 176.54	6 176.54	2.94	80.63
3.A Enteric Fermentation	CH_4	5 754.89	5 754.89	2.74	83.38
4.A.1 Forest Land remaining Forest Land	CO_2	-4 644.62	4 644.62	2.21	85.59
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	3 991.85	3 991.85	1.90	87.49
3.B Manure Management	N_2O	3 309.60	3 309.60	1.58	89.07
2.A.1 Cement Production	CO_2	2 489.18	2 489.18	1.19	90.26
5.A Solid Waste Disposal on Land	CH_4	1 979.27	1 979.27	0.94	91.20
3.B Manure Management	CH_4	1 772.43	1 772.43	0.84	92.05
4.G Harvested wood products	CO_2	-1 712.95	1 712.95	0.82	92.86
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	1 500.79	1 500.79	0.72	93.58
2.A.2 Lime Production	CO_2	1 336.65	1 336.65	0.64	94.21
1.A Stationary Combustion - Solid Fuels	CH_4	1 212.44	1 212.44	0.58	94.79
3.G Liming	CO_2	1 177.82	1 177.82	0.56	95.35
5.D Wastewater treatment and discharge	CH_4	1 138.23	1 138.23	0.54	95.90
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	1 079.91	1 079.91	0.51	96.41
2.B.2 Nitric Acid Production	N_2O	1 050.29	1 050.29	0.50	96.91
2.B.1 Ammonia Production	CO_2	990.80	990.80	0.47	97.38
2.B.8 Petrochemical and carbon black production	CO_2	792.47	792.47	0.38	97.76
1.A.3.c Transport - Railways	CO_2	653.86	653.86	0.31	98.07
1.B.1.a Coal Mining and Handling	CO_2	456.24	456.24	0.22	98.29
1.A Stationary Combustion - Solid Fuels	N_2O	450.92	450.92	0.21	98.51
4.A.2 Land converted to Forest Land	CO_2	-321.25	321.25	0.15	98.66
1.A Stationary Combustion - Biomass	CH_4	264.76	264.76	0.13	98.78
1.A Stationary Combustion - Liquid Fuels	N_2O	262.57	262.57	0.13	98.91
5.D Wastewater treatment and discharge	N_2O	234.18	234.18	0.11	99.02
2.G.3 N_2O from product uses	N_2O	206.22	206.22	0.10	99.12
4.C.2 Land converted to Grassland	CO_2	-145.34	145.34	0.07	99.19
1.A.3.a Transport - Domestic Aviation	CO_2	139.44	139.44	0.07	99.26
1.A.3.b Transport - Road Transportation	N_2O	136.73	136.73	0.07	99.32
2.A.3 Glass Production	CO_2	123.66	123.66	0.06	99.38
4.A.1 Forest Land remaining Forest Land	CH_4	117.30	117.30	0.06	99.44
2.D.1 Lubricant Use	CO_2	116.13	116.13	0.06	99.49
4.B.2 Land converted to Cropland	CO_2	113.99	113.99	0.05	99.55
2.A.4 Other process uses of carbonates	CO_2	109.15	109.15	0.05	99.60
3.H Urea application	CO_2	108.53	108.53	0.05	99.65
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	85.22	85.22	0.04	99.69
4.E.2 Land converted to Settlements	CO_2	85.09	85.09	0.04	99.73
1.A.3.c Transport - Railways	N_2O	75.21	75.21	0.04	99.77
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.04	99.80
1.A Stationary Combustion - Liquid Fuels	CH_4	60.16	60.16	0.03	99.83
1.A Stationary Combustion - Biomass	N_2O	58.76	58.76	0.03	99.86
1.A.3.d Transport - Domestic navigation	CO_2	56.61	56.61	0.03	99.88
1.A.3.b Transport - Road Transportation	CH_4	37.50	37.50	0.02	99.90
1.A Stationary Combustion - Other fuels - MSW	CO_2	36.53	36.53	0.02	99.92
2.B.8 Petrochemical and carbon black production	CH_4	36.17	36.17	0.02	99.94
5.C Incineration and open burning of waste	CO_2	23.15	23.15	0.01	99.95
4.D.2. Land converted to Wetlands	CO_2	21.51	21.51	0.01	99.96
2.C.1 Iron and Steel Production	CH_4	14.84	14.84	0.01	99.97
1.A Stationary Combustion - Gaseous Fuels	CH_4	12.79	12.79	0.01	99.97
2.C.5 Lead Production	CO_2	10.40	10.40	0.00	99.98
4.A.1 Forest Land remaining Forest Land	N_2O	9.61	9.61	0.00	99.98
2.D.2 Paraffin Wax Use	CO_2	9.43	9.43	0.00	99.99
4.B.2. Land converted to Cropland	N_2O	8.91	8.91	0.00	99.99
1.A Stationary Combustion - Gaseous Fuels	N_2O	6.12	6.12	0.00	99.99
1.A.3.e Transport - Other Transportation	CO_2	5.42	5.42	0.00	100.00
4.B.1 Cropland remaining Cropland	CO_2	-2.28	2.28	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	2.20	2.20	0.00	100.00
1.A.3.a Transport - Domestic Aviation	N_2O	1.19	1.19	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.92	0.92	0.00	100.00
1.B.1.b. Solid Fuel Transformation	CH_4	0.75	0.75	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.46	0.46	0.00	100.00

IPCC Source Categories	GHG	Base Year Estimate	Base Year Estimate (Abs)	Level Assessment	Cumulative Total (LA)
5.C Incineration and open burning of waste	N_2O	0.42	0.42	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.39	0.39	0.00	100.00
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.21	0.21	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.13	0.13	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.02	0.02	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.01	0.01	0.00	100.00
2.C.2 Ferroalloys Production	CH_4	0.01	0.01	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.00	0.00	100.00
2.C.2 Ferroalloys Production	CO_2	0.00	0.00	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	CO_2	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	CH_4	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	N_2O	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	0.00	0.00	100.00
2.B.10 Other	CO_2	0.00	0.00	0.00	100.00
2.C.6 Zinc Production	CO_2	0.00	0.00	0.00	100.00
2.D.3 Urea used as catalyst	CO_2	0.00	0.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	0.00	0.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor	NF_3	0.00	0.00	0.00	100.00
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.00	0.00	0.00	100.00
4.C.1 Grassland remaining Grassland	CO_2	0.00	0.00	0.00	100.00
4.F.2 Land converted to Other Land	CO_2	0.00	0.00	0.00	100.00
5.B Biological treatment of solid waste	CH_4	0.00	0.00	0.00	100.00
5.B Biological treatment of solid waste	N_2O	0.00	0.00	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0	0	0	100
1.A.3 Transport - Biomass	N_2O	0	0	0	100
	Total	**196154.79**	**209807.68**	**100.00**	

Tab. A1- 6 Spreadsheet for Approach 1 KC IPCC 2006 Gl., 1990 – Level Assessment excluding LULUCF

IPCC Source Categories	GHG	Base Year Estimate	Base Year Estimate (Abs)	LA,%	Cumulative Total (LA)
1.A Stationary Combustion - Solid Fuels	CO_2	110 822.55	110 822.55	54.69	54.69
1.A Stationary Combustion - Liquid Fuels	CO_2	22 219.95	22 219.95	10.97	65.66
1.A Stationary Combustion - Gaseous Fuels	CO_2	11 195.61	11 195.61	5.53	71.18
2.C.1 Iron and Steel Production	CO_2	9 642.54	9 642.54	4.76	75.94
1.B.1.a Coal Mining and Handling	CH_4	9 119.12	9 119.12	4.50	80.44
1.A.3.b Transport - Road Transportation	CO_2	6 176.54	6 176.54	3.05	83.49
3.A Enteric Fermentation	CH_4	5 754.89	5 754.89	2.84	86.33
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	3 991.85	3 991.85	1.97	88.30
3.B Manure Management	N_2O	3 309.60	3 309.60	1.63	89.94
2.A.1 Cement Production	CO_2	2 489.18	2 489.18	1.23	91.16
5.A Solid Waste Disposal on Land	CH_4	1 979.27	1 979.27	0.98	92.14
3.B Manure Management	CH_4	1 772.43	1 772.43	0.87	93.02
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	1 500.79	1 500.79	0.74	93.76
2.A.2 Lime Production	CO_2	1 336.65	1 336.65	0.66	94.42
1.A Stationary Combustion - Solid Fuels	CH_4	1 212.44	1 212.44	0.60	95.01
3.G Liming	CO_2	1 177.82	1 177.82	0.58	95.60
5.D Wastewater treatment and discharge	CH_4	1 138.23	1 138.23	0.56	96.16
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	1 079.91	1 079.91	0.53	96.69
2.B.2 Nitric Acid Production	N_2O	1 050.29	1 050.29	0.52	97.21
2.B.1 Ammonia Production	CO_2	990.80	990.80	0.49	97.70
2.B.8 Petrochemical and carbon black production	CO_2	792.47	792.47	0.39	98.09
1.A.3.c Transport - Railways	CO_2	653.86	653.86	0.32	98.41
1.B.1.a Coal Mining and Handling	CO_2	456.24	456.24	0.23	98.64
1.A Stationary Combustion - Solid Fuels	N_2O	450.92	450.92	0.22	98.86
1.A Stationary Combustion - Biomass	CH_4	264.76	264.76	0.13	98.99
1.A Stationary Combustion - Liquid Fuels	N_2O	262.57	262.57	0.13	99.12
5.D Wastewater treatment and discharge	N_2O	234.18	234.18	0.12	99.24
2.G.3 N_2O from product uses	N_2O	206.22	206.22	0.10	99.34
1.A.3.a Transport - Domestic Aviation	CO_2	139.44	139.44	0.07	99.41
1.A.3.b Transport - Road Transportation	N_2O	136.73	136.73	0.07	99.47
2.A.3 Glass Production	CO_2	123.66	123.66	0.06	99.53
2.D.1 Lubricant Use	CO_2	116.13	116.13	0.06	99.59
2.A.4 Other process uses of carbonates	CO_2	109.15	109.15	0.05	99.65
3.H Urea application	CO_2	108.53	108.53	0.05	99.70
2.G.1 Electrical Equipment (CO_2 eq.)	SF_6	85.22	85.22	0.04	99.74
1.A.3.c Transport - Railways	N_2O	75.21	75.21	0.04	99.78
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	0.04	99.82
1.A Stationary Combustion - Liquid Fuels	CH_4	60.16	60.16	0.03	99.84
1.A Stationary Combustion - Biomass	N_2O	58.76	58.76	0.03	99.87
1.A.3.d Transport - Domestic navigation	CO_2	56.61	56.61	0.03	99.90
1.A.3.b Transport - Road Transportation	CH_4	37.50	37.50	0.02	99.92
1.A Stationary Combustion - Other fuels - MSW	CO_2	36.53	36.53	0.02	99.94
2.B.8 Petrochemical and carbon black production	CH_4	36.17	36.17	0.02	99.96
5.C Incineration and open burning of waste	CO_2	23.15	23.15	0.01	99.97
2.C.1 Iron and Steel Production	CH_4	14.84	14.84	0.01	99.97
1.A Stationary Combustion - Gaseous Fuels	CH_4	12.79	12.79	0.01	99.98
2.C.5 Lead Production	CO_2	10.40	10.40	0.01	99.99
2.D.2 Paraffin Wax Use	CO_2	9.43	9.43	0.00	99.99
1.A Stationary Combustion - Gaseous Fuels	N_2O	6.12	6.12	0.00	99.99
1.A.3.e Transport - Other Transportation	CO_2	5.42	5.42	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	2.20	2.20	0.00	100.00
1.A.3.a Transport - Domestic Aviation	N_2O	1.19	1.19	0.00	100.00
1.A.3.c Transport - Railways	CH_4	0.92	0.92	0.00	100.00
1.B.1.b. Solid Fuel Transformation	CH_4	0.75	0.75	0.00	100.00
1.A.3.d Transport - Domestic navigation	N_2O	0.46	0.46	0.00	100.00
5.C Incineration and open burning of waste	N_2O	0.42	0.42	0.00	100.00
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.39	0.39	0.00	100.00
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.21	0.21	0.00	100.00
1.A.3.d Transport - Domestic navigation	CH_4	0.13	0.13	0.00	100.00
1.A.3.a Transport - Domestic Aviation	CH_4	0.02	0.02	0.00	100.00
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.01	0.01	0.00	100.00
2.C.2 Ferroalloys Production	CH_4	0.01	0.01	0.00	100.00
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.00	0.00	100.00
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.00	0.00	100.00
2.C.2 Ferroalloys Production	CO_2	0.00	0.00	0.00	100.00
5.C Incineration and open burning of waste	CH_4	0.00	0.00	0.00	100.00

IPCC Source Categories	GHG	Base Year Estimate	Base Year Estimate (Abs)	LA,%	Cumulative Total (LA)
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.00	0.00	0.00	100.00
1.A.3 Transport - Biomass	N_2O	0.00	0.00	0.00	100.00
1.A.3 Transport - Biomass	CH_4	0.00	0.00	0.00	100.00
5.B Biological treatment of solid waste	N_2O	0.00	0.00	0.00	100.00
5.B Biological treatment of solid waste	CH_4	0.00	0.00	0.00	100.00
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.5 Solvents (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.4 Aerosols (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.00	0.00	0.00	100.00
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	PFC	0.00	0.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor	NF_3	0.00	0.00	0.00	100.00
2.E.1 Integrated Circuit or Semiconductor (CO_2 eq.)	SF_6	0.00	0.00	0.00	100.00
2.D.3 Urea used as catalyst	CO_2	0.00	0.00	0.00	100.00
2.C.6 Zinc Production	CO_2	0.00	0.00	0.00	100.00
2.B.10 Other	CO_2	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.00	0.00	0.00	100.00
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.00	0.00	0.00	100.00
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	N_2O	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	CH_4	0.00	0.00	0.00	100.00
1.A Stationary Combustion - Other fuels - 1A2	CO_2	0.00	0.00	0.00	100.00
	Total	**202 624.82**	**202 624.82**	**100.00**	

Annex 2 Assessment of uncertainty

Tab. A2 - 1 Uncertainty analysis (Tier 1), first part of Table 3.3 of IPCC 2006 Gl.

Input DATA					
IPCC Source Category	Gas	Base year emissions (1990) abs	Year t emissions (2014) abs	Activity data uncertainty	Emission factor uncertainty
1.A Stationary Combustion - Biomass	CH_4	264.76	414.21	8	50
1.A Stationary Combustion - Biomass	N_2O	58.76	114.05	8	60
1.A Stationary Combustion - Gaseous Fuels	CO_2	11195.61	13719.29	3	3
1.A Stationary Combustion - Gaseous Fuels	CH_4	12.79	17.72	3	50
1.A Stationary Combustion - Gaseous Fuels	N_2O	6.12	7.39	3	60
1.A Stationary Combustion - Liquid Fuels	CO_2	22219.95	19121.96	5	3
1.A Stationary Combustion - Liquid Fuels	CH_4	60.16	22.54	5	50
1.A Stationary Combustion - Liquid Fuels	N_2O	262.57	673.47	5	60
1.A Stationary Combustion - Other fuels - 1A2	CO_2	0.00	301.59	10	15
1.A Stationary Combustion - Other fuels - 1A2	CH_4	0.00	0.81	10	50
1.A Stationary Combustion - Other fuels - 1A2	N_2O	0.00	1.35	10	60
1.A Stationary Combustion - Other fuels - MSW	CO_2	36.53	349.80	20	20
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.00	0.00	20	50
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.39	3.74	20	70
1.A Stationary Combustion - Solid Fuels	CO_2	110822.55	55609.34	4	3
1.A Stationary Combustion - Solid Fuels	CH_4	1212.44	186.20	4	50
1.A Stationary Combustion - Solid Fuels	N_2O	450.92	226.17	4	60
1.A.3.a Transport - Civil Aviation	CO_2	139.44	7.02	4	4
1.A.3.a Transport - Civil Aviation	CH_4	0.02	0.00	4	21
1.A.3.a Transport - Civil Aviation	N_2O	1.19	0.06	4	40
1.A.3.b Transport - Road Transportation	CO_2	6176.54	16117.13	3	2
1.A.3.b Transport - Road Transportation	CH_4	37.50	23.33	3	100
1.A.3.b Transport - Road Transportation	N_2O	136.73	610.49	3	100
1.A.3.c Transport - Railways	CO_2	653.86	273.78	5	1
1.A.3.c Transport - Railways	CH_4	0.92	0.38	5	100
1.A.3.c Transport - Railways	N_2O	75.21	31.49	5	100
1.A.3.d Transport - Navigation	CO_2	56.61	9.55	5	2
1.A.3.d Transport - Navigation	CH_4	0.13	0.02	5	50
1.A.3.d Transport - Navigation	N_2O	0.46	0.08	5	90
1.A.3.e Transport - Other Transportation	CO_2	5.42	83.72	4	3
1.A.3.e Transport - Other Transportation	CH_4	0.00	0.04	4	50
1.A.3.e Transport - Other Transportation	N_2O	0.00	0.05	4	60
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.00	71.21	7	3
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.00	0.36	7	50
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.00	3.04	7	60
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.00	260.37	7	3
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.00	0.49	7	50
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.00	6.72	7	60
1.B.1.a Coal Mining and Handling	CO_2	456.24	196.83	4	25
1.B.1.a Coal Mining and Handling	CH_4	9119.12	3129.84	4	13
1.B.1.b. Solid Fuel Transformation	CH_4	0.75	4.50	40	50
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	2.20	0.05	7	75
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	1079.91	625.48	7	75
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.01	0.03	7	75
2.A.1 Cement Production	CO_2	2489.18	1482.00	2	2
2.A.2 Lime Production	CO_2	1336.65	629.04	2	2
2.A.3 Glass Production	CO_2	123.66	111.93	5	10
2.A.4 Other process uses of carbonates	CO_2	109.15	320.51	5	10
2.B.1 Ammonia Production	CO_2	990.80	689.05	5	7
2.B.2 Nitric Acid Production	N_2O	1050.29	255.62	4	15
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	74.50	74.50	5	40

Input DATA					
IPCC Source Category	Gas	Base year emissions (1990) abs	Year t emissions (2014) abs	Activity data uncertainty	Emission factor uncertainty
2.B.8 Petrochemical and carbon black production	CH_4	792.47	1080.92	5	40
2.B.8 Petrochemical and carbon black production	CO_2	36.17	53.22	5	40
2.B.10 Other	CO_2	0.00	219.52	3	3
2.C.1 Iron and Steel Production	CH_4	9642.54	6498.79	7	10
2.C.1 Iron and Steel Production	CO_2	14.84	10.09	7	30
2.C.2 Ferroalloys Production	CH_4	0.00	56.72	5	25
2.C.2 Ferroalloys Production	CO_2	0.01	502.72	5	25
2.C.5 Lead Production	CH_4	10.40	24.10	10	50
2.C.6 Zinc Production	CO_2	0.00	0.29	10	50
2.D.1 Lubricant Use	CO_2	116.13	92.55	5	50
2.D.2 Paraffin Wax Use	CO_2	9.43	7.07	5	50
2.D.3 Urea used as catalyst	CO_2	0.00	17.02	5	5
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	CO_2	0.00	17.20	15	15
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	SF_6	0.00	2.35	15	15
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	NF_3	0.21	2796.90	37	23
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.00	4.85	37	23
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.00	2.64	37	23
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.00	0.00	37	23
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.00	20.88	37	23
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.00	0.03	37	23
2.F.4 Aerosols (CO_2 eq.)	PFC	0.00	8.11	37	23
2.F.4 Aerosols (CO_2 eq.)	HFC	0.00	0.00	37	23
2.F.5 Solvents (CO_2 eq.)	PFC	0.00	1.86	37	23
2.F.5 Solvents (CO_2 eq.)	HFC	0.00	0.00	37	23
2.G.1 Electrical Equipment (CO_2 eq.)	PFC	85.22	75.56	5	15
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.00	3.26	10	20
2.G.3 N2O from product uses	SF_6	206.22	223.50	5	40
3.A Enteric Fermentation	N_2O	5754.89	2817.27	5	20
3.B Manure Management	CH_4	1772.43	768.19	5	30
3.B Manure Management	CH_4	3309.60	1312.02	5	30
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	3991.85	2397.43	15	50
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	1500.79	784.92	20	50
3.G Liming	N_2O	1177.82	150.29	20	50
3.H Urea application	CO_2	108.53	57.03	20	50
4.A.1 Forest Land remaining Forest Land	CO_2	-4644.62	-6907.74	0	18
4.A.1 Forest Land remaining Forest Land	CO_2	117.30	73.31	0	50
4.A.1 Forest Land remaining Forest Land	CH_4	9.61	6.01	0	50
4.A.2 Land converted to Forest Land	N_2O	-321.25	-482.21	0	29
4.B.1 Cropland remaining Cropland	CO_2	-2.28	-76.00	0	52
4.B.2 Land converted to Cropland	CO_2	113.99	88.11	0	38
4.B.2. Land converted to Cropland	CO_2	8.91	0.00	0	250
4.C.1 Grassland remaining Grassland	N_2O	0.00	-273.92	0	17
4.C.2 Land converted to Grassland	CO_2	-145.34	-295.18	0	20
4.D.2. Land converted to Wetlands	CO_2	21.51	26.76	0	66
4.E.2 Land converted to Settlements	CO_2	85.09	127.60	0	101
4.F.2 Land converted to Other Land	CO_2	0.00	8.55	0	101
4.G Harvested wood products	CO_2	-1712.95	-94.13	0	62
5.A Solid Waste Disposal on Land	CO_2	1979.27	3330.79	30	40
5.B Biological treatment of solid waste	CH_4	0.00	617.79	20	10
5.B Biological treatment of solid waste	CH_4	0.00	36.50	20	1
5.C Incineration and open burning of waste	N_2O	23.15	131.74	20	5
5.C Incineration and open burning of waste	CO_2	0.00	0.00	20	50
5.C Incineration and open burning of waste	CH_4	0.42	2.39	20	70
5.D Wastewater treatment and discharge	N_2O	1138.23	731.05	21	50
5.D Wastewater treatment and discharge	CH_4	234.18	204.00	26	50
1.A.3 Transport - Biomass	N_2O	0.00	0.63	8	50
1.A.3 Transport - Biomass	CH_4	0.00	2.37	8	60
	Total	**196154.79**	**133054.08**		

Tab. A2 - 2 Uncertainty analysis (Tier 1), second part of Table 3.3 of IPCC 2006 Gl.

Uncertainty of Emissions				
IPCC Source Category	Gas	Combined uncertainty	Uncertain amount	Combined uncertainty as% of total national emissions in year t
1.A Stationary Combustion - Biomass	CH_4	50.64	209.74	0.1576
1.A Stationary Combustion - Biomass	N_2O	60.53	69.04	0.0519
1.A Stationary Combustion - Gaseous Fuels	CO_2	3.91	535.76	0.4027
1.A Stationary Combustion - Gaseous Fuels	CH_4	50.09	8.87	0.0067
1.A Stationary Combustion - Gaseous Fuels	N_2O	60.07	4.44	0.0033
1.A Stationary Combustion - Liquid Fuels	CO_2	5.83	1114.99	0.8380
1.A Stationary Combustion - Liquid Fuels	CH_4	50.25	11.33	0.0085
1.A Stationary Combustion - Liquid Fuels	N_2O	60.21	405.48	0.3047
1.A Stationary Combustion - Other fuels - 1A2	CO_2	18.03	54.37	0.0409
1.A Stationary Combustion - Other fuels - 1A2	CH_4	50.99	0.41	0.0003
1.A Stationary Combustion - Other fuels - 1A2	N_2O	60.83	0.82	0.0006
1.A Stationary Combustion - Other fuels - MSW	CO_2	28.28	98.94	0.0744
1.A Stationary Combustion - Other fuels - MSW	CH_4	53.85	0.00	0.0000
1.A Stationary Combustion - Other fuels - MSW	N_2O	72.80	2.72	0.0020
1.A Stationary Combustion - Solid Fuels	CO_2	5.00	2780.47	2.0897
1.A Stationary Combustion - Solid Fuels	CH_4	50.16	93.40	0.0702
1.A Stationary Combustion - Solid Fuels	N_2O	60.13	136.00	0.1022
1.A.3.a Transport - Civil Aviation	CO_2	5.47	0.38	0.0003
1.A.3.a Transport - Civil Aviation	CH_4	21.38	0.00	0.0000
1.A.3.a Transport - Civil Aviation	N_2O	40.20	0.03	0.0000
1.A.3.b Transport - Road Transportation	CO_2	3.82	615.19	0.4624
1.A.3.b Transport - Road Transportation	CH_4	100.04	23.34	0.0175
1.A.3.b Transport - Road Transportation	N_2O	100.04	610.76	0.4590
1.A.3.c Transport - Railways	CO_2	5.21	14.28	0.0107
1.A.3.c Transport - Railways	CH_4	100.12	0.38	0.0003
1.A.3.c Transport - Railways	N_2O	100.12	31.53	0.0237
1.A.3.d Transport - Navigation	CO_2	5.22	0.50	0.0004
1.A.3.d Transport - Navigation	CH_4	50.25	0.01	0.0000
1.A.3.d Transport - Navigation	N_2O	90.14	0.07	0.0001
1.A.3.e Transport - Other Transportation	CO_2	5.00	4.19	0.0031
1.A.3.e Transport - Other Transportation	CH_4	50.16	0.02	0.0000
1.A.3.e Transport - Other Transportation	N_2O	60.13	0.03	0.0000
1.A.5.b Other mobile sources not included elsewhere	CO_2	7.62	5.42	0.0041
1.A.5.b Other mobile sources not included elsewhere	CH_4	50.49	0.18	0.0001
1.A.5.b Other mobile sources not included elsewhere	N_2O	60.41	1.84	0.0014
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	7.62	19.83	0.0149
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	50.49	0.25	0.0002
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	60.41	4.06	0.0031
1.B.1.a Coal Mining and Handling	CO_2	25.32	49.83	0.0375
1.B.1.a Coal Mining and Handling	CH_4	13.60	425.70	0.3199
1.B.1.b. Solid Fuel Transformation	CH_4	64.03	2.88	0.0022
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	75.33	0.04	0.0000
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	75.33	471.15	0.3541
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	75.33	0.02	0.0000
2.A.1 Cement Production	CO_2	2.83	41.92	0.0315
2.A.2 Lime Production	CO_2	2.83	17.79	0.0134
2.A.3 Glass Production	CO_2	11.18	12.51	0.0094
2.A.4 Other process uses of carbonates	CO_2	11.18	35.83	0.0269
2.B.1 Ammonia Production	CO_2	8.60	59.27	0.0445
2.B.2 Nitric Acid Production	N_2O	15.52	39.68	0.0298
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	40.31	30.03	0.0226
2.B.8 Petrochemical and carbon black production	CH_4	40.31	435.73	0.3275
2.B.8 Petrochemical and carbon black production	CO_2	40.31	21.45	0.0161
2.B.10 Other	CO_2	3.91	8.57	0.0064
2.C.1 Iron and Steel Production	CH_4	12.21	793.28	0.5962
2.C.1 Iron and Steel Production	CO_2	30.81	3.11	0.0023
2.C.2 Ferroalloys Production	CH_4	25.50	14.46	0.0109
2.C.2 Ferroalloys Production	CO_2	25.50	128.17	0.0963
2.C.5 Lead Production	CH_4	50.99	12.29	0.0092
2.C.6 Zinc Production	CO_2	50.99	0.15	0.0001
2.D.1 Lubricant Use	CO_2	50.25	46.51	0.0350
2.D.2 Paraffin Wax Use	CO_2	50.25	3.55	0.0027
2.D.3 Urea used as catalyst	CO_2	7.07	1.20	0.0009
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	CO_2	21.21	3.65	0.0027

Uncertainty of Emissions				
IPCC Source Category	**Gas**	**Combined uncertainty**	**Uncertain amount**	**Combined uncertainty as% of total national emissions in year t**
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	SF_6	21.21	0.50	0.0004
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	NF_3	43.57	1218.50	0.9158
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	43.57	2.12	0.0016
2.F.2 Foam Blowing (CO_2 eq.)	PFC	43.57	1.15	0.0009
2.F.2 Foam Blowing (CO_2 eq.)	HFC	43.57	0.00	0.0000
2.F.3 Fire Protection (CO_2 eq.)	PFC	43.57	9.10	0.0068
2.F.3 Fire Protection (CO_2 eq.)	HFC	43.57	0.01	0.0000
2.F.4 Aerosols (CO_2 eq.)	PFC	43.57	3.53	0.0027
2.F.4 Aerosols (CO_2 eq.)	HFC	43.57	0.00	0.0000
2.F.5 Solvents (CO_2 eq.)	PFC	43.57	0.81	0.0006
2.F.5 Solvents (CO_2 eq.)	HFC	43.57	0.00	0.0000
2.G.1 Electrical Equipment (CO_2 eq.)	PFC	15.81	11.95	0.0090
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	22.36	0.73	0.0005
2.G.3 N2O from product uses	SF_6	40.31	90.10	0.0677
3.A Enteric Fermentation	N_2O	20.62	580.80	0.4365
3.B Manure Management	CH_4	30.41	233.64	0.1756
3.B Manure Management	CH_4	30.41	399.04	0.2999
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	52.20	1251.50	0.9406
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	53.85	422.69	0.3177
3.G Liming	N_2O	53.85	80.93	0.0608
3.H Urea application	CO_2	53.85	30.71	0.0231
4.A.1 Forest Land remaining Forest Land	CO_2	18.41	-1271.82	-0.9559
4.A.1 Forest Land remaining Forest Land	CO_2	50.00	36.65	0.0275
4.A.1 Forest Land remaining Forest Land	CH_4	50.00	3.00	0.0023
4.A.2 Land converted to Forest Land	N_2O	28.97	-139.68	-0.1050
4.B.1 Cropland remaining Cropland	CO_2	52.31	-39.76	-0.0299
4.B.2 Land converted to Cropland	CO_2	38.10	33.57	0.0252
4.B.2. Land converted to Cropland	CO_2	250.00	0.00	0.0000
4.C.1 Grassland remaining Grassland	N_2O	16.94	-46.41	-0.0349
4.C.2 Land converted to Grassland	CO_2	19.69	-58.13	-0.0437
4.D.2. Land converted to Wetlands	CO_2	65.90	17.64	0.0133
4.E.2 Land converted to Settlements	CO_2	101.47	129.48	0.0973
4.F.2 Land converted to Other Land	CO_2	101.47	8.67	0.0065
4.G Harvested wood products	CO_2	62.00	-58.36	-0.0439
5.A Solid Waste Disposal on Land	CO_2	50.00	1665.39	1.2517
5.B Biological treatment of solid waste	CH_4	22.36	138.14	0.1038
5.B Biological treatment of solid waste	CH_4	20.01	7.30	0.0055
5.C Incineration and open burning of waste	N_2O	20.62	27.16	0.0204
5.C Incineration and open burning of waste	CO_2	53.85	0.00	0.0000
5.C Incineration and open burning of waste	CH_4	72.80	1.74	0.0013
5.D Wastewater treatment and discharge	N_2O	54.23	396.45	0.2980
5.D Wastewater treatment and discharge	CH_4	56.36	114.97	0.0864
1.A.3 Transport - Biomass	N_2O	50.64	0.32	0.0002
1.A.3 Transport - Biomass	CH_4	60.53	1.44	0.0011
		Level uncertainty =	**14823.43**	**3.36**

Tab. A2 - 3 Uncertainty analysis (Tier 1), third part of Table 3.3 of IPCC 2006 Gl.

Uncertainty of Trend						
IPCC Source Category	Gas	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by EF uncertainty	Uncertainty in trend in national emissions introduced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
1.A Stationary Combustion - Biomass	CH_4	0.0012	0.0021	0.0598	0.0239	0.0644
1.A Stationary Combustion - Biomass	N_2O	0.0004	0.0006	0.0227	0.0066	0.0236
1.A Stationary Combustion - Gaseous Fuels	CO_2	0.0312	0.0699	0.0780	0.2967	0.3068
1.A Stationary Combustion - Gaseous Fuels	CH_4	0.0000	0.0001	0.0023	0.0004	0.0023
1.A Stationary Combustion - Gaseous Fuels	N_2O	0.0000	0.0000	0.0010	0.0002	0.0010
1.A Stationary Combustion - Liquid Fuels	CO_2	0.0206	0.0975	0.0619	0.6893	0.6921
1.A Stationary Combustion - Liquid Fuels	CH_4	-0.0001	0.0001	-0.0047	0.0008	0.0047
1.A Stationary Combustion - Liquid Fuels	N_2O	0.0025	0.0034	0.1515	0.0243	0.1535
1.A Stationary Combustion - Other fuels - 1A2	CO_2	0.0015	0.0015	0.0231	0.0217	0.0317
1.A Stationary Combustion - Other fuels - 1A2	CH_4	0.0000	0.0000	0.0002	0.0001	0.0002
1.A Stationary Combustion - Other fuels - 1A2	N_2O	0.0000	0.0000	0.0004	0.0001	0.0004
1.A Stationary Combustion - Other fuels - MSW	CO_2	0.0017	0.0018	0.0331	0.0504	0.0604
1.A Stationary Combustion - Other fuels - MSW	CH_4	0.0000	0.0000	0.0000	0.0000	0.0000
1.A Stationary Combustion - Other fuels - MSW	N_2O	0.0000	0.0000	0.0012	0.0005	0.0014
1.A Stationary Combustion - Solid Fuels	CO_2	-0.0992	0.2835	-0.2975	1.6037	1.6311
1.A Stationary Combustion - Solid Fuels	CH_4	-0.0032	0.0009	-0.1622	0.0054	0.1622
1.A Stationary Combustion - Solid Fuels	N_2O	-0.0004	0.0012	-0.0244	0.0065	0.0252
1.A.3.a Transport - Civil Aviation	CO_2	-0.0004	0.0000	-0.0017	0.0002	0.0017
1.A.3.a Transport - Civil Aviation	CH_4	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.3.a Transport - Civil Aviation	N_2O	0.0000	0.0000	-0.0002	0.0000	0.0002
1.A.3.b Transport - Road Transportation	CO_2	0.0608	0.0822	0.1435	0.3486	0.3770
1.A.3.b Transport - Road Transportation	CH_4	0.0000	0.0001	-0.0011	0.0005	0.0012
1.A.3.b Transport - Road Transportation	N_2O	0.0026	0.0031	0.2639	0.0132	0.2643
1.A.3.c Transport - Railways	CO_2	-0.0009	0.0014	-0.0013	0.0099	0.0100
1.A.3.c Transport - Railways	CH_4	0.0000	0.0000	-0.0001	0.0000	0.0001
1.A.3.c Transport - Railways	N_2O	-0.0001	0.0002	-0.0100	0.0011	0.0100
1.A.3.d Transport - Navigation	CO_2	-0.0001	0.0000	-0.0002	0.0003	0.0004
1.A.3.d Transport - Navigation	CH_4	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.3.d Transport - Navigation	N_2O	0.0000	0.0000	-0.0001	0.0000	0.0001
1.A.3.e Transport - Other Transportation	CO_2	0.0004	0.0004	0.0012	0.0024	0.0027
1.A.3.e Transport - Other Transportation	CH_4	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.3.e Transport - Other Transportation	N_2O	0.0000	0.0000	0.0000	0.0000	0.0000
1.A.5.b Other mobile sources not included elsewhere	CO_2	0.0004	0.0004	0.0011	0.0036	0.0038
1.A.5.b Other mobile sources not included elsewhere	CH_4	0.0000	0.0000	0.0001	0.0000	0.0001
1.A.5.b Other mobile sources not included elsewhere	N_2O	0.0000	0.0000	0.0009	0.0002	0.0009
1.A.5.b Mobile sources in Agriculture and Forestry	CO_2	0.0013	0.0013	0.0040	0.0131	0.0137
1.A.5.b Mobile sources in Agriculture and Forestry	CH_4	0.0000	0.0000	0.0001	0.0000	0.0001
1.A.5.b Mobile sources in Agriculture and Forestry	N_2O	0.0000	0.0000	0.0021	0.0003	0.0021
1.B.1.a Coal Mining and Handling	CO_2	-0.0006	0.0010	-0.0144	0.0057	0.0154
1.B.1.a Coal Mining and Handling	CH_4	-0.0156	0.0160	-0.2024	0.0903	0.2216
1.B.1.b. Solid Fuel Transformation	CH_4	0.0000	0.0000	0.0010	0.0013	0.0016
1.B.2 Fugitive Emission from Oil, Natural Gas	CO_2	0.0000	0.0000	-0.0006	0.0000	0.0006
1.B.2 Fugitive Emission from Oil, Natural Gas	CH_4	-0.0005	0.0032	-0.0409	0.0316	0.0517
1.B.2 Fugitive Emission from Oil, Natural Gas	N_2O	0.0000	0.0000	0.0000	0.0000	0.0000
2.A.1 Cement Production	CO_2	-0.0011	0.0076	-0.0021	0.0214	0.0215
2.A.2 Lime Production	CO_2	-0.0014	0.0032	-0.0028	0.0091	0.0095
2.A.3 Glass Production	CO_2	0.0001	0.0006	0.0014	0.0040	0.0043
2.A.4 Other process uses of carbonates	CO_2	0.0013	0.0016	0.0126	0.0116	0.0171
2.B.1 Ammonia Production	CO_2	0.0001	0.0035	0.0006	0.0248	0.0248
2.B.2 Nitric Acid Production	N_2O	-0.0023	0.0013	-0.0349	0.0074	0.0357
2.B.4 Caprolactam, glyoxal and glyoxylic acid production	N_2O	0.0001	0.0004	0.0049	0.0027	0.0056
2.B.8 Petrochemical and carbon black production	CH_4	0.0028	0.0055	0.1108	0.0390	0.1175
2.B.8 Petrochemical and carbon black production	CO_2	0.0001	0.0003	0.0059	0.0019	0.0062
2.B.10 Other	CO_2	0.0011	0.0011	0.0028	0.0047	0.0055
2.C.1 Iron and Steel Production	CH_4	-0.0002	0.0331	-0.0021	0.3280	0.3280

Uncertainty of Trend						
IPCC Source Category	**Gas**	**Type A sensitivity**	**Type B sensitivity**	**Uncertainty in trend in national emissions introduced by EF uncertainty**	**Uncertainty in trend in national emissions introduced by AD uncertainty**	**Uncertainty introduced into the trend in total national emissions**
2.C.1 Iron and Steel Production	CO_2	0.0000	0.0001	0.0000	0.0005	0.0005
2.C.2 Ferroalloys Production	CH_4	0.0003	0.0003	0.0072	0.0020	0.0075
2.C.2 Ferroalloys Production	CO_2	0.0026	0.0026	0.0641	0.0181	0.0666
2.C.5 Lead Production	CH_4	0.0001	0.0001	0.0043	0.0017	0.0047
2.C.6 Zinc Production	CO_2	0.0000	0.0000	0.0001	0.0000	0.0001
2.D.1 Lubricant Use	CO_2	0.0001	0.0005	0.0035	0.0033	0.0048
2.D.2 Paraffin Wax Use	CO_2	0.0000	0.0000	0.0002	0.0003	0.0003
2.D.3 Urea used as catalyst	CO_2	0.0001	0.0001	0.0004	0.0006	0.0008
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	CO_2	0.0001	0.0001	0.0013	0.0019	0.0023
2.E.1 Integrated circuit or semiconductor (CO_2 eq.)	SF_6	0.0000	0.0000	0.0002	0.0003	0.0003
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	NF_3	0.0143	0.0143	0.3279	0.7461	0.8150
2.F.1 Refrigeration and Air Conditioning Equipment (CO_2 eq.)	HFC	0.0000	0.0000	0.0006	0.0013	0.0014
2.F.2 Foam Blowing (CO_2 eq.)	PFC	0.0000	0.0000	0.0003	0.0007	0.0008
2.F.2 Foam Blowing (CO_2 eq.)	HFC	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.3 Fire Protection (CO_2 eq.)	PFC	0.0001	0.0001	0.0024	0.0056	0.0061
2.F.3 Fire Protection (CO_2 eq.)	HFC	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.4 Aerosols (CO_2 eq.)	PFC	0.0000	0.0000	0.0010	0.0022	0.0024
2.F.4 Aerosols (CO_2 eq.)	HFC	0.0000	0.0000	0.0000	0.0000	0.0000
2.F.5 Solvents (CO_2 eq.)	PFC	0.0000	0.0000	0.0002	0.0005	0.0005
2.F.5 Solvents (CO_2 eq.)	HFC	0.0000	0.0000	0.0000	0.0000	0.0000
2.G.1 Electrical Equipment (CO_2 eq.)	PFC	0.0001	0.0004	0.0014	0.0027	0.0030
2.G.2 SF_6 and PFC from other product use (CO_2 eq.)	SF_6	0.0000	0.0000	0.0003	0.0002	0.0004
2.G.3 N2O from product uses	SF_6	0.0004	0.0011	0.0171	0.0081	0.0189
3.A Enteric Fermentation	N_2O	-0.0055	0.0144	-0.1107	0.1016	0.1503
3.B Manure Management	CH_4	-0.0022	0.0039	-0.0664	0.0277	0.0719
3.B Manure Management	CH_4	-0.0048	0.0067	-0.1427	0.0473	0.1503
3.D.1 Agricultural Soils, Direct N_2O emissions	N_2O	-0.0016	0.0122	-0.0791	0.2593	0.2711
3.D.2 Agricultural Soils, Indirect N_2O emissions	N_2O	-0.0012	0.0040	-0.0594	0.1132	0.1278
3.G Liming	N_2O	-0.0033	0.0008	-0.1653	0.0217	0.1667
3.H Urea application	CO_2	-0.0001	0.0003	-0.0042	0.0082	0.0092
4.A.1 Forest Land remaining Forest Land	CO_2	-0.0192	-0.0352	-0.3527	0.0000	0.3527
4.A.1 Forest Land remaining Forest Land	CO_2	0.0000	0.0004	-0.0016	0.0000	0.0016
4.A.1 Forest Land remaining Forest Land	CH_4	0.0000	0.0000	-0.0001	0.0000	0.0001
4.A.2 Land converted to Forest Land	N_2O	-0.0013	-0.0025	-0.0390	0.0000	0.0390
4.B.1 Cropland remaining Cropland	CO_2	-0.0004	-0.0004	-0.0199	0.0000	0.0199
4.B.2 Land converted to Cropland	CO_2	0.0001	0.0004	0.0021	0.0000	0.0021
4.B.2. Land converted to Cropland	CO_2	0.0000	0.0000	-0.0077	0.0000	0.0077
4.C.1 Grassland remaining Grassland	N_2O	-0.0014	-0.0014	-0.0237	0.0000	0.0237
4.C.2 Land converted to Grassland	CO_2	-0.0010	-0.0015	-0.0197	0.0000	0.0197
4.D.2. Land converted to Wetlands	CO_2	0.0001	0.0001	0.0041	0.0000	0.0041
4.E.2 Land converted to Settlements	CO_2	0.0004	0.0007	0.0362	0.0000	0.0362
4.F.2 Land converted to Other Land	CO_2	0.0000	0.0000	0.0044	0.0000	0.0044
4.G Harvested wood products	CO_2	0.0054	-0.0005	0.3375	0.0000	0.3375
5.A Solid Waste Disposal on Land	CO_2	0.0101	0.0170	0.4054	0.7204	0.8266
5.B Biological treatment of solid waste	CH_4	0.0031	0.0031	0.0315	0.0891	0.0945
5.B Biological treatment of solid waste	CH_4	0.0002	0.0002	0.0001	0.0053	0.0053
5.C Incineration and open burning of waste	N_2O	0.0006	0.0007	0.0030	0.0190	0.0192
5.C Incineration and open burning of waste	CO_2	0.0000	0.0000	0.0000	0.0000	0.0000
5.C Incineration and open burning of waste	CH_4	0.0000	0.0000	0.0008	0.0003	0.0008
5.D Wastewater treatment and discharge	N_2O	-0.0002	0.0037	-0.0105	0.1107	0.1112
5.D Wastewater treatment and discharge	CH_4	0.0002	0.0010	0.0115	0.0382	0.0399
1.A.3 Transport - Biomass	N_2O	0.0000	0.0000	0.0002	0.0000	0.0002
1.A.3 Transport - Biomass	CH_4	0.0000	0.0000	0.0007	0.0001	0.0007
					Trend uncertainty =	**2.34**

Annex 3 Detailed methodological descriptions for individual sources or sink categories

A3. 1 Updates of the country specific emission and oxidation factors for determination of CO_2 emissions from combustion of bituminous coal and lignite (brown coal) in the Czech Republic

1. Introduction

Emissions of CO_2, produced during the combustion of solid fuels, have in the Czech Republic a very significant contribution to the overall emissions of greenhouse gases. Emissions of CO_2 are according to the IPCC methodology determined as a product of the consumption of fuels, expressed as amount of energy contained in the fuels determined on the basis of net calorific value (TJ), emission factor for CO_2 (t CO_2/TJ) and oxidation factor. In the methodology for GHG inventory, IPCC provides default emission factors for CO_2, for the individual types of fuels (IPCC,1997 and 2006).

The default emission factors, tabulated in IPCC methodology were determined as middle values on the basis of many calorimetric and analytical tests of individual types of fuels. It is necessary to remember that the used data for determination of this emission factors has predominantly American origin and further comes from the 80s. For the needs of current national inventory, where the nature of the various types of fuels may be different, the default emission factors are not necessary sufficiently satisfactory.

Hence, the new versions of the IPCC methodology (IPCC, 2000 and 2006) recommends to all countries, where emissions of CO_2 from combustion of solid fuels is a so called key category, to check and update the emission factors of CO_2 for calculation of emissions of CO_2 on the basis of national data. In the Czech Republic, where the main part of the CO_2 emissions from solid fuels comes from the combustion of lignite (brown coal) and bituminous coal, it is significant to determine country specific emission factors for these two types of fuels.

The default emission factors for lignite (brown coal) and bituminous coal, provided in the older and newer version of the IPCC methodology, practically do not differ. In the recommended values for oxidation factor, however a substantial change appeared: while the older version (IPCC, 1997) reported default value of oxidation factor 0.98, new version (IPCC, 2006) provides default value of 1, which is the maximum possible and considering the solid fuels, in practice unreachable. In the IPCC methodology this change was introduced, because the authors of the new version were aware that these values are for solid fuels so geographically and technologically specific, that it could be difficult to generalize them. Default value of 1 was chosen as a conservative estimate, preventing possible underestimation of emission determination. Therefore a country, which wants to prevent possible overestimation of the emissions of CO_2 from combustion of solid fuels, has to determine representative country specific values of oxidation factor for individual types of solid fuels, on the basis of local data.

For determination of the country specific emission factors it is necessary to obtain data about the carbon content in given type of fuel and its net calorific value.

The factor for the carbon content (CC) is for the individual types of solid fuels defined as the ratio of weight of the carbon and the amount of energy in this fuel of the mass m

$$CC = m \cdot \frac{w_c}{m} \cdot Q_i = \frac{w_c}{Q_i} \qquad \text{(A3-1)}$$

where wc is the fraction of mass of carbon in the fuel and Q_i is its net calorific value. It is important to notice, that all variables in the equation (A3-1) are related to the fuel (carbon) with its current water content in the supplied fuel, i.e. in the state, when it is determined the quantity (i.e. mass): raw - index ^{r} .

As the calorific value is expressed in MJ/kg (=TJ/kt), carbon content in% mass ($C^r = 100 * w_C$) and CC in t C/TJ, it is possible to rewrite the previous equation to:

$$CC\left[t\frac{C}{TJ}\right] = \frac{10 \cdot C^r[\%]}{Q_i^r\left[\frac{MJ}{kg}\right]} \qquad \text{(A3-2)}$$

The emission factor for CO_2 (t CO_2/TJ) is obtained by multiplying by the ratio of the molar weight of carbon dioxide and carbon

$$EF(CO_2) = CC \cdot 3.664 \qquad \text{(A3-3)}$$

IPCC methodology provides the following default factors for carbon content CC:

Lignite (brown coal): 27.6 (t C/TJ)

Bituminous coal: 25.8 (t C/TJ)

In the Czech national inventory these emission factors were used until 2006. On the basis of the recommendation of international expert review team (ERT) of UNFCCC, during the review conducted in February 2007, it was decided to use for lignite (brown coal) and bituminous coal factors for CC values 25.43 and 27.27 (t C/TJ), which can be found in the national study from 1999 (Fott, 1999) and are pertaining to the state of the coal in the Czech Republic in the 90s. For determination of the oxidation factor the necessary data were not available, therefore for all solid fuels was used the default value of 0.98 from 1996 Guidelines, for the whole time series from 1990 to 2012 (2006 Guidelines come into force from the current year 2013).

In the last years related to the implementation of the emission trading within EU ETS, the operators of the bigger plants combusting coal began to systematically address the laboratory determined emission factors for different types of coal, combusted in these plants according to the prescribed requirements of the European Directive 82/2003 EC including the relevant guidelines, regarding the methodology of monitoring. Some operators gradually extended this assessment also by the determination of oxidation factors, whose values depend not only on the type of coal, but also on the nature of the combustion source.

Data from the coal analysis from 1999 naturally was not so extensive. Further the coal base in the beginning of the 90s in the Czech Republic largely changed - production in less efficient mines have been gradually phased out and the in the existing mines now often is extracted on different places for example, in deeper coal layers. For these reasons, the research team of the Czech national inventory decided in the frame of its improvement plan to revise the emission factors, used until now and to determine new oxidation factors. Detailed description of the used approach, input data and discussion of the reached results, can be found in the study of authors E. Krtková, P. Fott and V. Neužil, prepared for publication in scientific journal. In the further text of this Annex clarification of the principle of the used method is reported and the reached results from the above mentioned paper are presented.

2. Revision and updating of nationally specific emission factors

In the last years, lignite (brown coal) is extracted mostly in the North Bohemia (Mostecko), where is the most significant brown coal area in the Czech Republic, and to a lesser extent in the West Bohemian region (Sokolovsko). Bituminous coal is currently quarried only in Ostrava-Karvina district, in the large coalfield, whose greater part is situated in the neighboring country Poland. Lignite (brown coal) is in the Czech Republic extracted from the surface mines, while bituminous coal is extracted from the underground mines.

Overview of data sets for updating emission factors

Set “ČEZ“

The most extensive collection of data with the results of chemical analyzes, including calorific values, gained the national inventory team from the company ČEZ, which operates most of the coal-fired power plants in CR, burning in particular energy (pulverized) lignite (brown coal). The set contains 29 samples of bituminous energy (pulverized) coal and 146 samples of lignite (brown coal), mainly energy one and to a lesser extent also sorted one - 25 samples and this is mostly from North Bohemian region, and in to a lesser extent from West Bohemian region.

Set “Dalkia”

Except from the company ČEZ, the research team received extended set of relevant coal data from the company Dalkia, which operates particularly power and heat plants, combusting mostly bituminous energy coal in the east part of the Czech Republic and with a lesser extent lignite (brown coal). The set “Dalkia” contains analyzes mostly of bituminous coal (143 samples) and 36 samples of lignite (brown coal).

Combined set of aggregated data

In order to evaluate the parameters, required for determining of country specific emission factors, the primary data were aggregated as it follows: aggregated items from the above mentioned sets (“ČEZ” and “Dalkia”) were acquired as average of calorific value and the percentage of carbon content from six to twelve analyzed samples (i.e. analysis of monthly collected samples).

Combined set was extended by 3 aggregated items (yearly average for 2012) by lignite (brown coal) from West Bohemian region (Sokolovská uhelná).

The combined set included three major operators of combustion sources in the Czech Republic and contains of 37 aggregated items altogether, from which 19 from the set “ČEZ”, 15 from set “Dalkia”, three were obtained as described in the previous paragraph. This set contains 23 aggregated items of lignite (brown coal) (from which 4 from set “Dalkia”) and 14 for bituminous coal (3 items come from the set “ČEZ”, the rest 11 items are from the set “Dalkia”). 18 aggregated items for lignite (brown coal) come from a larger North Bohemian region, 5 items of lignite (brown coal) – from smaller West Bohemian region.

The range of the net calorific value for lignite (brown coal) is, from this set, between 9.9 and 18.5 MJ/kg, while the range of the net calorific value for black coal is between (16.2 and 26.4 MJ/kg).

Set “ETS”

The set contains data from the ETS database created in CHMI, to which have been saved certified forms, filled by the operators of energy installations in the Czech Republic under the ETS. These forms, containing data for 2011, were provided to CHMI from the Ministry of Environment. For the processing there were taken into account only those installations whose annual emissions exceeded 50 kt CO_2 and which, in accordance with monitoring guidelines of EU, determined emission factors from the laboratory data. In this way there were processed 34 sources, combusting lignite (brown coal) and 13 – combusting bituminous coal.

The range of net calorific value for lignite (brown coal) was in this case between 10.4 and 18.8 MJ/kg, while for bituminous coal - was between 17.1 and 26.8 MJ/kg.

The procedure for evaluating of the emission factors

In the above mentioned article from 1999 (Fott, 1999) it was demonstrated linear correlation between the carbon content C^r [%] in the coal and its calorific value Q_i^r [MJ/kg].

$$C^r = a \cdot Q_i^r + b \qquad \text{(A3-4)}$$

with a correlation coefficient r^2 higher than 0.99. This correlation equation fits for bituminous and lignite (brown coal), therefore both types of coal can be described by one equation (i.e. a single pair of parameters a, b).

Taking into account the equation (A3-2), dependence between the carbon content CC (t C/TJ) and the calorific value Q_i^r [MJ/kg] is obtained.

$$CC = 10 \cdot \left(a + \frac{b}{Q_i^r}\right) \qquad \text{(A3-5)}$$

In this way a country specific parameters a, b were evaluated in equation (A3-4), (A3-5) instead of two separate values of country specific factor for lignite (brown coal) and for bituminous coal.

This procedure was applied also on current data. For the process there were used the two most representative sets: combined set of aggregated data, hereinafter referred as “Comb” and “ETS”.

On Fig. A3 1 it can be seen, that for the combined data set “Comb” a correlation between carbon content and net calorific value can be described for both types of coal with a regression line (see equation (A3-4)) with parameters a = 2.4142 and b = 4.0291, while the correlation coefficient value r^2 = 0.997 is close to one.

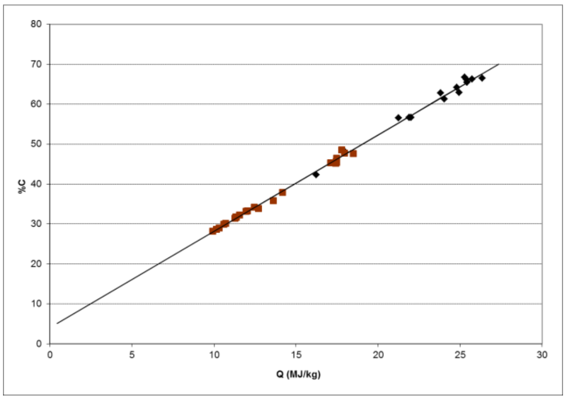

Fig. A3 1 Combined set of aggregated data “Comb”. Correlation between carbon content (%C) and net calorific value for lignite (brown coal) (indicated with brown squares) and bituminous coal (indicated with black squares)

In terms of the uncertainty of emission determination, it is necessary to assess the extent to which the carbon content factor values differ from the values determined by the curve (5). This is graphically illustrated on Fig. A3 2. Numerically, the difference between the individual points from the calculated curve can be characterized with the mean relative error, which is 1.14% for lignite (brown coal) and

1.30% for bituminous coal. Nevertheless, the mean relative error of any kind of coal does not exceed 3%. Therefore, the uncertainty of the carbon content factors and thus the uncertainty of CO_2 emission factors can be considered as acceptable.

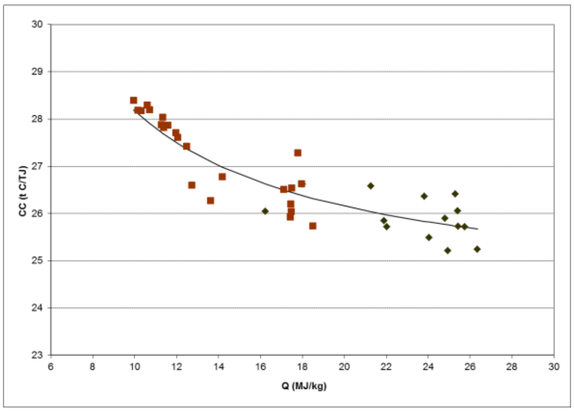

Fig. A3 2 Combined set of aggregated data "Comb". Correlation between the factor of carbon content CC and net calorific value for brown coal (indicated as brown squares) and black coal (indicated as black squares), found through the eq. A3-5.

In the set "ETS" values Q_i^r and factors for CC were available, but the carbon content in percentages was not given. Therefore the parameters a, b were assessed with non-liner regression, using the equation (A3-5). In this way the parameters a = 2.4211 and b = 3.9539 were determined. In this case the mean relative error for lignite (brown coal) was equal to 1.59% and for bituminous coal was equal to 1.73%.

The parameters a, b, evaluated from the both sets are very similar. However, statistical indicators characterizing uncertainty are in the case of set "ETS" somewhat higher, than for the combined set.

3. Determination of country specific oxidation factors

Formula for calculation of oxidation factor from analytical data

Oxidation factor from analytical data is calculated using the following formula.

$$OF = 1 - \frac{A}{C \cdot \left(\frac{1}{C,out - 1}\right)} = 1 - \frac{A \cdot C,out}{C \cdot (1 - C,out)}$$

where OF is oxidation factor (with value somewhat lower than 1), A is the mass fraction of ash, C is the mass fraction of carbon and C,out is the mass fraction of carbon on the exit of the combustion device (the mass fractions are values in the interval between 0 and 1, e.g. 40% corresponds to mass fraction of 0.4). In case, that on the exit both forms of ash are present (slag and dry ash), C,out is calculated as weighted average of the fraction of non-combusted carbon in both forms of ash.

Sets of data used for determination of oxidation factors and their processing

Set "ČEZ"

This is the set "ČEZ", which is described above, containing 146 samples of lignite (brown coal) and 29 samples of bituminous coal. This set contains also all data occurring in the resulting equation (A3-6), used for the calculation of oxidation factor.

Results from the processed data from the set "ČEZ" are these values of oxidation factors:

OF for lignite (brown coal): 0.9857

OF for bituminous coal: 0.9696

Set "Dalkia"

As a matter of fact the set "Dalkia" is that described above. The set contains analysis of mostly bituminous coal (143 samples). Representative value in case of the bituminous coal from the set "Dalkia" is 0.9719.

OF for lignite (brown coal) was possible to be obtained from the set "Dalkia", using only the part of the samples, combusted at not so important combustion installations (i.e. with relatively low emissions). From these was calculated average (0.979) considered only as approximate value for comparison purposes.

Set "ETS"

The set contains data from the ETS database, created in CHMI (see above), into which have been saved proven forms, provided by the energy operators, falling under ETS. For processing there were taken into account only these plants (installations), whose emissions exceeded 50 kt and where the indicated oxidation factors were identified based on chemical analysis. In this way were processed 10 sources combusting bituminous coal and 18 sources, combusting lignite (brown coal). From the set "ETS" were calculated the following representative values of OF for bituminous and lignite (brown coal).

Resulting values of OF from set "ETS" are:

OF for lignite (brown coal): 0.9835

OF for bituminous coal: 0.9708

For lignite (brown coal) was taken as the most representative current country value for OF, the value of **OF = 0.9846** determined as average of the two average values from sets "ČEZ" and "ETS":

$$OF = \frac{0.9857 + 0.9835}{2} = 0.9846$$

For bituminous coal was taken as the most representative current country value for OF, the value of **OF = 0.9707** determined as average of the three average values from sets "ČEZ", "Dalkia" and "ETS":

$$OF = \frac{0.9696\ +\ 0.9719\ +\ 0.9708}{3} = 0.9707$$

4. The method of determining carbon dioxide emissions, using country specific parameters

Carbon dioxide emissions for specific category sources is determined as a product of consumed fuel, expressed as the amount of energy contained in the fuel defined on the basis of calorific value (TJ), emission factor for CO_2 (t CO_2/TJ) and oxidation factor. CzSO provides annual fuel consumption for each category of sources, both in weight units and in energy units determined using the net calorific value. The national inventory research team uses this data as an input activity data.

For determination of the CO_2 emission factor it is necessary to define appropriate emission and oxidation factor for individual categories and for the whole time series. Regarding the updating of the country specific emission factors, the research team decided to determine them as an average of two values: emission factor, calculated using the eq. A3-5, using the parameters **a = 2.4142** and **b = 4.0291**, determined from the combined file "Comb" and emission factor calculated using the parameters **a =2.4211** and **b = 3.9539**, calculated from the file "ETS". The reason for this decision is the very good correspondence of the relevant curves calculated from equation (A3-5) of these two representative sets.

In the case of the oxidation factors the research team decided to use till 2010 so far used oxidation factor of 0.98 and from year 2011 the newly determined country specific oxidation factor presented in section 3. The reason for this decision is the fact that the current values were determined, based on data recorded between 2011 and 2012, while the data for the previous years was not available. However, the newly established oxidation factors suggest that so far used value 0.98 corresponds better to reality than the default value of 1 pursuant to 2006 Guidelines.

Examples of setting of CO_2 emission factors, 2013

a) Lignite (brown coal)

In Tab. 3-10, chapter "Energy" in the last year's NIR (CHMI, 2015) is provided average net calorific value of 13.409 MJ/kg, CC factor is calculated as:

$$\frac{10\cdot\left(\frac{2.4142+4.0291}{13.409}\right)+10\cdot\left(\frac{2.4211+3.9539}{13.409}\right)}{2}=\frac{27.147+27.160}{2}=27.153\ \frac{t\ C}{TJ}$$

To this corresponds emission factor for CO_2

$$27.153\cdot 3.664=99.489\ \frac{t\ CO_2}{TJ}$$

27.153 • 3.664= 99.489 t CO_2/TJ. Resultant emission factor for CO_2 including the oxidation factor has a value of.

$$99.489\cdot 0.9846=97.957\frac{t\ CO_2}{TJ}$$

b) Bituminous coal

In Tab. 3-10, chapter "Energy" in the last year's NIR (CHMI, 2015) is provided average net calorific value of 25.502 MJ/kg, CC factor is calculated as:

$$\frac{10\cdot\left(\frac{2.4142+4.0291}{25.502}\right)+10\cdot\left(\frac{2.4211+3.9539}{25.502}\right)}{2}=\frac{25.722+25.761}{2}=25.742\ \frac{t\ C}{TJ}$$

To this corresponds emission factor for CO_2

$$25.742\cdot 3.664=94.317\ \frac{t\ CO_2}{TJ}$$

Resultant emission factor for CO_2 including the oxidation factor has a value of

$$94.317\cdot 0.9707=91.554\frac{t\ CO_2}{TJ}$$

A3. 2 Country specific CO_2 emission factor for LPG

In order to enhance the accuracy of emission estimates from Energy sector the research with aim to develop country specific emission factor for LPG was carried out last year. LPG is the mixture of propane and butane and other C2 – C5 hydrocarbons and is available in two versions – summer and winter mixture. The basic qualitative parameters are available in the official Czech Standard ČSN EN ISO 4256. These parameters are given in Tab. A3 - 1.

Tab. A3 - 1 Qualitative parameters of LPG – summer and winter mixture

PARAMETER*)	summer mixture	winter mixture
C2-hydrocarbons and inerts -%, max.	7	7
C3- hydrocarbons -%, min.	30	55
C4- hydrocarbons -%	30 - 60	15 - 40
C5-and higher hydrocarbons -%, max.	3	2
Unsaturated hydrocarbons -%, max.	60	65
Hydrogen sulfide - $mg.kg^{-1}$, max.	0.2	0.2
Content of sulphur - $mg.kg^{-1}$, max.	200	200

**)% in the table mean mass percents*

For the determination of country specific emission factor is necessary to obtain data about composition of LPG, which is distributed in the territory of the Czech Republic. These data were obtained from the Česká rafinérská, a.s., which is the major distributor of the LPG in the CR. The quality of distributed LPG is based on the above mentioned official standard (ČSN EN ISO 4256) and so also the data provided by Česká rafinérská, a.s. are in line with this standard. The specific composition is listed in Tab. A3 - 3.

Tab. A3 - 2 Composition of LPG distributed in the Czech Republic (in mass percents)

Composition	summer mixture	winter mixture
C2+inerts	0.2	0.1
propane	38.5	58.7
propylene	7.2	4.5
iso-butane	25.6	27.9
n-butane	15.7	5.9
sum of butens	12.2	2.8
C5 and higher	0.6	0.1
Ratio of the production of summer : winter mixture = circa 1 : 1.1		

This elementary composition of LPG (given in Tab. A2-2) was used for the calculations of country specific emission factor (based on the carbon content in each component). At first carbon emission factors related to the mass of LPG (kg C/kg LPG) were computed. For the summer mixture is the carbon emission factor equal to 0.8287 kg C/kg; for winter mixture 0.8232 kg C/kg. Final value computed using weighted average taking in consideration the summer : winter mixture ratio is equal to 0.8258 kg C/kg.

The net calorific value related to the mass (MJ/kg) was computed using equation A2-2. For the summer mixture is net calorific value equal to 45.853 MJ/kg; for the winter mixture to 46.029 MJ/kg. Final value computed using weighted average taking in consideration the summer : winter mixture ratio is equal to 45.945 MJ/kg. This net calorific value was also used for the conversion of activity data from kilotons to TJ.

Final emission factor was determined using equation A3-7

$$\frac{1000 \cdot 0.8258}{45.945} = 17.974 \frac{t\,C}{TJ} \qquad \text{(A3-6)}$$

This value is in very good agreement with the value 17.9 t C/TJ determined in Harmelen and Koch (2002); corresponded net calorific value is 45.5 MJ/kg (Harmelen and Koch, 2002), which is also in a good agreement with the value determined as Czech country specific.

Tab. A3 – 3 indicates comparison of the newly developed country specific CO_2 emission factor and the default one provided either in Revised 1996 Guidelines (IPCC, 1997) or in 2006 Guidelines (IPCC, 2006). It is necessary to keep in mind, that 2006 Guidelines states the range of default emission factors, which for LPG is 16.8 – 17.9 t C/TJ. It is apparent that default emission factors slightly underestimate the emission estimates. The country specific emission factor does not fit into the default interval, which also supports this conclusion. Since country specific emission factor was evaluated based on the specific composition of LPG distributed in the Czech Republic, the newly developed emission factor will evaluate the emission estimates more accurate than the default emission factor.

Tab. A3 - 3 Comparison of country specific CO_2 and default emission factors for LPG

	[t C/TJ]	[t CO_2/TJ]
Revised 1996 Guidelines	17.2	63.07
2006 Guidelines	17.2	63.1
CO_2 country specific emission factor for CR	17.97	65.90

Based on the composition of LPG was also net calorific value computed, which agreed better to the specific conditions of CR then the net calorific value presented in CzSO questionnaire. The updated net calorific value was used for the computation of fuel consumption in TJ; the value 45 945 kJ/kg was used (conversion from kt to TJ).

A3. 3 Country specific CO_2 emission factor for Refinery Gas

Another improvement concerning emission factor from combustion of Refinery Gas was accomplished in 2013. Refinery gas is defined as non-condensable gas obtained during distillation of crude oil or treatment id oil products in refineries. It consists mainly of hydrogen, methane, ethane and olefins (IPCC, 2006).

Refinery Gas in CR is also used mainly by Česká rafinérská, a.s. This company is also included in the EU ETS and in terms of this obligation also carries out the analyses of molar composition of Refinery Gas. These analyses were provided to the inventory team for the purposes of the development of country specific CO_2 emission factor from combustion of Refinery Gas. These analyses obtain the information about content of hydrogen, content of CO_2, content of CO, content of methane, ethane, propane, iso-butane, n-butane, butenes, iso-pentanes, n-pentanes, ethylene, propylene, C6 and higher hydrocarbons, content of oxygen, nitrogen, hydrogen sulphide and water in the Refinery Gas. The analyses are available for the 2008 – 2012 in the time step 3 – 4 days.

It is apparent that the available analyses are sufficiently detailed, so it allowed the inventory to team to develop country specific emission factor for the Czech Republic. The approach of ‘carbon content in the fuel’, which was fully attested in case of determination of country specific emission factor from combustion of Natural Gas (Krtková et al., 2014), was also used for determination of Refinery Gas emission factor. Based on the molar composition of the gas mixture the country specific emission factors for years 2008 – 2012 were determined. For the years before the average value of the 2008 – 2012 values was used. The table below shows the used values.

Tab. A3 - 4 Country specific carbon emission factors from combustion of Refinery Gas (t C/TJ)

1990 - 2007	2008	2009	2010	2011	2012
15.03	15.06	14.93	14.58	15.24	15.34

All values in the table lies within the default range 13.1 – 18.8 t C/TJ specified in the 2006 Guidelines and further more are close to the default value 15.7 t C/TJ (IPCC, 2006). However, the previously used default value provided by the 1996 Guidelines (IPCC, 1997) was somewhat higher, 18. 2 t C/TJ.

Also net calorific value of Refinery Gas was computed based on the available analyses of the molar composition. CzSO has updated this value based on the request of the inventory team. The updated value is 46.023 MJ/kg. This value was used for the whole time series.

A3. 4 Country specific CO_2 emission factor for Natural Gas combustion

Extensive research was carried out in 2012 with aim to develop the country-specific emission factor for Natural Gas combustion (CHMI, 2012b). This research was part of a project of The Technical Assistance of the Green Savings programme. Final evaluation of the CO_2 emission factor for Natural Gas combustion is based on its correlation with the net calorific value. Detailed description of the research is given in the following paragraphs.

Complete description of this research will be published in Greenhouse Gas Measurement & Management journal, the manuscript is entitled Carbon dioxide emissions from natural gas combustion – country specific emission factors for the Czech Republic (Krtková et al., 2014).

The net calorific value of Natural Gas can be computed on the basis of the molar composition according to:

$$Q_m = \sum w_i \cdot Q_{mi} \quad \text{(A3-8)}$$

$$Q_m = Q_m \cdot d \quad \text{(A3-9)}$$

where Q_m [MJ/kg] is the net calorific value of Natural Gas related to its mass, w [kg/kg] is the mass fraction, Q_{mi} [MJ/kg] is the net calorific value of different components of Natural Gas related to their mass, Q_v [MJ/m^3] is the net calorific values of Natural Gas related to its volume and d [kg/m^3] is its density.

Tab. A3 - 5 lists the net calorific values of the basic components of Natural Gas.

Tab. A3 - 5 Net calorific values of the basic components of Natural Gas (ČSN EN ISO 6976, 2006)

Net calorific values of basic components of Natural Gas [MJ/kg]	
methane	50.035
ethane	47.52
propane	46.34
iso-butane	45.57
n-butane	45.72
iso-pentane	45.25
n-pentane	45.35
sum C>6 (like heptane)	44.93

The carbon emission factor for Natural Gas related to its energy content (CEF_{TJ} [t C/TJ]) is computed according to

$$CEF_{TJ} = \frac{CEF_m}{Q_m} \quad \text{(A3-10)}$$

where CEF_m is carbon emission factor related to the mass.

Carbon dioxide emission factor (EF (CO_2) [t CO_2/TJ]) is then calculated

$$EF_{CO_2} = CEF_{TJ} \cdot \frac{M_{CO_2}}{M_c} \quad \text{(A3-11)}$$

where M_{CO2} and M_C are the molecular weight of carbon dioxide and atomic weight of carbon, respectively.

A similar method (to the one described here) of computing EF (CO_2) and Q_v for 10 characteristic samples of Natural Gas was used in the article (Čapla and Havlát, 2006). Samples 1 – 4 were chosen based on their place of origin: sample 1 – Natural Gas from Russian gas fields distributed in Czech Republic in 2001; sample 2 – Natural Gas from Norwegian gas fields in the North Sea; sample 3 – Natural Gas coming from Dutch gas fields; sample 4 – Natural Gas mined in Southern Moravia. Samples 5 – 10 represented the composition of the Natural Gas distributed in the Czech Republic in 2005 – 2006.

This rather representative dataset was used to determine the regression curve, which was similar to the line

$$EF_{CO_2} = 0.269 \cdot \left(\frac{Q_V}{3.6}\right)^2 - 2.988 \cdot \left(\frac{Q_V}{3.6}\right) + 59.212 \quad \text{(A3-12)}$$

which was tightly fit to all 10 points (correlation coefficient $R^2 = 0.999$). In this correlation expression Q_v represents the net calorific value related to the volume under "trade conditions" (101.3 kPa, 15° C).

The calculations of the regression curve for the samples 5 – 10 indicated in particularly close range of Qv: 34.11 – 34.27 MJ/m^3. The lowest net calorific value (31.31 MJ/m^3) was determined for sample number 3 (Dutch field) and the highest (38.28 MJ/m^3) for Norwegian gas type. The low net calorific value of Dutch Natural Gas is caused by relatively high content of nitrogen; the high net calorific value of the Norwegian Natural Gas is a result of the higher content of C2, C3 and C4 hydrocarbons (especially ethane).

The above-described methodology was tested on a relatively small dataset. To obtain sufficiently reliable correlation, this methodology had to be tested on a dataset which would provide composition of Natural Gas in sufficient time series. In cooperation with CzSO a dataset comprising analyses of Natural Gas composition was obtained. These analyses are continuously evaluated in the laboratory of NET4GAS, Ltd. Daily average values on the Natural Gas composition from the first day in the month were available for evaluation of the CO_2 emission factor. The dataset of these analyses began on 1st January 2007 and the last data are from 1st September 2011. Furthermore data for 1st February 2012 were also available. The report on each analysis contains data on the molar composition of the Natural Gas, physical characteristics and conditions during which the analysis was performed. Overall, 58 analyses were available. Fig. A2- 1 depicts the trend of net calorific values in time.

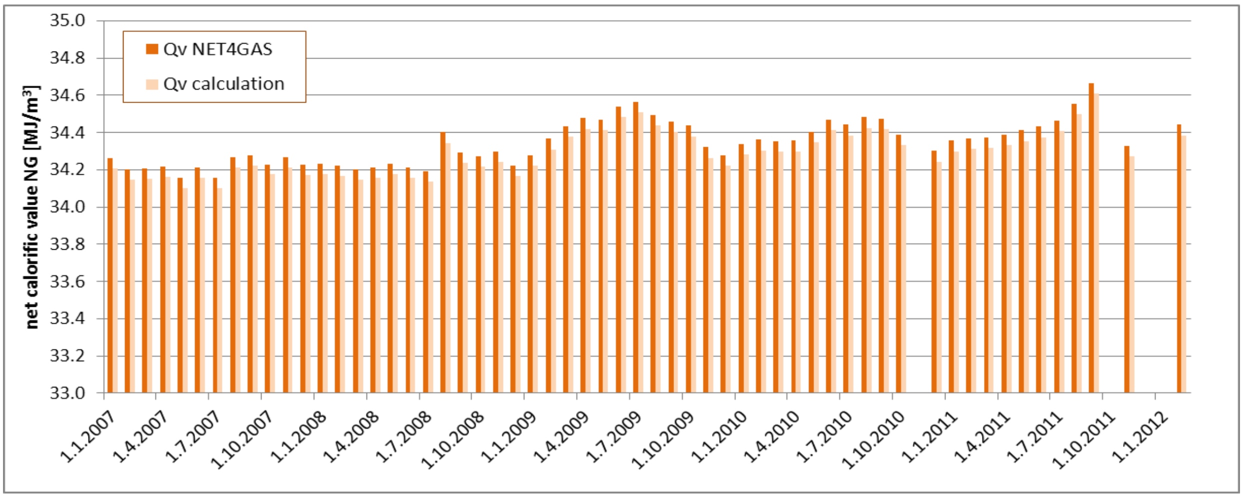

Fig. A3 3 Net calorific values given in NET4GAS Ltd. reports and net calorific values calculated on the basis of composition of Natural Gas in 1.1.2007 – 1.2.2012 (both values are given at 15°C)

The figure indicates a good match between the two depicted values; the deviation is almost constant and reaches an average value of 0.16%. The deviation is probably caused by the fact that the measured values correspond to the non-state gas behaviour; however the calculation is based on the assumption of ideal gas behaviour. For this reason, the net calorific values from the NET4GAS Ltd. reports were used for calculation of the emission factor. The reports contain data related to the reference temperature 20° C; thus, it was necessary to recalculate net calorific values and densities for 15° C.

The results of the calculations are depicted in Fig.A2- 2. This figure also contains computation of the correlation

$$EF_{CO_2}{=}0.787 \cdot Q_V + 28.21 \qquad \text{(A3-13)}$$

where Q_v [MJ/m^3] is the net calorific value of Natural Gas at "trade conditions": temperature 15°C and pressure of 101.3 kPa.

These findings were compared with the results obtained during preparation of this research. First, the data about analyses of Natural Gas obtained from RWE Transgas were used for comparison. This dataset contains data from 2003, 2004 and 2009 and evaluation of these data resulted in the correlation

$$EF_{CO_2}{=}0.6876 \cdot Q_V + 31.619 \qquad \text{(A3-14)}$$

The second source for comparison is the paper of Čapla and Havlát (2006), where the correlation resulted in equation (A3-13).

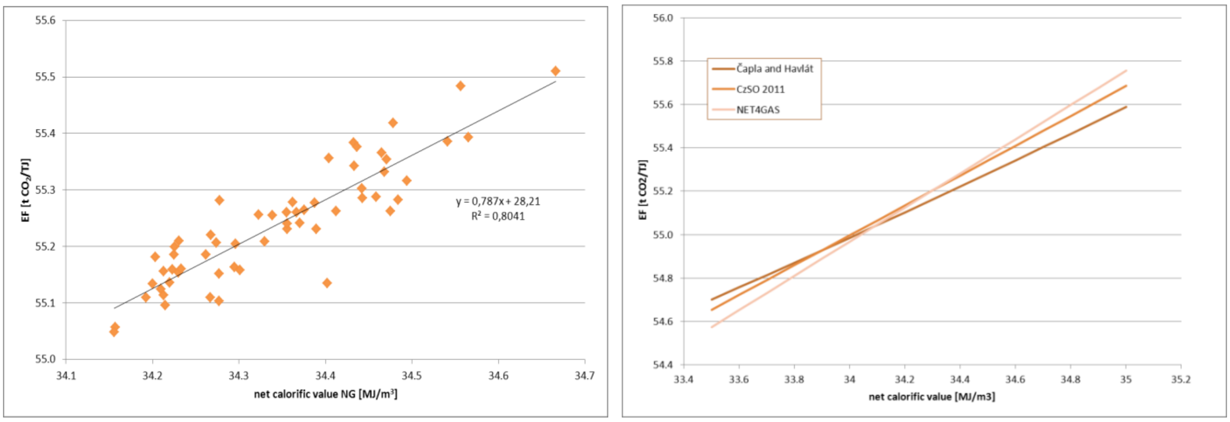

Fig. A3 4 Correlation of EF [t CO_2/TJ] and net calorific value of Natural Gas and Comparison of three approaches used for calculation

Fig. A3- 3 indicates good correlation between all three approaches in the region of 34.1 – 34.3 MJ/m^3, where the deviation between the results is 0.3% in maximum.

Each year in its energy balance, the Czech Statistical Office reports the average value of net calorific value of Natural Gas. Fig. A3- 4 indicates the trend of these calorific values. It is apparent that NCV is continuously slightly increasing.

The dark line in Fig. A2- 4 indicates the lowest net calorific value determined in the dataset provided by NET4GAS Ltd in 2007 - 2012. For the period of 2007 towards all the net calorific values are lower than 34.1 MJ/m^3. For this reason, it is more accurate to use the correlation obtained from the dataset representing the data before this year, i.e. the correlation evaluated by Čapla and Havlát (2006).

Fig. A3- 5 depicts the correlation curve combined on the basis of both correlations. It is given for the whole range of net calorific values, which was identified in Natural Gas in the Czech Republic in the 1990 - 2010 period. The value 34.1 MJ/m^3 is depicted by the dashed line.

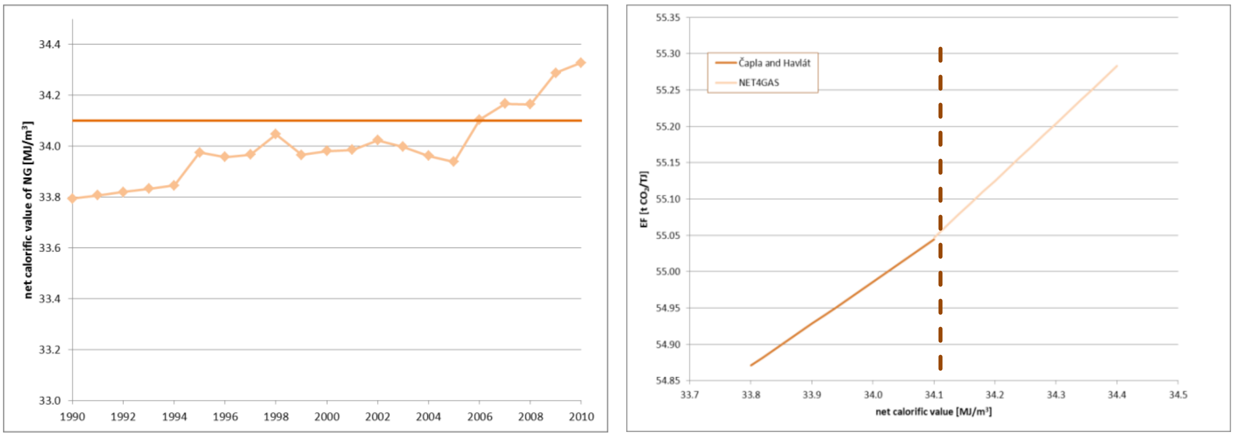

Fig. A3 5 Trend in Natural Gas NCV 1990 – 2010 and Correlation between NCV and EF combined from two approaches – Čapla and Havlát (NCV lower than 34.1 MJ/m^3) and computed correlation on the basis of NET4GAS dataset (NCV higher than 34.1 MJ/m^3)

Evaluation of CO_2 emission factors for Natural Gas combustion is based on the computational approach described above. There are two correlation relations; each of them is used for a different range of net calorific values. As depicted in Fig. A2- 5, both correlations follow each other closely. Tab A3 - 6 lists all the calculated emission factors for both correlations; the recommended values are in bold.

Tab. A3 - 6 Comparison of both recommended correlations

year	Average net calorific value of NG reported by CzSO	EF CO_2 calculated on the basis of Čapla and Havlát correlation (eq. A2-5)	EF CO_2 calculated on the basis of NET4GAS, Ltd. dataset correlation (eq. A2-6)
	[MJ/m^3]	[t CO_2/TJ]	[t CO_2/TJ]
1990	33.794	**54.87**	*54.81*
1991	33.807	**54.87**	*54.82*
1992	33.820	**54.88**	*54.83*
1993	33.832	**54.89**	*54.84*
1994	33.845	**54.90**	*54.85*
1995	33.975	**54.97**	*54.95*
1996	33.957	**54.96**	*54.93*
1997	33.966	**54.97**	*54.94*
1998	34.046	**55.01**	*55.00*
1999	33.965	**54.97**	*54.94*
2000	33.980	**54.97**	*54.95*
2001	33.986	**54.98**	*54.96*
2002	34.023	**55.00**	*54.99*
2003	33.997	**54.98**	*54.97*
2004	33.962	**54.96**	*54.94*
2005	33.938	**54.95**	*54.92*
2006	34.105	*55.05*	**55.05**
2007	34.167	*55.08*	**55.10**
2008	34.164	*55.08*	**55.10**
2009	34.288	*55.16*	**55.19**
2010	34.328	*55.18*	**55.23**

The deviations between the two calculations are less than 0.15%. The values written in bold were used for recalculation of CO_2 emissions from Natural Gas combustion for the 1990 – 2010 time series (held in 2013 submission). Former submissions employed the default emission factor 56.1 t CO_2/TJ, which overestimated the CO_2 emissions from Natural Gas combustion, especially at the beginning of the nineteen nineties (about 2.4% in 1990).

For years 2011 and 2012 the correlation relation based on the NET4GAS, Ltd. dataset was used (eq. A3-13):

$$EF_{CO_2} = 0.787 \cdot Q_V + 28.21 \qquad \text{(A3-15)}$$

The availability of analyses of the Natural Gas composition should be ensured in the coming years. The validity of equation (A2-7) will be continuously tested using new data, and if necessary, the correlation equation will be modified to fit the new data as best as possible.

Starting with submission 2013 updated emission factors are used for all categories in 1A Energy for the whole time series.

For other detailed discussion of methodology and data for estimating CO_2 emissions from fossil fuel combustion please see the relevant parts in Chapter 3.2 and in the Annex 5.

A3. 5 Methodology for Road Transport (1.A.3.b)

The Methodology of determination of air polluting emissions from transport in the Czech Republic is used for transport emission calculations on a national and regional level. The results are reported not only to UNFCCC, but also to CLRTAP and other international bodies. The methodology was adopted by the Ministry of Transport, Ministry of Environment and Czech Hydrometeorological Institute in 2002 and was updated in 2006. The methodology includes only emissions from transport and does not include emissions from electricity production used by electric vehicles. It also does not include emissions from the engines of off-road machines and vehicles used, for example, in agriculture, the building industry, the army or households.

The underlying principles of the methodology are:

- categorization of vehicles
- measured emission factors
- distribution of fuel consumption between individual transport modes
- annual mileages in selected vehicle categories

The methodology is based on the classification of vehicles in 23 categories using the following criteria: transport mode, fuel type, weight of vehicles (in road freight traffic) and equipment with effective catalytic converter systems (cars). Every category has associated emission factors for CO_2, CO, NO_X, N_2O, CH_4, NMVOC, SO_2, Pb and PM, based on the available measurements. Emission factors are expressed in $g.kg^{-1}$ of fuel and are processed in the MS Access database.

Two parallel approaches are used for classification of fuel consumption. The first one is "top - down", i.e. allocating total fuel consumption according to transport performances and numbers of vehicles, and the second one is "bottom - up", i.e. from annual mileages and average consumption in $1.100km^{-1}$. This consumption is classified in 5 categories (motorcycles, gasoline passenger cars with or without catalytic converter systems, diesel light duty vehicles, diesel heavy duty vehicles), taken from the 23 categories mentioned above, which exhibit the largest differences in annual mileages ($km.year^{-1}$).

Mileages are reported in a manner such that the sum of the fuel consumptions in the first three categories (motorcycles, gasoline passenger cars with or without catalytic convert systems) calculated using the "bottom - up" method is identical with the fuel consumption in the individual transport categories calculated using the "top - down" method. A similar approach is employed for road freight transport. The relationship of the mileages employed must be in line with the relationships of the above mentioned categories in real situations. These are derived from the transport census. This is based on the total fuel consumption in the appropriate transport modes. Transport performances are used to derive the relative fuel consumption for the individual transport modes.

The categorization of vehicles enables separate calculation of the N_2O production from the total amount of NO_X. VOCs are separated into CH_4 (which contributes to the greenhouse effect) and nonmethane VOCs. Every category has associated emission factors according to the available measurements in the Czech Republic and the recommended values from international statistics (IPCC, Emission Inventory Guidebook). Emission factors are given in $g.kg^{-1}$ of fuel and are processed in the MS Access database.

Reference:

DUFEK, J., HUZLÍK, J., ADAMEC, V. Methodology of determination of air pollution emissions from transport in the Czech Republic. Brno: CDV, 2006, 26 s.(in Czech). http://www.cdv.cz/metodiky/

A3. 6 Country specific CO_2 emission factor for Lime Production

Emissions of GHG from lime production are classified into two different categories. The first category relates to the combustion processes taking place in the production of lime and emissions from this are reported in the "Energy" sector in the Czech National Inventory Report. The second category includes emissions from decomposition of carbonates and decomposition of the organic carbon contained in the raw material used for the production of lime. These emissions are described in the "Industrial processes" sector, in the “Mineral industry” subsector. The following calculations apply only to the second category of emissions.

Production of lime is based on heating limestone, during which decomposition (calcination) of carbonates contained in the limestone occurs and carbon dioxide is released. Mainly a mixture of calcium carbonate and magnesium carbonate is present in the limestone in contents of 75.0 to 98.5% by weight, of which the magnesium carbonate corresponds to 0.5 to 15.0% by weight. The detailed chemical compositions and the division of limestone into classes according to the national standards are shown in Tab. A3 - 7 (ČSN, 1992).

Tab. A3 - 7 Division of limestone according to chemical composition

Chemical composition in% weight		Quality class							
		I	II	III	IV	V	VI	VII	VIII
$CaCO_3 + MgCO_3$	min	98.5	97.5	96.0	95.0	93.0	85.0	80.0	75.0
of which $MgCO_3$	min	0.5	0.8	2.0	4.0	6.0	10.0	15.0	
SiO_2	max	0.3	0.8	1.5	3.0	4.5	6.0	8.0	18.0
$Al_2O_3 + Fe_2O_3$	max	0.2	0.4	0.8	2.0	3.5	5.0	6.0	6.0
of which Fe_2O_3	max	0.03	0.1	0.03	1.0	2.0	2.5	2.5	
MnO	max	0.01	0.03	0.03	0.03				
SO_3	max	0.08	0.1	0.2	0.2	0.3	0.5	0.5	2.0

The composition of limestone is closely associated with the emission factor. As calcium carbonate and magnesium carbonate have different emission factors and the ratio between the two emission factors is reflected in the resulting emission factor. The emission factor derived from $CaCO_3$ or $MgCO_3$ is defined as the emission factor of method A. This method is based on the input materials in the process of lime production. Further, the emission factor can be determined for the outgoing materials or for CaO and MgO in lime. This procedure is called method B. Emission factors from method A and B are listed in Tab. A3-8 (Commission Regulation (EU) № 601/2012).

Tab. A3 - 8 Emission factors for method A and B

Method	Material	EF [t CO_2/ t material]
A (input)	$CaCO_3$	0.440
	$MgCO_3$	0.522
B (output)	CaO	0.785
	MgO	1.092

Additional ingredients (other carbonates and organic carbon) which occur in limestone in very small quantities may also be a source of emissions. These small amounts will affect the total emission factor to a minor extent; therefore, for the inventory of GHG can be considered as negligible.

Thus the most significant impact on the emission factor comes from the composition of the input material, which is subsequently reflects the composition of the lime. Therefore, we can affirm that it is immaterial whether we calculate from the composition of the input material (Method A) or the composition of the output material (Method B); both approaches would lead to the same emission factor for the given process.

The best way to do this is to observe the relation between the emission factor and mass in% of $MgCO_3$ in the input material (Method A). This dependence can be observed in Fig. A3-4.

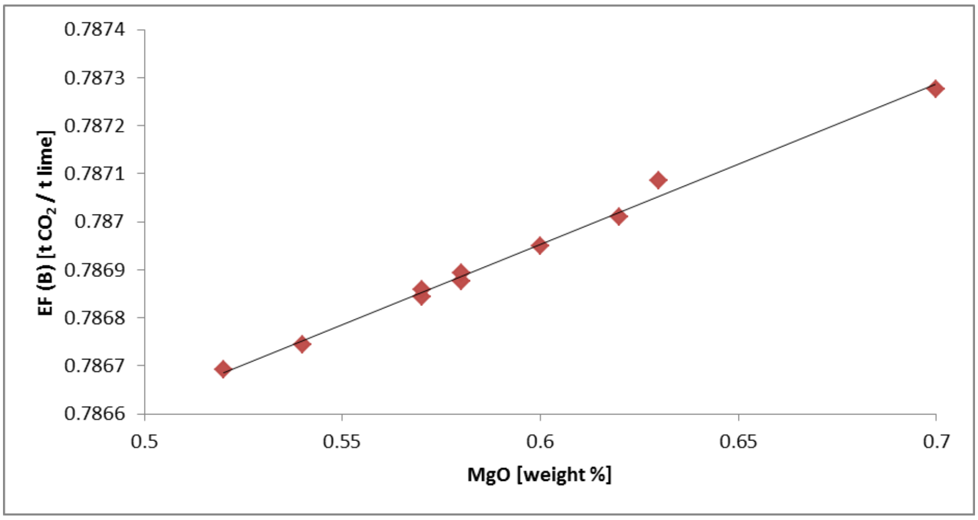

Fig. A3 6 Correlation between emission factor and mass representation of $MgCO_3$ in input material

The dependence between the emission factor and the output material (weight% MgO) occurs naturally, even when using method B, as can be seen in Fig. A3 - 5.

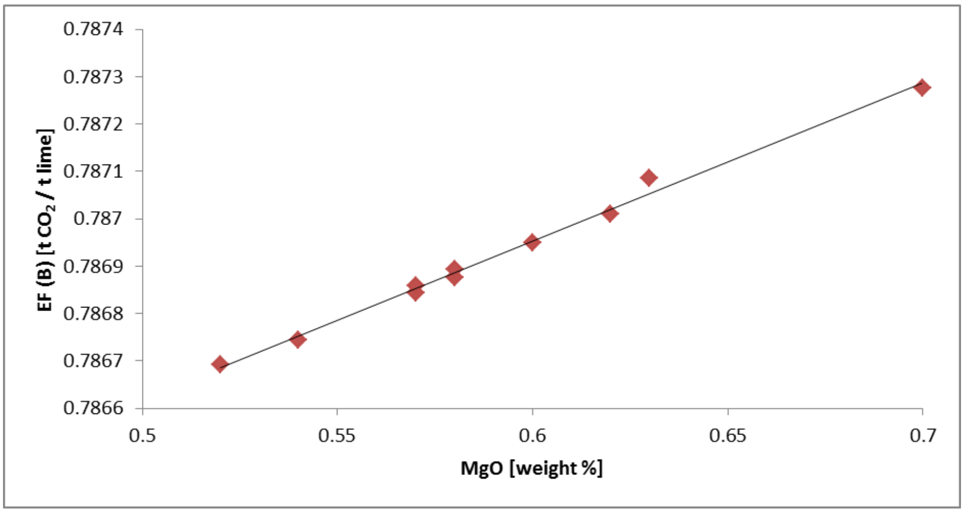

Fig. A3 7 Correlation of emission factor in mass representation of MgO in output material

As Fig. A3 -4 and Fig. A3 - 5 show, the emission factor varies only very slightly with the amount of $MgCO_3$ or MgO. The limestone that is processed in the Czech Republic is supplied to the lime plants from the same source and its composition at the individual sources does not change much with time. These facts indicate that, similarly, the emission factor for lime production will vary only within a narrow range, which will have a small impact on calculation of the emissions. As it is evident from Fig. A3 – 6, the emissions calculated using the Tier 1 approach, which employs the country specific emission factor (Vacha, 2004), are only very slightly overestimated compared to emissions from the ETS, which are obtained by measuring or the Tier 3 approach.

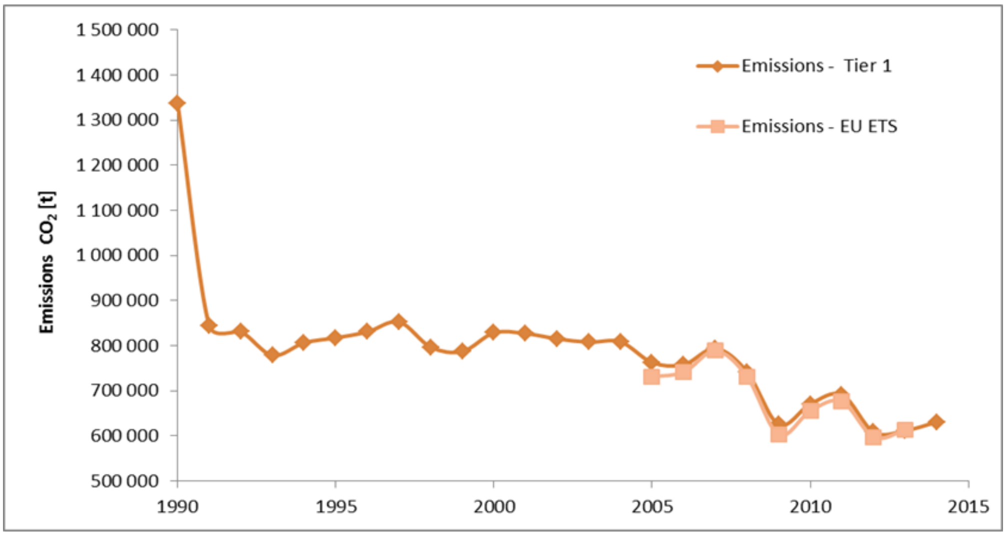

Fig. A3 8 Development of emissions of CO_2 from production of lime in CR for period 1990 – 2014

Figure A3 - 7 depicts the oscillating weighted total emission factor derived from ETS data which fluctuates near the country specific emission factor values. It can be seen in Fig. 4 that there could be a slight decrease in the emission factor after 2009. For the 1990 – 2004 period, for which ETS data are not available, the emission factors could be calculated as the average of the available data from ETS. The average of these values is 0.7885 t CO_2/t lime and it differs from the country specific emission factor only by one ten-thousandth. For this reason, for this time period it is considered reasonable to retain the country-specific emission factor.

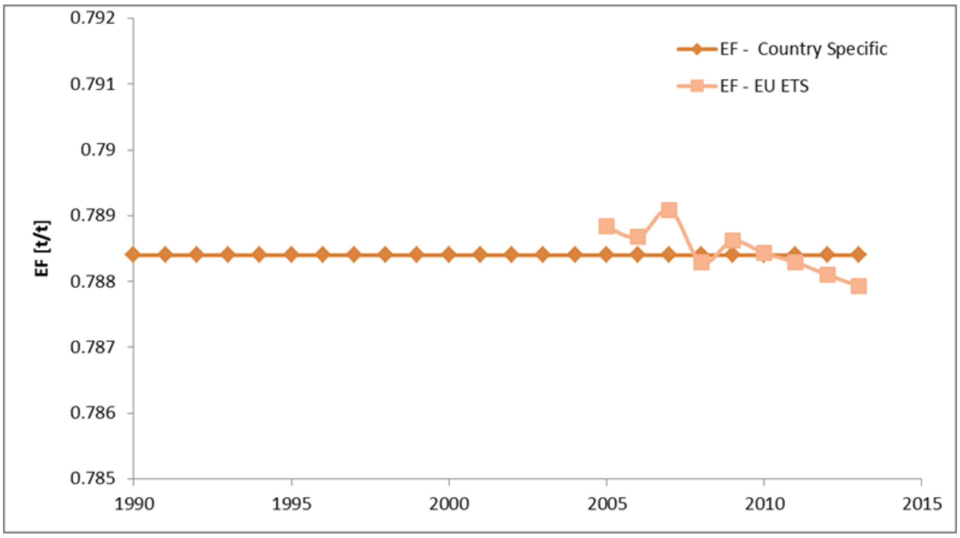

Fig. A3 9 Development of EF for production of lime in CR for period 1990 - 2014 (method B)

Since the composition of limestone has not changed significantly from 1990 to the present time, the emission factor also does not undergo any major change. Therefore, the country specific emission factor (0.7884 t CO_2/t lime; Vacha, 2004) can be used for the 1990 – 2004 period and emission factors derived from ETS will be employed for the remaining period.

Due to the very small variation of the $MgCO_3$ content in limestone, the emission factor changes slightly over time. Therefore, the proposed country specific emission factor, which is equal to 0.7884 t CO_2/t lime (Method B), can be used for the 1990 – 2004 period and the activity data for emission calculations are based on the Czech Statistical Office and Czech Lime Association values. Since 2005 it has been possible to use ETS data, which have greater accuracy than the country-specific EF, together with data from CSO and CLA.

Annex 4 The national energy balance for the most recent inventory year

Following tables present energy balance for the Czech Republic for 2014.

Tab. A4 - 1 Energy balance for solid fuels 2014

SOLID FUELS	Coking Coal [kt/year]	Sub Bituminous Coal [kt/year]	Lignite/Brown Coal [kt/year]	Coke Oven Coke [kt/year]	Coal Tar [kt/year]
Indigenous Production	4 559	4 035	40 385	2 489	193
Total Imports (Balance)	1 006	807	312	429	304
Total Exports (Balance)	2 230	2 581	1 111	457	9
International Marine Bunkers	0	0	0	0	0
Stock Changes (National Territory)	-40	1 200	-650	-11	3
Inland Consumption (Calculated)	3 295	3 611	38 936	2 450	491
Statistical Differences	87	-209	-343	0	0
Transformation Sector	3 208	3 349	35 953	1 993	7
Main Activity Producer Electricity Plants	0	960	21 801	0	0
Main Activity Producer CHP Plants	0	2 178	10 224	0	4
Main Activity Producer Heat Plants	0	9	173	0	0
Autoproducer Electricity Plants	0	0	438	0	0
Autoproducer CHP Plants	0	201	1 933	0	0
Autoproducer Heat Plants	0	1	30	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0
Coke Ovens (Transformation)	3 208	0	0	93	0
BKB Plants (Transformation)	0	0	0	0	0
Gas Works (Transformation)	0	0	1 354	0	0
Blast Furnaces (Transformation)	0	0	0	1 900	3
Coal Liquefaction Plants (Transformation)	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0
Energy Sector	0	0	794	0	89
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0
Coal Mines	0	0	794	0	0
Patent Fuel Plants (Energy)	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0
BKB Plants (Energy)	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	89
Blast Furnaces (Energy)	0	0	0	0	0
Petroleum Refineries	0	0	0	0	0
Coal Liquefaction Plants (Energy)	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0
Distribution Losses	0	0	0	0	0
Total Final Consumption	0	471	2 532	457	395
Total Non-Energy Use	0	0	0	0	356
Final Energy Consumption	0	471	2 532	457	39
Industry Sector	0	367	902	426	39
Iron and Steel	0	107	23	384	7
Chemical (including Petrochemical)	0	65	564	0	12
Non-Ferrous Metals	0	0	0	5	0
Non-Metallic Minerals	0	168	33	21	20
Transport Equipment	0	0	26	0	0
Machinery	0	1	31	9	0
Mining and Quarrying	0	2	3	0	0
Food, Beverages and Tobacco	0	14	93	7	0
Paper, Pulp and Printing	0	10	101	0	0
Wood and Wood Products	0	0	2	0	0
Construction	0	0	8	0	0
Textiles and Leather	0	0	11	0	0
Non-specified (Industry)	0	0	7	0	0
Transport Sector	0	0	1	0	0
Other Sectors	0	104	1 629	31	0
Commercial and Public Services	0	5	66	10	0
Residential	0	97	1 530	20	0
Agriculture/Forestry	0	2	24	1	0
Fishing	0	0	0	0	0
Non-specified (Other)	0	0	9	0	0

Tab. A4 - 2 Energy balance for solid fuels 2014

SOLID FUELS	BKB-PB [kt/year]	Gas Works Gas [TJ/year]	Coke Oven Gas [TJ/year]	Blast Furnace Gas [TJ/year]	Other Recovered Gases [TJ/year]
Indigenous Production	0	16 396	20 550	20 513	1 813
Total Imports (Balance)	159	0	0	0	0
Total Exports (Balance)	18	0	0	0	0
International Marine Bunkers	0	0	0	0	0
Stock Changes (National Territory)	0	0	0	0	0
Inland Consumption (Calculated)	141	16 396	20 550	20 513	1 813
Statistical Differences	0	0	0	0	0
Transformation Sector	0	16 269	6 371	8 585	637
Main Activity Producer Electricity Plants	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	6 371	8 585	637
Main Activity Producer Heat Plants	0	0	0	0	0
Autoproducer Electricity Plants	0	21	0	0	0
Autoproducer CHP Plants	0	16 248	0	0	0
Autoproducer Heat Plants	0	0	0	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0
BKB Plants (Transformation)	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0
Coal Liquefaction Plants (Transformation)	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0
Energy Sector	0	127	8 862	3 187	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0
Coal Mines	0	127	0	0	0
Patent Fuel Plants (Energy)	0	0	0	0	0
Coke Ovens (Energy)	0	0	8 862	1 532	0
BKB Plants (Energy)	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	1 655	0
Petroleum Refineries	0	0	0	0	0
Coal Liquefaction Plants (Energy)	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0
Distribution Losses	0	0	266	0	0
Total Final Consumption	141	0	5 051	8 741	1 176
Total Non-Energy Use	0	0	0	0	0
Final Energy Consumption	141	0	5 051	8 741	1 176
Industry Sector	0	0	5 051	8 741	1 176
Iron and Steel	0	0	4 896	8 695	1 123
Chemical (including Petrochemical)	0	0	0	0	0
Non-Ferrous Metals	0	0	0	0	0
Non-Metallic Minerals	0	0	50	1	53
Transport Equipment	0	0	0	0	0
Machinery	0	0	105	45	0
Mining and Quarrying	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0
Paper, Pulp and Printing	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0
Construction	0	0	0	0	0
Textiles and Leather	0	0	0	0	0
Non-specified (Industry)	0	0	0	0	0
Transport Sector	0	0	0	0	0
Other Sectors	141	0	0	0	0
Commercial and Public Services	0	0	0	0	0
Residential	141	0	0	0	0
Agriculture/Forestry	0	0	0	0	0
Fishing	0	0	0	0	0
Non-specified (Other)	0	0	0	0	0

Tab. A4 - 3 Energy balance for Crude Oil, Refinery Gas and Additives/Oxygenates for 2014

LIQUID FUELS	Crude Oil [kt/year]	Refinery Feedstocks [kt/year]	Additives Oxygenates [kt/year]
Indigenous Production	154	0	106
From Other Sources	0	0	319
From Other Sources - Solid fuels	0	0	0
From Other Sources - Natural Gas	0	0	0
From Other Sources - Renewables	0	0	319
Backflows	0	73	0
Primary Product Receipts	0	0	0
Refinery Gross Output	0	0	0
Inputs of Recycled Products	0	0	0
Refinery Fuel	0	0	0
Total Imports (Balance)	6 552	18	18
Total Exports (Balance)	25	0	0
International Marine Bunkers	0	0	0
Interproduct Transfers	0	0	0
Products Transferred	0	123	0
Direct Use	0	0	197
Stock Changes (National Territory)	-17	-4	6
Refinery Intake (Calculated)	6 664	210	252
Gross Inland Deliveries (Calculated)	0	0	0
Statistical Differences	0	0	0
Gross Inland Deliveries (Observed)	0	0	0
Refinery Intake (Observed)	6 664	210	252

Tab. A4 - 4 Energy balance for liquid fuels 2014

LIQUID FUELS	Refinery Gas [kt/year]		LPG [kt/year]		Naphtha [kt/year]		Motor Gasoline [kt/year]		Biogasoline [kt/year]		Aviation Gasoline [kt/year]	
Refinery Gross Output	134		180		737		1,252		39		0	
Refinery Fuel	118		0		0		0		0		0	
Total Imports (Balance)	0		107		141		556		3		2	
Total Exports (Balance)	0		90		2		320		12		0	
International Marine Bunkers	0		0		0		0		0		0	
Stock Changes (National Territory)	0		0		-2		-5		5		0	
Gross Inland Deliveries (Calculated)	16		234		874		1,483		87		2	
Statistical Differences	0		0		0		-4		4		0	
Gross Inland Deliveries (Observed)	16		234		874		1,487		83		2	
Refinery Intake (Observed)	0		0		0		0		0		0	
Non-energy use in Petrochemical industry	16		120		874		0		0		0	
	Energy Use	**Non Energy Use**	**Energy Use**	**Non Energy Use**	**Energy Use**	**Non Energy Use**	**Energy Use**	**Non Energy Use**	**Energy Use**	**Non Energy Use**	**Energy Use**	**Non Energy Use**
Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer CHP Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
For Blended Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0
Total Final Consumption	0	16	114	120	0	874	1 487	0	83	0	2	0
Transport Sector	0	0	69	0	0	0	1 487	0	83	0	2	0
International Aviation	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Aviation	0	0	0	0	0	0	0	0	0	0	2	0
Road	0	0	69	0	0	0	1 487	0	83	0	0	0
Rail	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Navigation	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0
Industry Sector	0	16	34	120	0	874	0	0	0	0	0	0
Iron and Steel	0	0	0	0	0	0	0	0	0	0	0	0
Chemical (including Petrochemical)	0	16	0	120	0	874	0	0	0	0	0	0
Non-Ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0
Non-Metallic Minerals	0	0	1	0	0	0	0	0	0	0	0	0
Transport Equipment	0	0	1	0	0	0	0	0	0	0	0	0
Machinery	0	0	5	0	0	0	0	0	0	0	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	1	0	0	0	0	0	0	0	0	0
Paper, Pulp and Printing	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0
Textiles and Leather	0	0	1	0	0	0	0	0	0	0	0	0
Non-specified (Industry)	0	0	25	0	0	0	0	0	0	0	0	0
Other Sectors	0	0	11	0	0	0	0	0	0	0	0	0
Commercial and Public Services	0	0	1	0	0	0	0	0	0	0	0	0
Residential	0	0	4	0	0	0	0	0	0	0	0	0
Agriculture/Forestry	0	0	4	0	0	0	0	0	0	0	0	0
Fishing	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Other)	0	0	2	0	0	0	0	0	0	0	0	0

Tab. A4 - 5 Energy balance for liquid fuels 2014

LIQUID FUELS	Kerosene Type Jet Fuel [kt/year]		Other Kerosene [kt/year]		Transport Diesel [kt/year]		Biodiesel [kt/year]		Heating and Other Gasoil [kt/year]		Residual Fuel Oil [kt/year]	
Refinery Gross Output	111		0		2 865		86		117		148	
Refinery Fuel	0		0		0		0		0		0	
Total Imports (Balance)	171		2		1 696		46		14		13	
Total Exports (Balance)	0		0		664		24		26		120	
International Marine Bunkers	0		0		0		0		0		0	
Stock Changes (National Territory)	9		0		19		0		0		57	
Gross Inland Deliveries (Calculated)	291		2		4 053		253		110		108	
Statistical Differences	0		0		0		0		0		32	
Gross Inland Deliveries (Observed)	291		2		4 053		253		110		76	
Refinery Intake (Observed)	0		0		0		0		0		0	
Non-energy use in Petrochemical industry	0		0		0		0		6		0	
	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use	Energy Use	Non Energy Use
Transformation Sector	0	0	0	0	1	0	0	0	2	0	27	0
Main Activity Producer Electricity Plants	0	0	0	0	0	0	0	0	0	0	7	0
Autoproducer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	0	0	0	0	0	0	1	0	5	0
Autoproducer CHP Plants	0	0	0	0	0	0	0	0	0	0	8	0
Main Activity Producer Heat Plants	0	0	0	0	1	0	0	0	1	0	5	0
Autoproducer Heat Plants	0	0	0	0	0	0	0	0	0	0	2	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
For Blended Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	0
Patent Fuel Plants (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Energy Sector	0	0	0	0	16	0	0	0	1	0	0	0
Coal Mines	0	0	0	0	16	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0	0	0	0	1	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0
Total Final Consumption	291	0	2	0	4 036	0	253	0	101	6	49	6
Transport Sector	291	0	0	0	3 661	0	253	0	85	0	0	0
International Aviation	274	0	0	0	0	0	0	0	0	0	0	0
Domestic Aviation	17	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	0	3 659	0	253	0	0	0	0	0
Rail	0	0	0	0	0	0	0	0	85	0	0	0
Domestic Navigation	0	0	0	0	2	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0
Industry Sector	0	0	0	0	43	0	0	0	9	6	42	6
Iron and Steel	0	0	0	0	0	0	0	0	0	0	5	0
Chemical (including Petrochemical)	0	0	0	0	0	0	0	0	0	6	1	6
Non-Ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0
Non-Metallic Minerals	0	0	0	0	0	0	0	0	0	0	7	0
Transport Equipment	0	0	0	0	0	0	0	0	1	0	0	0
Machinery	0	0	0	0	0	0	0	0	2	0	2	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	1	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	1	0	1	0
Paper, Pulp and Printing	0	0	0	0	0	0	0	0	0	0	4	0
Wood and Wood Products	0	0	0	0	0	0	0	0	1	0	3	0
Construction	0	0	0	0	41	0	0	0	3	0	0	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Industry)	0	0	0	0	2	0	0	0	1	0	18	0
Other Sectors	0	0	2	0	332	0	0	0	7	0	7	0
Commercial and Public Services	0	0	0	0	5	0	0	0	2	0	3	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture/Forestry	0	0	0	0	319	0	0	0	4	0	2	0
Fishing	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Other)	0	0	2	0	8	0	0	0	1	0	2	0

Tab. A4 - 6 Energy balance for liquid fuels 2014

LIQUID FUELS	White Spirit SBP [kt/year]		Lubricants [kt/year]		Bitumen [kt/year]		Paraffin Wax [kt/year]		Petroleum Coke [kt/year]		Other Products [kt/year]	
Refinery Gross Output	0		100		477		9		0		925	
Refinery Fuel	0		0		0		0		0		65	
Total Imports (Balance)	13		130		272		7		10		166	
Total Exports (Balance)	0		69		347		5		2		102	
International Marine Bunkers	0		0		0		0		0		0	
Stock Changes (National Territory)	-1		-1		3		-1		0		-21	
Gross Inland Deliveries (Calculated)	12		161		402		10		8		750	
Statistical Differences	0		0		0		0		0		0	
Gross Inland Deliveries (Observed)	12		161		402		10		8		750	
Refinery Intake (Observed)	0		0		0		0		0			
Non-energy use in Petrochemical industry	0		0		0		0		0		514	
	Energy Use	**Non Energy Use**	**Energy Use**	**Non Energy Use**	**Energy Use**	**Non Energy Use**	**Energy Use**	**Non Energy Use**	**Energy Use**	**Non Energy Use**	**Energy Use**	**Non Energy Use**
Transformation Sector	0	0	0	0	0	0	0	0	0	0	0	73
Main Activity Producer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer Electricity Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer CHP Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer CHP Plants	0	0	0	0	0	0	0	0	0	0	0	0
Main Activity Producer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Autoproducer Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
For Blended Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Petrochemical Industry	0	0	0	0	0	0	0	0	0	0	0	73
Patent Fuel Plants (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transformation)	0	0	0	0	0	0	0	0	0	0	0	0
Energy Sector	0	0	0	0	0	0	0	0	0	0	0	0
Coal Mines	0	0	0	0	0	0	0	0	0	0	0	0
Oil and Gas Extraction	0	0	0	0	0	0	0	0	0	0	0	0
Coke Ovens (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Blast Furnaces (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Gas Works (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Own Use in Electricity, CHP and Heat Plants	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Energy)	0	0	0	0	0	0	0	0	0	0	0	0
Distribution Losses	0	0	0	0	0	0	0	0	0	0	0	0
Total Final Consumption	0	12	0	161	2	400	0	10	0	8	111	566
Transport Sector	0	0	0	137	0	0	0	0	0	0	0	0
International Aviation	0	0	0	0	0	0	0	0	0	0	0	0
Domestic Aviation	0	0	0	0	0	0	0	0	0	0	0	0
Road	0	0	0	130	0	0	0	0	0	0	0	0
Rail	0	0	0	7	0	0	0	0	0	0	0	0
Domestic Navigation	0	0	0	0	0	0	0	0	0	0	0	0
Pipeline Transport	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Transport)	0	0	0	0	0	0	0	0	0	0	0	0
Industry Sector	0	12	0	24	0	400	0	10	0	8	111	566
Iron and Steel	0	0	0	0	0	0	0	0	0	4	0	0
Chemical (including Petrochemical)	0	1	0	0	0	0	0	0	0	0	0	514
Non-Ferrous Metals	0	0	0	0	0	0	0	0	0	0	0	0
Non-Metallic Minerals	0	0	0	0	0	0	0	0	0	0	5	0
Transport Equipment	0	0	0	0	0	0	0	0	0	0	0	0
Machinery	0	0	0	0	0	0	0	0	0	2	0	0
Mining and Quarrying	0	0	0	0	0	0	0	0	0	0	0	0
Food, Beverages and Tobacco	0	0	0	0	0	0	0	0	0	0	1	0
Paper, Pulp and Printing	0	0	0	0	0	0	0	0	0	0	0	0
Wood and Wood Products	0	0	0	0	0	0	0	0	0	0	0	0
Construction	0	0	0	0	0	400	0	0	0	0	1	0
Textiles and Leather	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Industry)	0	11	0	24	0	0	0	10	0	2	104	52
Other Sectors	0	0	0	0	2	0	0	0	0	0	0	0
Commercial and Public Services	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture/Forestry	0	0	0	0	0	0	0	0	0	0	0	0
Fishing	0	0	0	0	0	0	0	0	0	0	0	0
Non-specified (Other)	0	0	0	0	2	0	0	0	0	0	0	0

Tab. A4 - 7 Energy balance for Natural Gas 2014 [TJ] in GCV

Indigenous Production	9 579
Associated Gas	5 730
Non-Associated Gas	
Colliery Gas	3 849
From Other Sources	0
Total Imports (Balance)	324 154
Total Exports (Balance)	310
International Marine Bunkers	0
Stock Changes (National Territory)	-10 276
Inland Consumption (Calculated)	323 147
Statistical Differences	0
Inland Consumption (Observed)	323 147
Recoverable Gas	
Opening Stock Level (National Territory)	73 543
Closing Stock Level (National Territory)	83 819
Opening stock level (Held abroad)	13 173
Closing stock level (Held abroad)	14 203
Memo:	
Gas Vented	0
Gas Flared	0
Memo: Cushion Gas	
Cushion Gas Closing Stock Level	40 768
Memo: From other sources	
From Other Sources - Oil	0
From Other Sources - Coal	0
From Other Sources - Renewables	0

Transformation Sector	45 116
Main Activity Producer Electricity Plants	252
Autoproducer Electricity Plants	0
Main Activity Producer CHP Plants	17 197
Autoproducer CHP Plants	4 061
Main Activity Producer Heat Plants	20 921
Autoproducer Heat Plants	2 685
Gas Works (Transformation)	0
Coke Ovens (Transformation)	0
Blast Furnaces (Transformation)	0
Gas-to-Liquids (GTL) Plants (Transformation)	0
Non-specified (Transformation)	0
Energy Sector	4 388
Coal Mines	0
Oil and Gas Extraction	152
Petroleum Refineries	4 236
Coke Ovens (Energy)	0
Blast Furnaces (Energy)	0
Gas Works (Energy)	0
Own Use in Electricity, CHP and Heat Plants	0
Liquefaction (LNG)/Regasification Plants	0
Gas-to-Liquids (GTL) Plants (Energy)	0
Non-specified (Energy)	0
Distribution Losses	5 418
Transport Sector	2 482
Road	632
of which Biogas	0
Pipeline Transport	1 850
Non-specified (Transport)	0
Industry Sector	98 240
Iron and Steel	10 171
Chemical (including Petrochemical)	12 264
Non-Ferrous Metals	1 860
Non-Metallic Minerals	21 888
Transport Equipment	7 842
Machinery	12 562
Mining and Quarrying	2 020
Food, Beverages and Tobacco	13 845
Paper, Pulp and Printing	4 802
Wood and Wood Products	1 472
Construction	3 676
Textiles and Leather	2 278
Non-specified (Industry)	3 560
Other Sectors	162 433
Commercial and Public Services	62 170
Residential	94 433
Agriculture/Forestry	2 980
Fishing	0
Non-specified (Other)	2 850

Annex 5 Any additional information, as applicable

Information provided in A5.1 – A5.2 are related to emission estimation in Energy sector.

A5.1 Improved ratio NCV/GCV for Natural Gas

Default ratio NCV/GCV for natural gas according to the IPCC methodology (IPCC 2006) is equal to 0.9

The NET4GAS data set was used for more accurate determination of the ratio. Among other values, this data set contains NCV and GCV in MJ/m^3 for a reference temperature of 20˚C, for each month and for a time period of 5 years (1997 to 2011). All monthly values for NCV and GCV were recalculated for a temperature of 15˚C (i.e. trading conditions), and further the annual average of the monthly values for NCV and GCV and their ratio NCV/GCV were determined, see Tab. A5-1

Tab. A5 1 Annual average NCV, GCV and their ratio (determined and calculated using correlation)

MJ/m^3	2007	2008	2009	2010	2011	Average	Standard deviation	%Standard deviation
NCV, 15 ˚C	34.2236	34.2498	34.4267	34.3921	34.4469	34.3478	0.0927	0.27%
GCV, 15 ˚C	37.9572	37.9841	38.1724	38.1363	38.1942	38.0888	0.0986	0.26%
Ratio NCV/GCV	0.90164	0.90169	0.90187	0.90182	0.90189	0.90178	0.0001	0.01%
0.001011*GCV + 0.863274 [a)]	0.90165	0.90168	0.90187	0.90183	0.90189			

[a)] *Precise calculation of the ratio NCV/GCV*

As CzSO reports mainly yearly gross calorific values for natural gas (GCV), while data expressing net calorific value (NCV) is needed, correlation for the calculation of NCV from known values for GCV, reported every year from CzSO, was determined by linear regression, see. Fig. A5-1

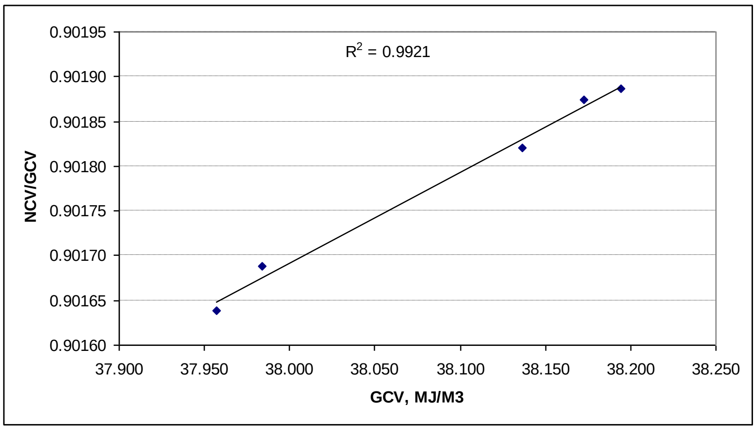

Fig. A5 1 Regression line corresponds with the data shown in Tab. A5-1.

The resulting equation for exact calculation of NCV from known values for GCV is:

NCV = (0.001011 * GCV + 0.863274) * GCV (A5 – 1)

where NCV and GCV are expressed in MJ/m^3 in the reference temperatures of 15 ˚C (i.e. trading conditions)

A5.2 Improved ratio NCV/GCV for coke oven gas

The recommended ratio NCV/GCV for coke oven gas according to CzSO is equal to 0.9.

For more accurate determination of the ratio, the data set obtained from one of the significant coke producers in the Czech Republic was mostly used. This data set uses calculation sheets developed by CHMI for determination of emission factors for CO_2, density and NCV for gaseous fuels, calculated from its composition, etc.

This calculation sheet bases the calculation of NCV and GCV for fuels in the gaseous state on the calorific value and GCV, based on the weight of the individual components that are listed in regulation ČSN 38 5509 (DIN 1872), so this also enables calculation of the NCV/GCV ratio.

Unlike natural gas, industrially produced fuels NCV and GCV are usually provided for a reference temperature of 0˚C (273.15 K), i.e. in “normal conditions”. The same value is used in the above-mentioned data set. Default ratio NCV/GCV does not depend on the reference temperature, because the recalculation coefficients for different reference temperatures in the ratio NCV/GCV are cancelled out. The NCV/GCV ratio is calculated for each month in 2010, i.e. 12 times, from which the ratio, standard deviation and its relative value are calculated.

Results are presented in Tab. A5-2.

Tab. A5 2 Annual averages of NCV, GCV under normal condition (i.e. 0˚C) and their ratio

Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
NCV. MJ/Nm^3	16.935	17.108	16.847	16.040	16.459	17.210	17.162	
GCV, MJ/NM^3	19.053	19.251	18.953	18.059	18.530	19.342	19.270	
NCV/GCV	0.8888	0.8886	0.8889	0.8882	0.8883	0.8898	0.8906	
Month	**8**	**9**	**10**	**11**	**12**	**Average**	**Standard deviation**	**%**
NVC. MJ/Nm^3	17.177	16.832	17.056	17.218	17.312	16.946	0.353	2.1%
GCV, MJ/NM^3	19.309	18.925	19.183	19.357	19.443	19.056	0.386	2.0%
NCV/GCV	0.8896	0.8894	0.8891	0.8895	0.8904	0.8893	0.0007	0.1%

Average value of the ratio NCV/GCV is **0.8893** (precisely 0.88926).

In addition, a control calculation was performed, based on the data obtained from another significant coke producer. Due to the incompleteness of the data in comparison with the dataset mentioned above, the NCV/GCV ratio was determined from an average of 4 values (January, April, July, October) yielding a value of 0.8861, which is relatively close to the more precisely determined value above.

A5.3 Net calorific values of individual types of fuels in the period 1990-2014

Net Calorific Values (NCV) of each individual fossil fuel in the 1990 – 2014 period used in the Energy sector were taken from the standard CzSO Questionnaires (IEA/OECD, Eurostat, UN Questionnaires). For liquid fuels, CzSO provides one net calorific value for each year for all sectors while, for solid fuels, it generally provides three values: for 1A1, 1A2 and 1A4, which were used in the sectoral approach. For clarity Table A5- 3 gives aggregated values, calculated as the weighted average of these three values.

For solid and liquid fuels the calorific values are expressed in kJ/kg. For natural gas CzSO provides primarily Gross Calorific Values (GCV) in kJ/m^3 (volume related to the trading conditions: 15 ° C and 101.3 kPa). Conversion of GCV to NCV, derived in the Czech Hydrometeorological Institute in cooperation with KONEKO, is shown in this Annex above. For COG (Coke Oven Gas) CzSO provides activity data directly in energy units TJ related to GCV (denoted as TJ_{Gross}), but without GCV values for the individual years. Conversion to TJ related to NCV (denoted as TJ_{Net}), which is required for the calculation of emissions with respect to the definition of the emission factors, also appears in this Annex. It can be seen that ratio NCV/GCV = 0.8893 is equal to the TJ_{Net}/TJ_{Gross} ratio.

Table A5-3 lists the net calorific values for solid and liquid fuels in the 1990 – 2014 period. As in CRF, the symbol "NO" means that the fuel was not used, the symbol “NE” indicates that the value of NCV has not been estimated. Table A5-3 gives the definitions of fuels used by CzSO. In most cases, these definitions of fuel are identical to the IPCC definitions (IPCC, 2006). It should be noted, however, that fuels marked as "Fuel oil - high sulphur" and "Fuel oil - low sulphur" in the table, according to the terminology of CzSO, fall according to IPCC under "Residual Fuel Oil". Similarly fuels marked as "Road diesel" and "Heating and other gas oil" are covered by IPCC under "Gas/Diesel Oil ".

Tab. A5 3a Net calorific values for fossil fuels

NCV [kJ/kg]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Anthracite	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	32 000
Bituminous Coal	19 411	19 229	21 420	21 655	21 724	21 907	22 046	22 233	23 838	24 072	21 710	22 205	23 119
Coking Coal	28 413	27 178	28 419	28 467	28 467	28 466	28 464	28 608	28 608	28 537	28 392	28 596	28 752
Lignite	12 076	12 062	12 046	12 075	12 211	12 496	12 614	12 112	12 114	12 824	12 481	12 443	12 441
Coke Oven Coke	27 167	27 177	27 426	27 375	27 215	27 216	27 218	28 225	28 230	28 688	28 013	28 502	28 542
Coal Tar	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	37 148
BKB	22 868	23 058	21 854	22 922	23 136	22 941	22 918	22 924	24 080	24 620	24 912	24 243	23 803
Crude oil	41 646	41 646	41 650	41 652	41 652	41 652	41 650	41 650	41 622	41 628	41 543	41 889	41 483
Refinery gas	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023
LPG	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945
Naphtha	43 300	43 300	43 300	43 300	43 300	43 352	43 416	43 391	43 709	43 686	43 669	42 837	42 858
Motor gasoline	43 340	43 332	43 342	43 340	43 308	43 320	43 320	43 300	43 300	43 300	43 300	43 300	43 300
Aviation gasoline	43 836	43 836	43 836	43 836	43 836	43 836	43 836	43 800	43 800	43 800	43 800	43 800	43 800
Biogasoline	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000
Kerosene Jet Fuel	43 454	43 454	43 454	43 454	43 454	43 445	43 433	43 116	43 000	43 000	43 000	42 800	42 800
Other kerosene	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800
Road diesel	42 503	42 492	42 505	42 513	42 513	42 497	42 506	42 500	42 505	42 622	42 571	41 850	41 832
Heating and other gas oil	42 300	42 300	42 300	42 300	42 300	42 279	42 310	42 300	42 300	42 412	42 461	41 764	41 748
Biodiesel	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000
Fuel oil - low sulphur	38 850	38 850	38 850	38 850	38 850	38 825	37 041	38 784	38 890	39 639	39 694	39 286	39 313
Fuel oil - high sulphur	40 700	40 700	40 700	40 700	40 700	40 863	40 804	40 783	40 775	40 917	40 893	39 636	40 316
Residential Fuel Oil	40 576	40 589	40 619	40 626	40 635	40 738	40 258	40 595	40 538	40 544	40 659	39 511	39 670
Petroleum coke	37 500	37 500	37 500	37 500	37 500	37 500	37 500	37 500	37 500	37 500	37 500	37 500	37 500
Lubricants	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193
Bitumen	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193
Other Oil*)	40 193	40 193	40 193	40 193	40 193	41 497	39 398	39 411	38 503	39 348	39 474	40 717	40 693

**) Weighted average of NCV for Other products, White spirit and SPB reported by CzSO*

Tab. A5 3b Net calorific values for fossil fuels

NCV [kJ/kg]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Anthracite	32 000	32 000	32 000	30 941	30 000	30 000	30 000	30 000	29 809	28 170	28 944	28 756
Bituminous Coal	23 436	23 292	22 333	22 390	23 389	23 418	22 642	22 706	22 975	23 443	23 305	22 249
Coking Coal	28 971	28 745	28 818	29 148	29 279	29 326	29 381	29 385	29 207	29 373	29 244	29 468
Lignite	12 418	12 605	12 687	12 793	12 451	12 609	12 470	12 519	12 204	12 327	12 591	12 082
Coke Oven Coke	28 562	28 024	27 880	28 631	28 312	28 344	28 588	27 892	27 833	28 209	28 465	28 572
Coal Tar	36 944	36 686	37 336	36 301	37 000	37 000	37 161	36 936	36 995	37 716	37 756	36 738
BKB	25 505	24 025	22 948	23 638	23 525	22 098	22 253	20 772	21 437	21 933	20 809	21 149
Crude oil	41 991	41 980	41 980	41 986	42 259	42 357	42 353	42 400	42 370	42 392	42 400	42 400
Refinery gas	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023	46 023
LPG	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945	45 945
Naphtha	42 940	42 841	42 841	42 841	43 935	43 951	43 947	43 961	43 971	43 993	43 600	43 600
Motor gasoline	43 300	43 300	43 300	43 817	43 800	43 839	44 165	44 235	44 308	44 302	44 315	44 433
Aviation gasoline	43 793	43 790	43 790	43 790	43 790	43 790	43 790	43 790	43 790	43 790	43 790	43 790
Biogasoline	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000	27 000
Kerosene Jet Fuel	42 800	42 800	42 800	43 300	43 300	43 300	43 300	43 300	43 300	43 300	43 300	43 300
Other kerosene	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800	42 800
Road diesel	41 833	41 839	41 827	42 760	42 706	42 760	42 762	42 753	42 594	42 599	42 600	42 600
Heating and other gas oil	41 711	41 718	41 800	42 600	42 600	42 600	42 600	42 600	42 600	42 600	42 600	42 600
Biodiesel	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000	37 000
Fuel oil - low sulphur	40 000	39 584	39 538	39 599	41 484	39 718	39 700	39 696	39 522	39 436	39 439	39 500
Fuel oil - high sulphur	40 371	40 519	39 869	39 663	39 758	39 700	39 695	39 489	39 427	39 581	39 500	39 500
Residential Fuel Oil	40 182	39 997	39 686	39 628	40 594	39 710	39 698	39 603	39 482	39 509	39 475	39 500
Petroleum coke	37 500	37 500	37 500	37 500	37 500	37 500	37 500	37 500	37 500	38 500	38 500	38 500
Lubricants	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193
Bitumen	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193	40 193
Other Oil*)	40 642	40 787	40 862	39 337	39 338	40 007	40 078	39 831	40 189	40 350	40 179	39 921

**) Weighted average of NCV for Other products, White spirit and SPB reported by CzSO*

Tab. A5 4a Net calorific values for Natural Gas

NCV [MJ/m^3]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Natural Gas**)	33 436	33 431	33 458	33 908	33 962	34 037	34 008	34 020	34 104	34 021	34 035	34 041	34 079

***) 15 °C, 101.3 kPa*

Tab. A5 4b Net calorific values for Natural Gas

NCV [MJ/m^3]	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Natural Gas**)	34 052	34 015	34 029	34 165	34 234	34 228	34 263	34 405	34 371	34 295	34 424	34 489

***) 15 °C, 101.3 kPa*

A5. 4 General quality control protocol used in NIS

The following table shows general QC form for NIR, which is used for QC procedures in each specific sector. The QC form follows the guidance provided in IPCC 2006 Gl. This form is completed by each sectoral expert prior to submitting chapter to the national inventory compiler.

Detailed checklist for Inventory Document

(NIR)

Reviewed documents: (e.g. relevant chapter in NIR)

Responsible compiler of reviewed category: ...

Persons, who carried out the controls: autocontrol – ..., control – ...

Date of finalization of control:

Instructions for filling

This form should be fulfilled after finalizing the whole chapter of the NIR. This form should be fulfilled in line with QA/QC plan. In case when it is not clear how to solve founded discrepancies the worker responsible for control should problematic issues discuss with the sector compiler and if needed with other relevant experts.

The table should be fulfilled according to each listed item. In the form can be added additional issues which are characteristic for the relevant chapter.

Checklist for Inventory Document

Activities	Task completed	
	Name	**Date**
Tables and Figures		
All numbers in tables match numbers in spreadsheets		
Check that all tables have correct number of significant digits		
Check alignment in columns and labels		
Check that table formatting is consistent		
Check that all tables and figures are updated with new data and referenced in the text		
Check table and figure titles for accuracy and consistency with content		
Check that figure formatting is consistent		
Check that coloring of figures is consistent		
Other (specify)		
Equations		
Check for consistency in equation formatting		
Check that variables used in equations are defined following the equation		
Other (specify)		
References		
Check consistency of references		
Check that in text citations and references match		
Other (specify)		

General Format		
All acronyms and abbreviations are spelled out first time and not subsequent times throughout each chapter		
All headings, titles and subheadings are kept the same as the original structure		
All fonts in the text are consistent		
All highlighting, notes and comments are removed from the final document		
Size, style and indenting of bullets are consistent		
Spell check is complete		
Check the consistency in names and numbering of CRF categories		
Other (specify)		
Other Issues		
Check that each section is updated with current year (or most recent year that inventory report includes)		
Check that the most recent relevant IPCC methodology is used		
Check that all sections and subchapters follow the provided structure		
Other (specify)		

Notes or comments:

....

The following table shows QC form for general technical control (Tier 1). The QC form follows the guidance provided in IPCC 2006 Gl. This form is completed for each source/sink category and it can be further adapted to the specific needs of the expert/ controlling person, depending on the type of control conducted.

QC form for general technical control

QC (Tier 1)

Source category/ removals: (e.g. 2A Mineral Products)

Reviewed documents: (e.g. CRF Reporter, computational spreadsheet for 2A, relevant chapter in NIR)

Responsible compiler of reviewed category: ...

Persons, who carried out the controls: autocontrol – ..., control – ...

Date of finalization of control:

Instructions for filling

This form should be completed for each source/sink category and provides a record of the checks which were carried out and possible consequent corrections. This form should be fulfilled in line with QA/QC plan. In case when it is not clear how to solve founded discrepancies the worker responsible for control should discuss the problematic issues with the sector compiler and if needed with other relevant experts.

The first part of the form summarizes results of the controls (once completed) and highlights all significant findings or actions. The second part should be fulfilled according to each listed item. Some explanations of items are given below the checklist. For particular categories not all checks (items) will be applicable - these items are then noted as not relevant (n.r.) or not available (n.a.). This way no check and no row should be left blank or deleted. On the contrary, rows for additional checks that are relevant to the source/sink category can be added to the form.

Summary of control results

Overview of findings and corrections:

description of findings

Suggested corrections, which should be realized in the next submission:

description of suggested corrections

Issues remaining after the corrections:

description of remaining issues

QC form for general and technical control (QC, Tier 1)

	Item	Checked completed			Corrective action		
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	Supporting documents
Input data QC							
1	Cross-check activity data from each category (either measurements or parameters used in calculations) for transcription error (errors between the source of data and spreadsheets).						
2	Check that units are properly labelled in calculation sheets.						
3	Check that units are correctly carried through from beginning to end of calculations.						
4	Check that conversion factors are correct.						
5	Check that temporal and spatial adjustment factors are used correctly.						
6	Cross-check activity data between calculation spreadsheets and **CRF** tables (and if needed in **NIR**).						
7	Other (please specify)						
Calculation							
8	Reproduce a set of emissions and removals calculations.						
9	Use a simple approximation method that gives similar results to the original and more complex calculation to ensure that there is no data input error or calculation error.						
10	Identify parameters (e.g., activity data, constants) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emission/removal calculations.						
11	Check that emissions and removals data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries (also in **CRF** tables)						

12	Check that emissions and removals data are correctly transcribed between different intermediate products, including calculation spreasheets, **CRF** tables and **NIR**						
13	Other (please specify)						
Database files							
14	Confirm that the appropriate data processing steps are correctly represented in the database.						
15	Confirm that data relationships are correctly represented in the database.						
16	Ensure that data fields are properly labelled and have the correct design specifications.						
17	Ensure that adequate documentation of database and model structure and operation are archived.						
18	Other (please specify)						
Consistency							
19	Check for temporal consistency in time series input data for each category.						
20	Check for consistency in the algorithm/method used for calculations throughout the time series.						
21	Check methodological and data changes resulting in recalculations.						
22	Check that the effects of mitigation activities have been appropriately reflected in time series calculations.						
23	Other (please specify)						
Completeness							
24	Confirm that estimates are reported for all categories and for all years from the appropriate base year to the period of the current inventory.						
25	For subcategories, confirm that entire category is being covered.						
26	Provide clear definition of 'Other' type categories (**NIR** and spreadsheets)						

27	Check that known data gaps that result in incomplete estimates are documented, including a qualitative evaluation of the importance of the estimate in relation to total emissions (e.g., subcategories classified as 'not estimated').						
28	Other (please specify)						
Trend QC							
29	For each category, current inventory estimates should be compared to previous estimates, if available.						
30	If there are significant changes from expected trends, re-check estimates and explain any differences.						
31	Check value of implied emission factors (aggregate emissions divided by activity data) across time series.						
32	Do any years show outliers that are not explained?						
33	If they remain static across time series, are changes in emissions or removals being captured?						
34	Check if there are any unusual and unexplained trends noticed for activity data or other parameters across the time series.						
35	Other (please specify)						
Data documentation (NIR + DATA)							
36	Check of data file (e.g. importing tables) from the view of completeness						
37	Confirm that bibliographical data references are properly cited in the internal documentation						
38	Check of the references on source of input data in the spreadsheets						
39	Check that all references in spreadsheets are documented						
40	Check of completeness of references on the sources of input data in the computational spreadsheets						
41	Random check of referred materials, if they really contains referred data						

42	Check that assumptions and criteria for the selection of activity data, emission factors and other estimation parameters are properly recorded and archived.						
43	Check that the changes in data or methodology (e.g. recalculations) are described and documented						
44	Check that quotes are realized uniformly						
45	Other (please specify)						

Explanations of some items:

5. Spatial adjustment factors refer to factors used to adjust average data, obtained from one or more locations within the Member State to national average data.

22. Check that effects of actions/activities taken to avoid or minimize environmental damage are considered and reflected in time series.

General notes to controls

description

Notes for each parts and founded issues

notes which are needed to add in order to finish adequate control

The following table shows QC form for category – specific technical control (QC Tier 2). The QC form follows the guidance provided in IPCC 2006 Gl. This form is completed for each key category and it can be further adapted to the specific needs of the expert/ controlling person, depending on the type of control conducted.

QC form for category-specific technical control

QC (Tier 2)

Source category/ removals: (e.g. 2A Mineral Products)

Reviewed documents: (e.g. CRF Reporter, computational spreadsheet for 2A, relevant chapter in NIR)

Responsible compiler of reviewed category: ...

Persons, who carried out the controls: autocontrol – ..., control – ...

Date of finalization of control:

Instructions for filling

This form should be completed for key categories or categories where significant methodological and data revision have taken place and provides a record of the checks which were carried out and possible consequent corrections. This form should be fulfilled in line with QA/QC plan. In case when it is not clear how to solve founded discrepancies the worker responsible for control should problematic issues discuss with the sector compiler and if needed with other relevant experts.

The first part of the form summarizes results of the controls (once completed) and highlights all significant findings or actions. The second part should be fulfilled according to each listed item. Some explanations of items are given below the checklist. For particular categories not all checks (items) will be applicable - these items are then noted as not relevant (n.r.) or not available (n.a.). This way no check and no row should be left blank or deleted. On the contrary, rows for additional checks that are relevant to the source/sink category can be added to the form.

Summary of control results

Overview of findings and corrections:

description of findings

Suggested corrections, which should be realized in the next submission:

description of suggested corrections

Issues remaining after the corrections:

description of remaining issues

QC form for category-specific and technical control (QC, Tier 2)

Item		Checked completed			Corrective action		
		Date	Individual (first initial, last name)	Errors (Y/N)	Date	Individual (first initial, last name)	Supporting documents
EMISSION DATA QUALITY CHECKS							
1	Are emission comparisons for historical data source performed						
2	Are emission comparisons for significant sub-source categories performed						
3	If applicable, are checks against independent estimates or estimates based on alternative methods performed						
4	Are reference calculations performed						
5	Is completeness check performed						
6	Other (detailed checks)						
EMISSION FACTOR QUALITY CHECKS							
IPCC default emission factors							
7	Are the national conditions comparable to the context of the IPCC default emission factors study						
8	Are default IPCC factors compared with site or plant-level factors						
Country-specific emission factors							
QC on models							
9	Are the model assumptions appropriate and applicable to the GHG inventory methods and national circumstances						
10	Are the extrapolations/interpolations appropriate and applicable to the GHG inventory methods and national circumstances						
11	Are the calibration-based modifications appropriate and applicable to the GHG inventory methods and national circumstances						
12	Are the data characteristics appropriate and applicable to the GHG inventory methods and national circumstances						
13	Are the model documentation (including descriptions, assumptions, rationale, and scientific evidence and references supporting the approach and parameters used for modelling) available						
14	Are model validation steps performed by model developers and data suppliers						
15	Are QA/QC procedures performed by model developers and data suppliers						
16	Are the responses to these results documented						
17	Are plans to periodically evaluate and update or replace assumptions with appropriate new measurements prepared						
18	Is there completeness in relation to the IPCC source/sink categories						
Comparisons							
19	Are country-specific factors compared with IPCC default factors						
20	Is comparison between countries, including historical trends, min and max value, base and most recent year value, IEF performed						
21	If applicable, is comparison to plant-level emission factors performed						
22	Other (detailed checks)						
ACTIVITY DATA QUALITY CHECKS							
National level activity data							
23	Are alternative activity data sets based on independent data available						
24	Were comparisons with independently compiled data sets performed						
25	Were the national data compared with extrapolated samples or partial data at sub-national level						
26	Was a historical trend check performed						

27	Are any sharp increases/decreases detected and checked for calculation errors						
28	Are any sharp increases/decreases explained and documented						
	Site-specific activity data						
29	Are there any inconsistencies between the sites						
30	If yes, was a QC check performed to identify the cause of the inconsistency (errors, different measurement techniques or real differences in emissions, operating conditions or technology)						
31	Are the activity data compared between different reference sources and geographic scales (national production statistics vs. aggregated activity data)						
32	Are the differences explained						
33	If applicable, is a comparison between bottom up (site-specific) and top down (national level) account balance performed						
34	Are large differences explained						
35	Other (please specify)						
CALCULATION RELATED QUALITY CHECKS							
36	Are checks of the calculation algorithm (duplications, unit conversion, calculation errors) performed						
37	Are the calculations reproducible						
38	Are all calculation procedures recorded						
39	Other (please specify)						

Explanations of some items:

3. For example comparisons can be made to similar statistics prepared by FAO (for agriculture), IEA (for energy) etc.

8. Compare IPCC default emission factors with site or plant-level factor to determine their representativeness relative to actual sources in the country. This check is good practice even if data are only available for a small percentage of sites or plants.

18. If the model computes and comprises all data covered/required by the IPCC category.

19. Comparison should be made, taking into consideration the characteristics and properties on which the default factors are based. The intent is to determine whether country-specific factors are reasonable, given the similarities or differences between the national category and the "average" category, represented by the default.

25. For example, if national production data are being used to calculate the inventory, it may also be possible to obtain plant-specific production or capacity data for a subset of the total population of plants. The effectiveness of this check depends on how representative the sub-sample is of the national population, and how well the extrapolation technique captures the national population.

General notes to controls

description

Notes for each parts and founded issues

notes which are needed to add in order to finish adequate control

A5. 5 Completeness check form used for controlling of data in CRF Reporter

Following table is presenting example of form used for completeness evaluation for all sectors. The table contain also comments by expert in case the completeness function is not working properly. Following shortcuts have been used:

COMPLETED	C
PARTLY COMPLETED	P
INCOMPLETE	I
MISSING	M

Tab. A5 – 5 Completeness check for Waste sector (2014)

Waste		15 May check	19 October check	Comment by expert
5	Waste	i	p	complete
5.A	Solid waste disposal	c	p	complete
5.A.1	Managed waste disposal sites	c	p	complete
5.A.1.a	Anaerobic	c	p	complete
5.A.1.b	Semi-aerobic	c	c	
5.A.2	Unmanaged waste disposal sites	c	c	
5.A.3	Uncategorised waste disposal sites	c	c	
5.B	Biological treatment of solid waste	c	p	complete
5.B.1	Composting	c	p	complete
5.B.1.a	Municipal solid waste	c	c	
5.B.1.b	Other	c	i	complete
5.B.2	Anaerobic digestion at biogas facilities	c	p	complete
5.B.2.a	Municipal solid waste	c	p	complete
5.B.2.b	Other	c	i	complete
5.C	Incineration and open burning of waste	c	p	complete
5.C.1	Waste incineration	c	p	complete
5.C.1.1	Biogenic	c	p	complete
5.C.1.1.a	Municipal solid waste	c	p	complete
5.C.1.1.b	Other	c	i	complete
5.C.1.2	Non-biogenic	c	p	complete
5.C.1.2.a	Municipal solid waste	c	p	complete
5.C.1.2.b	Other	c	c	
	Hazardous waste		c	
5.C.2	Open burning of waste	c	c	
5.C.2.1	Biogenic	c	c	
5.C.2.1.a	Municipal solid waste	c	c	
5.C.2.1.b	Other	c	i	complete
5.C.2.2	Non-biogenic	c	c	
5.C.2.2.a	Municipal solid waste	c	c	
5.C.2.2.b	Other	c	i	complete
5.D	Wastewater treatment and discharge	i	p	complete
5.D.1	Domestic wastewater treatment and discharge	c	c	
5.D.2	Industrial waste water and discharge	c	p	complete
5.D.3	Other	i	i	complete
5.E	Other	c	i	complete
5.F	Memo Items	c	p	complete
5.F.1	Long-term Storage of C in Waste Disposal Sites	c	c	
5.F.2	Annual Change in Total Long-term C Storage	c	c	
5.F.3	Annual Change in Total Long-term C Storage in HWP Waste	c	p	complete

The following tables shows categories that are not estimated (NE) including relevant explanations of the reasons. Categories that are included elsewhere (IE) are shown in similar way.

A5. 6 Additional information to be considered as part of the annual inventory submission and the supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol or other useful reference information

Standard electronic format (SEF) tables

SEF Table 1

Party	Czech Republic
Submission Year	2016
Reported Year	2015
Commitment Period	1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	348 536 263	14 006	NO	5 750	NO	NO
Entity holding accounts	NO	NO	NO	NO	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation account	NO	NO	NO	NO		
Other cancellation accounts	27	NO	NO	8 157	NO	NO
Retirement account	334 650 295	18 735 943	NO	19 874 444	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	683 186 585	18 749 949	NO	19 888 351	NO	NO

SEF Table 2A

Party	Czech Republic
Submission Year	2016
Reported Year	2015
Commitment Period	1

Table 2a. Annual internal transactions

	Additions						Subtractions					
Transaction type	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Art6 issuance and conversion												
Party verified projects		NO					NO		NO			
Independently verified projects		NO					NO		NO			
Art3.3 and 3.4 issuance or cancellation												
3.3 Afforestation reforestation			1 571 674				NO	NO	NO	NO		
3.3 Deforestation			NO				NO	NO	854 212	NO		
3.4 Forest management			5 866 667				NO	NO	NO	NO		
3.4 Cropland management			NO				NO	NO	NO	NO		
3.4 Grazing land management			NO				NO	NO	NO	NO		
3.4 Revegetation			NO				NO	NO	NO	NO		
Art 12 afforestation and reforestation												
Replacement of expired tCERs							NO	NO	NO	NO	NO	
Replacement of expired lCERs							NO	NO	NO	NO		
Replacement for reversal of storage							NO	NO	NO	NO		NO
Replacement for non-submission of certification report							NO	NO	NO	NO		NO
Other cancellation							NO	NO	NO	451	NO	NO
Subtotal		NO	7 438 341				NO	NO	854 212	451	NO	NO

Transaction type	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	292 141 351	6 392 822	6 584 129	1 770 982	NO	NO

SEF Table 2BC

Party	Czech Republic
Submission Year	2016
Reported Year	2015
Commitment Period	1

Table 2b. Annual external transactions

	Additions						Subtractions					
Transfers and acquisitions	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
EU	21 729	6 379 290	NO	1 780 654	NO	NO	8 144 627	472	NO	128	NO	NO
NZ	15 675	165 684	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
GB	NO	212 769	NO	NO	NO	NO	NO	212 769	NO	NO	NO	NO
CH	NO	212 769	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NL	NO	NO	NO	NO	NO	NO	NO	378 453	NO	NO	NO	NO
Subtotal	37 404	6 970 512	NO	1 780 654	NO	NO	8 144 627	591 694	NO	128	NO	NO

Additional Information

	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Independently verified ERU								NO				

Table 2c. Total annual transactions

	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Total (Sum of table 2(a) and 2(b))	37 404	6 970 512	7 438 341	1 780 654	NO	NO	8 144 627	591 694	854 212	579	NO	NO

SEF Table 3

Party	Czech Republic
Submission Year	2016
Reported Year	2015
Commitment Period	1

Table 3. Expiry, cancellation and replacement

	Expiry, cancellation and requirement to replace		Replacement					
Transaction or event type	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Temporary CERs (tCERs)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

SEF Table 4

Party	Czech Republic
Submission Year	2016
Reported Year	2015
Commitment Period	1

Table 4. Total quantities of Kyoto Protocol units by account type at end of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	48 272 014	NO	NO	NO	NO	NO
Entity holding accounts	15 675	2	NO	14 843	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	854 212	NO		
Non-compliance cancellation account	NO	NO	NO	NO		
Other cancellation accounts	27	NO	NO	8 608	NO	NO
Retirement account	626 791 646	25 128 765	6 584 129	21 645 426	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	675 079 362	25 128 767	7 438 341	21 668 877	NO	NO

SEF Table 5ABC

Party	Czech Republic
Submission Year	2016
Reported Year	2015
Commitment Period	1

Table 5a. Summary information on additions and subtractions

	Additions						Subtractions					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Starting Values												
Issuance pursuant to Article 3.7 and 3.8	893 541 801											
Non-compliance cancellation							NO	NO	NO	NO		
Carry-over	NO	NO		NO								
Subtotal	893 541 801	NO		NO			NO	NO	NO	NO		
Annual Transactions												
Year 0 (2007)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 1 (2008)	6 423 610	NO	NO	5 052 040	NO	NO	35 377 857	NO	NO	722 906	NO	NO
Year 2 (2009)	59 665 197	428 939	NO	7 722 832	NO	NO	109 090 556	330 302	NO	6 123 076	NO	NO
Year 3 (2010)	40 059 068	2 539 673	NO	6 751 365	NO	NO	75 690 649	2 136 642	NO	2 853 506	NO	NO
Year 4 (2011)	19 017 124	3 617 809	NO	6 025 303	NO	NO	32 202 279	2 306 359	NO	3 810 407	NO	NO
Year 5 (2012)	5 332 856	4 183 302	NO	1 967 087	NO	NO	23 922 224	1 933 342	NO	525 679	NO	NO
Year 6 (2013)	2	15 003 411	NO	7 418 048	NO	NO	64 577 151	311 799	NO	1 013 919	NO	NO
Year 7 (2014)	7 616	14 006	NO	11 393	NO	NO	NO	18 747	NO	18 381	NO	NO
Year 8 (2015)	37 404	6 970 512	7 438 341	1 780 654	NO	NO	8 144 627	591 694	854 212	579	NO	NO
Subtotal	130 542 877	32 757 652	7 438 341	36 728 722	NO	NO	349 005 343	7 628 885	854 212	15 068 453	NO	NO
Total	1 024 084 678	32 757 652	7 438 341	36 728 722	NO	NO	349 005 343	7 628 885	854 212	15 068 453	NO	NO

Table 5b. Summary information on replacement

	Expiry, cancellation and requirement to replace		Replacement					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table 5c. Summary information on retirement

Year	Retirement					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	NO	NO	NO	NO	NO	NO
Year 3 (2010)	NO	NO	NO	NO	NO	NO
Year 4 (2011)	219 835 850	754 388	NO	9 382 544	NO	NO
Year 5 (2012)	67 795 483	3 085 075	NO	3 112 580	NO	NO
Year 6 (2013)	47 018 962	14 896 480	NO	7 379 320	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	292 141 351	6 392 822	6 584 129	1 770 982	NO	NO
Total	626 791 646	25 128 765	6 584 129	21 645 426	NO	NO

SEF Table 6ABC

Party	Czech Republic
Submission Year	2016
Reported Year	2015
Commitment Period	1

Table 6a. Memo item: corrective transactions relating to additions and subtractions

Additions						Subtractions					
AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6b. Memo item: corrective transactions relating to replacement

Expiry, cancellation and requirement to replace		Replacement					
tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Table 6c. Memo item: corrective transactions relating to retirement

Retirement					
AAUs	ERUs	RMUs	CERs	tCERs	lCERs