CZECH
HYDROMETEOROLOGICAL
INSTITUTE

Ministry of the Environment
of the Czech Republic

# NATIONAL GREENHOUSE GAS INVENTORY REPORT OF THE CZECH REPUBLIC

*SUBMISSION UNDER THE UNFCCC AND UNDER THE KYOTO PROTOCOL*

*REPORTED INVENTORIES 1990-2011*

Compiled by institutions involved in
National Inventory System, NIS:

KONEKO, CDV, CHMI, IFER, CUEC
coordinated by CHMI

with contribution of
MoE and OTE

**Prague**

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# Contents

# Executive Summary

# ES 1 Background information

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 Decision of the European Parliament and Council No. 280/2004/EC. This edition of National Inventory Report (NIR) deals with national greenhouse gas inventories for the period 1990 to 2011 with accent on the latest year 2011.

Inventories of emissions and removals of greenhouse gases were prepared according to the IPCC methodology: Revised 1996 Guidelines (IPCC, 1997); Good Practice Guidance (IPCC, 2000); Good Practice Guidance for LULUCF (IPCC, 2003); application of this general methodology on country specific circumstances will be 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, 2006). 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. Thus the second part contains the Kyoto elements of the report. The both parts of the National Inventory Report, together with the data output - Common Reporting Format (CRF) Tables, are submitted annually by 15th April.

The structure of this NIR follows new methodical handbook published by the Secretariat “Annotated outline of the National Inventory Report including elements under the Kyoto Protocol” (UNFCCC, 2009).

# ES 2 Summary of national emission and removal related trends and emission and removals from KP-LULUCF activities

## ES 2.1 GHG inventory

In 2011, the most important GHG in the Czech Republic was $CO_2$ contributing 84.65 % to total national GHG emissions and removals expressed in $CO_2$ eq., followed by $CH_4$ 8.20 % and $N_2O$ 6.20 %. PFCs, HFCs and $SF_6$ contributed for 0.95 % to the overall GHG emissions in the country. $CO_2$ net emissions from LULUCF totalled at -7.55 % from the overall $CO_2$ emissions.

Tab. ES 2-1 provides data on GHG emissions in comparison of overall trend from 1990 to 2011. For overview of GHG emissions and removals by categories please see chapter ES 3 on page 15.

**Tab. ES 2-1 GHG emission/removal overall trends**

| | Base year | 2011 | Base year | 2011 | trend |
|---|---|---|---|---|---|
| | [Gg $CO_2$ eq.] | | % | | |
| **$CO_2$ emissions** | 164 813 | 114 296 | 85.65 | 91.05 | -30.65 |
| **$CO_2$ (LULUCF)** | -3 749 | -8 026 | -1.95 | -6.39 | 114.07 |
| **$CO_2$ Total** | 161 063 | 106 270 | 83.70 | 84.65 | -34.02 |
| **$CH_4$** | 17 915 | 10 289 | 9.31 | 8.20 | -42.57 |
| **$N_2O$** | 13 365 | 7 783 | 6.95 | 6.20 | -41.77 |
| **F-gases** | 78 | 1 194 | 0.04 | 0.95 | 1 437.68 |
| **Total** | 192 421 | 125 536 | 100.00 | 100.00 | -34.76 |

Over the period 1990 - 2011 $CO_2$ emissions and removals decreased by 30.7 %, $CH_4$ emissions decreased by 42.6 % during the same period mainly due to lower emissions from *1 Energy*, *4 Agriculture* and *6 Waste*; $N_2O$ emissions decreased by 41.8 % over the same period due to emission reduction in *4 Agriculture* and despite increase from the *1A3 Transport* category. Emissions of HFCs and PFCs increased by orders of magnitude, whereas $SF_6$ emissions decreased significantly, resulting the overall F-gases trend at 15.4-times increase in $CO_2$ eq.

## ES 2.2 KP-LULUCF activities

Emission and removal estimates of GHGs for applicable KP-LULUCF activities in the years 2008 - 2011 are presented in Tab. ES 2-2.

**Tab. ES 2-2 Summary of GHG emissions and removals for KP LULUCF activities [Gg $CO_2$ eq.]**

| Year | Article 3.3 activities | | Article 3.4 activities | | | |
|---|---|---|---|---|---|---|
| | Afforestration and Reforestration | Deforestation | Forest Management* | Cropland Management | Grazing Land Management | Revegetation |
| **2008** | -271.99 | 160.20 | -4 403.99 | NA | NA | NA |
| **2009** | -294.68 | 170.19 | -6 441.15 | NA | NA | NA |
| **2010** | -322.26 | 206.87 | -5 096.22 | NA | NA | NA |
| **2011** | -356.88 | 163.70 | -7 568.71 | NA | NA | NA |

*) Net emissions or removals / accounting quantity

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

## ES 3.1 GHG inventory

**Tab. ES 3-1 Overview of GHG emission/removal overall trends by categories**

| | Base year | 2011 | Base year | 2011 | Trend |
|---|---|---|---|---|---|
| | | | Category share [%] | | [%] |
| **1. Energy** | **156 764.91** | **109 514.58** | **81.47** | **87.24** | **-30.14** |
| A. Fuel Combustion (Sectoral Approach) | 147 806.55 | 105 297.38 | 94.29 | 96.15 | -28.76 |
| 1. Energy Industries | 57 966.86 | 58 423.89 | 36.98 | 53.35 | 0.79 |
| 2. Manufacturing Industries and Construction | 46 753.89 | 17 942.69 | 29.82 | 16.38 | -61.62 |
| 3. Transport | 7 755.89 | 17 255.39 | 4.95 | 15.76 | 122.48 |
| 4. Other Sectors | 33 702.37 | 10 559.39 | 21.50 | 9.64 | -68.67 |
| 5. Other | 1 627.55 | 1 116.01 | 1.04 | 1.02 | -31.43 |
| B. Fugitive Emissions from Fuels | 8 958.36 | 4 217.21 | 5.71 | 3.85 | -52.92 |
| 1. Solid Fuels | 8 056.84 | 3 538.18 | 5.14 | 3.23 | -56.08 |
| 2. Oil and Natural Gas | 901.52 | 679.03 | 0.58 | 0.62 | -24.68 |
| **2. Industrial Processes** | **19 602.83** | **11 790.63** | **10.19** | **9.39** | **-39.85** |
| A. Mineral Products | 4 832.78 | 3 827.11 | 24.65 | 32.46 | -20.81 |
| B. Chemical Industry | 2 032.51 | 1 089.84 | 10.37 | 9.24 | -46.38 |
| C. Metal Production | 12 659.87 | 5 679.28 | 64.58 | 48.17 | -55.14 |
| F. Consumption of Halocarbons and $SF_6$[1] | 76.06 | 1 194.40 | 0.39 | 10.13 | 1 470.37 |
| **3. Solvent and Other Product Use** | **764.83** | **469.42** | **0.40** | **0.37** | **-38.62** |
| **4. Agriculture** | **16 233.28** | **8 064.84** | **8.44** | **6.42** | **-50.32** |
| A. Enteric Fermentation | 4 219.42 | 2 002.90 | 25.99 | 24.83 | -52.53 |
| B. Manure Management | 2 709.60 | 1 042.77 | 16.69 | 12.93 | -61.52 |
| D. Agricultural Soils | 9 304.26 | 5 019.17 | 57.32 | 62.24 | -46.06 |
| **5. Land Use, Land-Use Change and Forestry[2]** | **-3 617.94** | **-7 959.22** | **-1.88** | **-6.34** | **119.99** |
| A. Forest Land | -4 947.02 | -7 903.49 | 136.74 | 99.30 | 59.76 |
| B. Cropland | 1 336.55 | 154.09 | -36.94 | -1.94 | -88.47 |
| C. Grassland | -127.89 | -328.93 | 3.53 | 4.13 | 157.19 |
| D. Wetlands | 22.53 | 31.62 | -0.62 | -0.40 | 40.31 |
| E. Settlements | 86.08 | 87.48 | -2.38 | -1.10 | 1.63 |
| G. Other | 11.82 | 0.01 | -0.33 | 0.00 | -99.89 |
| **6. Waste** | **2 673.17** | **3 656.03** | **1.39** | **2.91** | **36.77** |
| A. Solid Waste Disposal on Land | 1 662.59 | 2 744.53 | 62.20 | 75.07 | 65.08 |
| B. Waste-water Handling | 987.00 | 720.59 | 36.92 | 19.71 | -26.99 |
| C. Waste Incineration | 23.59 | 190.91 | 0.88 | 5.22 | 709.41 |
| ***Total $CO_2$ equivalent Emissions*** *including* ***LULUCF*** | **192 421.08** | **125 536.29** | **100.00** | **100.00** | **-34.76** |
| ***Total $CO_2$ equivalent Emissions*** *excluding* ***LULUCF*** | **196 039.02** | **133 495.50** | **-** | **-** | **-** |

*NO, NA, NE sub-categories omitted*

[1] *Base year 1995*

[2] *Negative numbers indicate GHG removal*

In 2011, 109 514.58 Gg $CO_2$ eq., that are 87.24 % of national total emissions (including *5 Land Use, Land-Use Change and Forestry*) arose from *1 Energy*; 96.15 % of these emissions arise from fuel combustion activities. The most important sub-category of *1 Energy* with 53.35 % of total sectoral emissions in 2011 is *1A1 Energy Industries*, *1A2* M*anufacturing Industries and Construction* responses for 16.38 % and *1A3 Transport* for 15.76 % of total sectoral emissions. From 1990 to 2011 emissions from *1 Energy* decreased by *30.14* %.

*2 Industrial Processes* is the second largest category with 9.39 % of total GHG emissions (including *5 Land Use, Land-Use Change and Forestry*) in 2011 (1 194.40 Gg $CO_2$ eq.); the largest sub-category is 2C *Metal Production* with 48.17 % of sectoral share. From 1990 to 2011 emissions from *2 Industrial Processes* decreased by 39.85 %.

In 2011, 0.37 % of total GHG emissions (including *5 Land Use, Land-Use Change and Forestry*) in the Czech Republic (506 Gg $CO_2$ eq.) arose from the category *3 Solvent and Other Product Use*. From 1990 - 2011 emissions from *3 Solvent and Other Product Use* decreased by 38.62 %.

*4 Agriculture* is the third largest category in the Czech Republic with 6.42 % share of total GHG emissions (including *5 Land Use, Land-Use Change and Forestry*) in 2011 (8 064.84 Gg $CO_2$ eq.); 62.24 % of these emissions arose from *4D Agricultural Soils*. From 1990 to 2011 emissions from *4 Agriculture* decreased by 50.32 %.

*5 Land Use, Land-Use Change and Forestry* is the only category where removals exceed emissions. Net removals from this category increased from 1990 to 2011 by 119.99 % to 7 959.22Gg $CO_2$ eq.

2.91 % of the national total GHG emissions (including *5 Land Use, Land-Use Change and Forestry*) in 2011 arose from *6 Waste. 75.07 %* share of GHG emissions arose from *6C Solid waste disposal on land*. Emissions from *6 Waste* increased from 1990 to 2011 by 36.77 % to 3 656.03 Gg $CO_2$ eq.

## ES 3.2 KP-LULUCF activities

Emission and removals estimates of GHGs for the KP LULUCF activities in the years 2008-2011 are presented in Tab. ES 3-2.

**Tab. ES 3-2 Summary**

| | $CO_2$ emissions | $CO_2$ removals | $CH_4$ | $N_2O$ |
|---|---|---|---|---|
| **2008** | 159.78 | -4 834.2 | 6.8 | 0.05 |
| **2009** | 169.76 | -6 869.6 | 5.8 | 0.04 |
| **2010** | 206.45 | -5 559.7 | 6.11 | 0.04 |
| **2011** | 163.31 | -7986.3 | 2.62 | 0.02 |

# ES 4 Overview of emission estimates and trends of indirect GHGs and $SO_2$

Emission estimates of indirect GHGs and $SO_2$ for the period from 1990 to 2011 are presented in Tab. ES 4-1.

**Tab. ES 4-1 Indirect GHGs and $SO_2$ for 1990 to 2011 [Gg]**

| | $NO_X$ | CO | NMVOC | $SO_2$ |
|---|---|---|---|---|
| **1990** | 742.38 | 1 071.77 | 311.27 | 1 875.52 |
| **1991** | 732.22 | 1 157.56 | 272.97 | 1 772.20 |
| **1992** | 708.26 | 1 162.92 | 257.47 | 1 559.14 |
| **1993** | 690.79 | 1 194.58 | 233.04 | 1 468.85 |
| **1994** | 450.88 | 1 075.83 | 255.31 | 1 290.19 |
| **1995** | 430.23 | 933.51 | 215.35 | 1 095.32 |
| **1996** | 446.74 | 966.67 | 265.16 | 934.45 |
| **1997** | 470.75 | 982.74 | 271.86 | 980.79 |
| **1998** | 414.18 | 813.96 | 267.15 | 442.22 |
| **1999** | 391.14 | 728.03 | 247.17 | 268.92 |
| **2000** | 396.74 | 681.52 | 244.31 | 264.45 |
| **2001** | 332.87 | 688.67 | 219.88 | 250.89 |
| **2002** | 319.45 | 589.18 | 202.86 | 237.39 |
| **2003** | 325.75 | 632.38 | 203.26 | 232.13 |
| **2004** | 333.61 | 624.45 | 198.46 | 227.22 |
| **2005** | 279.19 | 557.96 | 181.70 | 218.63 |
| **2006** | 283.84 | 542.08 | 178.60 | 211.23 |
| **2007** | 285.94 | 584.27 | 173.97 | 216.96 |
| **2008** | 262.81 | 498.36 | 165.66 | 174.34 |
| **2009** | 252.78 | 454.10 | 151.06 | 173.47 |
| **2010** | 240.08 | 455.58 | 150.89 | 170.32 |
| **2011** | 226.09 | 404.89 | 139.79 | 169.01 |
| Trend [%] | -69.54 | -62.22 | -55.09 | -90.99 |
| **NEC[3]** | 286 | - | 220 | 283 |

Emissions of indirect greenhouse gases decreased from the period from 1990 to 2011: for $NO_X$ by 69.54 %, for CO by 62.22 %, for NMVOC by 55.09 % and for SO2 by 90.99 %. The most important emission source for indirect greenhouse gases and SO2 are fuel combustion activities, for details see chapter 2.4 in Part1: Annual inventory report.

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

# Part 1: Annual inventory submission

# 1 Introduction and general issues

## 1.1 Background information

### 1.1.1 Climate change

Greenhouse gases (i.e. gases that contribute to the greenhouse effect) have always been present in the atmosphere, but now 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 *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC, 2007), the atmospheric concentrations of $CO_2$ have increased by 35 %, $CH_4$ concentrations have more than doubled and $N_2O$ concentrations have risen by 18 %, 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 use is on the 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 average surface temperature of the earth has risen by about 0.6–0.9 °C in the past 100 years and, according to the IPCC 4AR, will rise by another 1.8–4.0 °C in the next 100 years, depending on the emission scenario. 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).

### 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 fulfill its reporting requirements concerning GHG emissions and removals following from Decision of the European Parliament and Council 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, $SF_6$ and indirect greenhouse gases $NO_X$, CO, NMVOC 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 and $SF_6$ 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 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 2011. Full time series of emissions and removals from 1990 to 2011 are included in the submission.

Inventories of emissions and removals of greenhouse gases were prepared according to the IPCC methodology: *Revised 1996 Guidelines* (IPCC, 1997); *Good Practice Guidance* (IPCC, 2000); *Good Practice Guidance for LULUCF* (IPCC, 2003); application of this general methodology under country-specific circumstances will be described in the sector-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 change in the next submission.

At the beginning of 2009, the Secretariat published a methodical handbook entitled "*Annotated outline of the National Inventory Report including elements under the Kyoto Protocol*" (UNFCCC, 2009), providing instructions on how to combine the existing requirements on reporting pursuant to decision 18/CP.8 and 14/CP.11, see (UNFCCC, 2006) with the requirements on reporting pursuant to Article 7.1 of the Kyoto Protocol given in Decision 15/CMP.1. This report attempts to follow this methodical handbook.

The current data submission (2013) for UNFCCC and for the EU contains all the data sets for 1990 - 2011 in the form of the official UNFCCC software called *CRF Reporter* (version 3.6.2).

## 1.2 National Inventory System and institutional arrangement

The National Inventory System (NIS), as required by the *Kyoto Protocol* (Article 5.1) and by Decision No. 280/2004/EC, has been in place since 2005. As approved by the *Ministry of Environment* (MoE), which is the single national entity with overall responsibility for the national greenhouse gas inventory, the founder of CHMI and its superior institution, the established institutional arrangement is as follows:

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. Mr. Ondrej Minovsky is the representative of CHMI for NIS performance.

Sectoral inventories are prepared by sectoral experts from sector-solving institutions, which are coordinated and controlled by CHMI. The responsibilities for GHG inventory compilation from the individual sectors are allocated in the following way:

- 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 sectors 2 and 3, Industrial Processes and Solvent and Other Product Use
- Institute of Forest Ecosystem Research Ltd. (IFER), Jilove u Prahy, is responsible for compilation of the inventory in sectors 4 and 5, Agriculture and Land Use, Land Use Change and Forestry
- Charles University Environment Centre (CUEC), Prague, is responsible for compilation of the inventory in sector 6, 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 5th *National Communication* (MoE, 2009).

## 1.3 Inventory preparation

### 1.3.1 Brief description of the inventory process

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 2013 submission contains estimates for the calendar year of 2011. 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).

The preparation of the inventory includes the following three stages:

1) inventory planning,
2) inventory preparation and
3) 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 1.5). 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 1.5).

### 1.3.2 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 1A *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).

So far, data from the emission trading system has been used to only a limited degree in the Czech national greenhouse gas inventory (e.g. in the sector of Industrial processes - Mineral Products). It was recommended to the Czech inventory team during the recent “in-country review” that the data from EU ETS be used to a greater degree. For this purpose, the team has prepared an “improvement plan” to provide for gradual inclusion of the relevant EU ETS data in the national inventory. At the present time, CHMI, in cooperation with MoE, is preparing a database of the activity and emission data from the EU ETS system, which could be used in preparation of the national inventory. Consequently, it can be expected that these data will be employed more extensively only in future inventories.

The main part of this “improvement plan” consists in gradual introduction of higher tiers into the national inventory.

### 1.3.3 Data processing and storage

Data Sector *1A Fuel Combustion Activities* are processed by the system of interconnected spreadsheets, compiled in MS Excel following “Worksheets” presented in IPCC *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. On the other hand, in some cases, e.g. for solvent use, such a system is not as efficient and thus it is substituted by spreadsheets inspired by the CORINAIR methodology. 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.

#### *1.3.3.1 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 methodical 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 methodology

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 existing and valid version of the IPCC methodology consists of the Revised 1996 Guidelines (IPCC, 1997), IPCC Good Practice Guidance (IPCC, 2000), IPCC Good Practice Guidance for LULUCF (IPCC, 2003) and, in well-founded cases (respecting national circumstances), also 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006).

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 and hard coal, while the default emission factors are employed for the other fuels. 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 $CO_2$, 21 for $CH_4$ and 310 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 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 in February 2013).

In September of 2012, the Czech national greenhouse gas inventory was subject to “*cetralised review*”. The Czech national inventory team has not yet received annual inventory report (ARR) and thus was not able to take into account final comments and recommendations of the international Expert Review Team (ERT) in this submission. Therefore in most cases, the comments and recommendations will be taken into account in the 2014 submission.

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

## 1.5 Information on the QA/QC 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 (Decision of the European Parliament and of the Council No 280/2004/EC).

Annex 8 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.

### 1.5.1 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.

### 1.5.2 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.

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 specifical 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 the 2013 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.

### 1.5.3 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 Good Practice Guidance*. General inventory QC checks (IPCC, 2000), Table 8.1 and (IPCC, 2003), Table 5.5.1 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, Mr. Ondrej Minovsky), their QA/QC guarantors, responsible for the compliance of all the QA/QC procedures in the given sector with the IPCC *Good Practice Guidance* (IPCC, 2000) and (IPCC, 2003) and also with the QA/QC plan.

At the basic level of control (Tier 1), individual steps should be controlled according to the Table 8.1 (IPCC, 2000) and Table 5.5.1 (IPCC, 2003). 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.

### 1.5.4 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

I. 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

II. Recommendation of improvements in both cases.

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.

### 1.5.5 Implementation of QA/QC procedures in cases of recalculations

The QA/QC procedures described 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 (Tier 1), it is necessary to employ more demanding control procedures (Tier 2) 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.

## 1.6 Key source categories

The *Good Practice Guidance* (IPCC, 2000) and (IPCC, 2003) provides two tiers of determining these *key categories (key sources)*. *Key categories* by definition contribute to ninety percent of the overall uncertainty in a level (in emissions per year) or in a trend. The procedure in the Tier 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.

The procedure of the Tier 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.

In previous submissions, only *key sources* identification not considering the LULUFC sector based on *Good Practice Guidance* (IPCC, 2000), were performed. Starting with the 2008 submission, the *key categories* are identified according to *Good Practice Guidance for LULUCF* (IPCC, 2003), which also considers categories from LULUCF. However, for the right identification of *key categories*, also assessment without consideration of the LULUCF categories was employed. It is obvious from Tab. 1-1 that no additional *key category* was identified when the LULUCF categories were not considered.

On the whole, 25 *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. 1-1 Identification of key categories by level assessment (LA) and trend assessment (TA) for 2011 evaluated with and without LULUCF (Tier 1)**

| | Level Assessment (LA) with LULUCF | | | | | | Trend Assessment (TA) with LULUCF | | | | with | without* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sec. | IPCC Source Categories | GHG | LA, % | Cum, % | KC | Sec. | IPCC Source Categories | GHG | Rel TA,% | NT | LULUCF | |
| 1A | 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 45.8 | 45.8 | 1 | 1A | 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 21.65 | 1 | LA,TA | LA,TA |
| 1A | 1.A.3.b Transport - Road Transportation | $CO_2$ | 11.3 | 57.15 | 2 | 1A | 1.A.3.b Transport - Road Transportation | $CO_2$ | 20.44 | 2 | LA,TA | LA,TA |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 10.7 | 67.83 | 3 | 1A | 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 11.58 | 3 | LA,TA | LA,TA |
| 5 | 5.A.1 Forest Land remaining Forest Land | $CO_2$ | 5.37 | 73.2 | 4 | 5 | 5.A.1 Forest Land remaining Forest Land | $CO_2$ | 7.46 | 5 | LA,TA | |
| 2 | 2.C.1 Iron and Steel Production | $CO_2$ | 3.96 | 77.16 | 5 | 2 | 2.C.1 Iron and Steel Production | $CO_2$ | 5.49 | 6 | LA,TA | LA,TA |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 3.49 | 80.65 | 6 | 1A | 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 7.84 | 4 | LA,TA | LA,TA |
| 1B | 1.B.1.a Coal Mining and Handling | $CH_4$ | 2.31 | 82.96 | 7 | 1B | 1.B.1.a Coal Mining and Handling | $CH_4$ | 3.55 | 7 | LA,TA | LA,TA |
| 4 | 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 2.1 | 85.06 | 8 | 4 | 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 1.48 | 11 | LA,TA | LA,TA |
| 6 | 6.A Solid Waste Disposal on Land | $CH_4$ | 1.93 | 86.99 | 9 | 6 | 6.A Solid Waste Disposal on Land | $CH_4$ | 2.75 | 8 | LA,TA | LA,TA |
| 4 | 4.A Enteric Fermentation | $CH_4$ | 1.41 | 88.4 | 10 | 4 | 4.A Enteric Fermentation | $CH_4$ | 1.66 | 10 | LA,TA | LA,TA |
| 4 | 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 1.25 | 89.65 | 11 | 4 | 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 1.18 | 14 | LA,TA | LA,TA |
| 2 | 2.A.1 Cement Production | $CO_2$ | 1.17 | 90.82 | 12 | | | | | | LA | LA |
| 2 | 2.A.3 Limestone and Dolomite Use | $CO_2$ | 0.81 | 91.63 | 13 | 2 | 2.A.3 Limestone and Dolomite Use | $CO_2$ | 1.18 | 15 | LA,TA | LA,TA |
| 2 | 2.F.1-6 F-gases Use - ODS substitutes | F-gas | 0.8 | 92.43 | 14 | 2 | 2.F.1-6 F-gases Use - ODS substitutes | F-gas | 1.97 | 9 | LA,TA | LA,TA |
| 1A | 1.A.5.b Mobile sources in Agricult. & Forestry | $CO_2$ | 0.77 | 93.2 | 15 | | | | | | LA | LA |
| 2 | 2.A.2 Lime Production | $CO_2$ | 0.49 | 93.68 | 16 | | | | | | LA | LA |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas | $CH_4$ | 0.47 | 94.15 | 17 | | | | | | LA | LA |
| 4 | 4.B Manure Management | $N_2O$ | 0.47 | 94.62 | 18 | 4 | 4.B Manure Management | $N_2O$ | 0.93 | 17 | LA,TA | LA,TA |
| 1A | 1.A.3.b Transport - Road Transportation | $N_2O$ | 0.46 | 95.08 | 19 | 1A | 1.A.3.b Transport - Road Transportation | $N_2O$ | 0.99 | 16 | LA,TA | TA |
| | | | | | 20 | 1A | 1.A Stationary Combustion - Solid Fuels | $CH_4$ | 1.35 | 12 | TA | TA |
| | | | | | 21 | 5 | 5.B.1 Cropland remaining Cropland | $CO_2$ | 1.22 | 13 | TA | |
| | | | | | 22 | 1A | 1.A Stationary Combustion -Other fuels-1A2 | $CO_2$ | 0.66 | 18 | TA | TA |
| | | | | | 23 | 2 | 2.B.2 Nitric Acid Production | $N_2O$ | 0.65 | 19 | TA | TA |
| | | | | | 24 | 4 | 4.B Manure Management | $CH_4$ | 0.56 | 20 | TA | TA |
| | | | | | 25 | 1A | 1.A Stationary Combustion - Biomass | $CH_4$ | 0.53 | 21 | TA | TA |

**Tab. 1-2 Figures for key categories assessed in different ways**

| Key categories (KC) with LULUCF | 25 | KC assessed without LULUCF | 23 |
|---|---|---|---|
| KC assessed by LA | 19 | KC assessed by LA | 17 |
| KC assessed by TA | 21 | KC assessed by TA | 19 |
| KC assessed by LA + TA concurrently | 15 | KC assessed by LA + TA concurrently | 13 |
| KC assessed by only LA | 4 | KC assessed by only LA | 4 |
| KC assessed by only TA | 6 | KC assessed by only TA | 6 |

Of the overall number of 25 key categories, some of them are right on the 95 % borderline and thus appear only occasionally.

## 1.7 Uncertainty analysis

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 methodical manuals (IPCC, 2000 and 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 2011 after above mentioned revision of the input parameters are given in Tab. 1-3 – 1-5.

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 3.62 %. The corresponding uncertainty in trend is 2.30 %. When LULUCF is not considered in uncertainty analysis, the results are similar: uncertainty evaluated by level assessment is 3.24 % and uncertainty evaluated by trend assessment is 2.23 %.

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.

**Tab. 1-3 Uncertainty analysis in level and trend assessments for 2011 (Tier 1)**

| Input DATA | | | | | | Uncertainty in Level | | Uncert. in trend |
|---|---|---|---|---|---|---|---|---|
| **IPCC Source Category** | Gas | Base year emissions (1990) | Year emissions (2011) | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions in 2011 | Uncertainty introduced into the trend in total national emissions |
| | | [Gg $CO_2$ eq.] | | [%] | [%] | [%] | [%] | [%] |
| 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 110 713 | 65 099 | 4 | 3 | 5 | 6.72 | 3.67 |
| 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 12 165 | 15 181 | 3 | 2.5 | 3.91 | 0.22 | 0.12 |
| 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 13 518 | 4 965 | 5 | 3 | 5.83 | 0.05 | 0.04 |
| 1.A Stationary Combustion - Other fuels - MSW | $CO_2$ | 37 | 326 | 20 | 20 | 28.28 | 0.01 | 0 |
| 1.A Stationary Combustion - Other fuels - 1A2 | $CO_2$ | 0 | 377 | 10 | 15 | 18.03 | 0 | 0 |
| 1.A.3.a Transport - Civil Aviation | $CO_2$ | 146 | 5 | 4 | 3.7 | 5.47 | 0 | 0 |
| 1.A.3.b Transport - Road Transportation | $CO_2$ | 6 239 | 16 124 | 3 | 2.4 | 3.82 | 0.24 | 0.15 |
| 1.A.3.c Transport - Railways | $CO_2$ | 651 | 282 | 5 | 1.5 | 5.21 | 0 | 0 |
| 1.A.3.d Transport - Navigation | $CO_2$ | 56 | 9 | 5 | 1.5 | 5.22 | 0 | 0 |
| 1.A.3.e Transport - Other Transportation | $CO_2$ | 484 | 144 | 4 | 3 | 5 | 0 | 0 |
| 1.A.5.b Mobile sources in Agriculture and Forestry | $CO_2$ | 1 601 | 1 091 | 7 | 3 | 7.62 | 0 | 0 |
| 1.B.1.a Coal Mining and Handling | $CO_2$ | 456 | 255 | 4 | 25 | 25.32 | 0 | 0 |
| 1.B.1.b Fugitive Emission from Oil, Natural Gas … | $CO_2$ | 4 | 13 | 7 | 75 | 75.33 | 0 | 0 |
| 2.A.1 Cement Production | $CO_2$ | 2 489 | 1 665 | 2 | 2 | 2.83 | 0 | 0 |
| 2.A.2 Lime Production | $CO_2$ | 1 337 | 691 | 2 | 2 | 2.83 | 0 | 0 |
| 2.A.3 Limestone and Dolomite Use | $CO_2$ | 678 | 1 151 | 5 | 4 | 6.4 | 0 | 0 |
| 2.A.4 Soda Ash Use | $CO_2$ | 0 | 1 | 5 | 10 | 11.18 | 0 | 0 |
| 2.A.7 Glass, Bricks and Ceramics | $CO_2$ | 326 | 315 | 5 | 10 | 11.18 | 0 | 0 |
| 2.B.1 Ammonia Production | $CO_2$ | 807 | 553 | 5 | 7 | 8.6 | 0 | 0 |
| 2.C.1 Iron and Steel Production | $CO_2$ | 12 533 | 5 623 | 7 | 10 | 12.21 | 0.3 | 0.1 |
| 3 Solvents and Other Product Use | $CO_2$ | 550 | 237 | 5 | 5 | 7.07 | 0 | 0 |
| 6.C Waste Incineration | $CO_2$ | 23 | 187 | 20 | 5 | 20.62 | 0 | 0 |
| 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 1 335 | 159 | 4 | 50 | 50.16 | 0 | 0.03 |
| 1.A Stationary Combustion - Solid Fuels | $CH_4$ | 21 | 26 | 3 | 50 | 50.09 | 0 | 0 |
| 1.A Stationary Combustion - Gaseous Fuels | $CH_4$ | 14 | 3 | 5 | 50 | 50.25 | 0 | 0 |
| 1.A Stationary Combustion - Liquid Fuels | $CH_4$ | 56 | 343 | 8 | 50 | 50.64 | 0.02 | 0.01 |
| 1.A Stationary Combustion - Biomass | $CH_4$ | 0 | 0 | 20 | 50 | 53.85 | 0 | 0 |
| 1.A Stationary Combustion - Other fuels - MSW | $CH_4$ | 110 713 | 65 099 | 4 | 3 | 5 | 6.72 | 3.67 |

**Tab. 1-4 Uncertainty analysis in levels and trend assessments for 2011 (Tier 1), continuation**

| Input DATA | | | | | | Uncertainty in Level | | Uncert. in trend |
|---|---|---|---|---|---|---|---|---|
| **IPCC Source Category** | Gas | Base year emissions (1990) | Year emissions (2011) | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions in 2011 | Uncertainty introduced into the trend in total national emissions |
| | | [Gg $CO_2$ eq.] | | [%] | [%] | [%] | [%] | [%] |
| 1.A.3.a Transport - Civil Aviation | $CH_4$ | 0 | 1 | 10 | 50 | 50.99 | 0 | 0 |
| 1.A.3.b Transport - Road Transportation | $CH_4$ | 1 | 0 | 4 | 21 | 21.38 | 0 | 0 |
| 1.A.3.c Transport - Railways | $CH_4$ | 26 | 25 | 3 | 100 | 100.04 | 0 | 0 |
| 1.A.3.d Transport - Navigation | $CH_4$ | 1 | 0 | 5 | 100 | 100.12 | 0 | 0 |
| 1.A.3.e Transport - Other Transportation | $CH_4$ | 0 | 0 | 5 | 50 | 50.25 | 0 | 0 |
| 1.A.5.b Mobile sources in Agriculture and Forestry | $CH_4$ | 1 | 0 | 4 | 50 | 50.16 | 0 | 0 |
| 1.B.1.a Coal Mining and Handling | $CH_4$ | 7 | 2 | 7 | 50 | 50.49 | 0 | 0 |
| 1.B.1.b Fugitive Emission from Oil, Natural Gas….. | $CH_4$ | 7 601 | 3 283 | 4 | 13 | 13.6 | 0.13 | 0.02 |
| 2.A.7 Glass, Bricks and Ceramics | $CH_4$ | 897 | 666 | 7 | 75 | 75.33 | 0.16 | 0 |
| 2.B.5 Other | $CH_4$ | 3 | 3 | 5 | 50 | 50.25 | 0 | 0 |
| 2.C.1 Iron and Steel Production | $CH_4$ | 15 | 24 | 5 | 40 | 40.31 | 0 | 0 |
| 4.A Enteric Fermentation | $CH_4$ | 127 | 56 | 7 | 30 | 30.81 | 0 | 0 |
| 4.B Manure Management | $CH_4$ | 4 219 | 2 003 | 5 | 20 | 20.62 | 0.11 | 0.01 |
| 6.A Solid Waste Disposal on Land | $CH_4$ | 1 001 | 379 | 5 | 30 | 30.41 | 0.01 | 0 |
| 6.B Wastewater Handling | $CH_4$ | 1 663 | 2 745 | 30 | 40 | 50 | 1.19 | 0.49 |
| 1.A.3.a Transport - Civil Aviation | $CH_4$ | 825 | 516 | 21 | 50 | 54.23 | 0.05 | 0.01 |
| 1.A Stationary Combustion - Solid Fuels | $N_2O$ | 495 | 299 | 4 | 60 | 60.13 | 0.02 | 0 |
| 1.A Stationary Combustion - Gaseous Fuels | $N_2O$ | 7 | 9 | 3 | 60 | 60.07 | 0 | 0 |
| 1.A Stationary Combustion - Liquid Fuels | $N_2O$ | 34 | 13 | 5 | 60 | 60.21 | 0 | 0 |
| 1.A Stationary Combustion - Biomass | $N_2O$ | 27 | 120 | 8 | 60 | 60.53 | 0 | 0 |
| 1.A Stationary Combustion - Other fuels - MSW | $N_2O$ | 0 | 4 | 20 | 70 | 72.8 | 0 | 0 |
| 1.A Stationary Combustion - Other fuels - 1A2 | $N_2O$ | 0 | 2 | 10 | 60 | 60.83 | 0 | 0 |
| 1.A.3.a Transport - Civil Aviation | $N_2O$ | 6 | 0 | 4 | 40 | 40.2 | 0 | 0 |
| 1.A.3.b Transport - Road Transportation | $N_2O$ | 132 | 660 | 3 | 100 | 100.04 | 0.28 | 0.09 |
| 1.A.3.c Transport - Railways | $N_2O$ | 12 | 5 | 5 | 100 | 100.12 | 0 | 0 |
| 1.A.3.d Transport - Navigation | $N_2O$ | 1 | 0 | 5 | 90 | 90.14 | 0 | 0 |
| 1.A.3.e Transport - Other Transportation | $N_2O$ | 0 | 0 | 4 | 60 | 60.13 | 0 | 0 |
| 1.A.5.b Mobile sources in Agriculture and Forestry | $N_2O$ | 20 | 23 | 7 | 60 | 60.41 | 0 | 0 |

**Tab. 1-5 Uncertainty analysis in levels and trend assessments for 2011 (Tier 1), continuation**

| Input DATA | | | | | | Uncertainty in Level | | Uncert. in trend |
|---|---|---|---|---|---|---|---|---|
| **IPCC Source Category** | Gas | Base year emissions (1990) | Year emissions (2011) | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as % of total national emissions in 2011 | Uncertainty introduced into the trend in total national emissions |
| | | [Gg $CO_2$ eq.] | | [%] | [%] | [%] | [%] | [%] |
| 2.B.2 Nitric Acid Production | $N_2O$ | 1 127 | 418 | 4 | 15 | 15.52 | 0 | 0 |
| 2.B.5 Other | $N_2O$ | 84 | 94 | 20 | 40 | 44.72 | 0 | 0 |
| 3 Solvents and Other Product Use | $N_2O$ | 215 | 233 | 50 | 0 | 50 | 0.01 | 0.01 |
| 4.B Manure Management | $N_2O$ | 1 708 | 664 | 5 | 30 | 30.41 | 0.03 | 0.01 |
| 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 5 484 | 2 989 | 15 | 50 | 52.2 | 1.54 | 0.13 |
| 4.D.2 Pasture, Range and Padock Manure | $N_2O$ | 317 | 254 | 10 | 100 | 100.5 | 0.04 | 0 |
| 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 3 503 | 1 776 | 20 | 50 | 53.85 | 0.58 | 0.09 |
| 6.B Wastewater Handling | $N_2O$ | 162 | 205 | 26 | 50 | 56.36 | 0.01 | 0 |
| 6.C Waste Incineration | $N_2O$ | 0 | 4 | 20 | 70 | 72.8 | 0 | 0 |
| 2.F.1-6 F-gases Use - ODS substitutes | F-gas | 0 | 1 130 | 37 | 23 | 43.57 | 0.15 | 0.11 |
| 2.F.7 F-gases Use - Semiconductore Manufacture | F-gas | 0 | 29 | 15 | 15 | 21.21 | 0 | 0 |
| 2.F.8 F-gases Use - Electrical Equipment | $SF_6$ | 78 | 31 | 5 | 15 | 15.81 | 0 | 0 |
| 2.F.9 F-gases Use - Other $SF_6$ | $SF_6$ | 0 | 3 | 10 | 20 | 22.36 | 0 | 0 |
| 5.A.1 Forest Land remaining Forest Land | $CO_2$ | -4 777 | -7 635 | | 18.1 | 18.1 | 1.21 | 0.18 |
| 5.A.1 Forest Land remaining Forest Land | $CH_4$ | 100 | 55 | | 50 | 50 | 0 | 0 |
| 5.A.1 Forest Land remaining Forest Land | $N_2O$ | 10 | 6 | | 50 | 50 | 0 | 0 |
| 5.B.1 Cropland remaining Cropland | $CO_2$ | 1 089 | 61 | | 12.5 | 12.47 | 0 | 0 |
| 5.C.1 Grassland remaining Grassland | $CO_2$ | 59 | 2 | | 9.4 | 9.39 | 0 | 0 |
| 5.A.2 Land converted to Forest Land | $CO_2$ | 0 | 0 | | 50 | 50 | 0 | 0 |
| 5.B.2 Land converted to Cropland | $CO_2$ | 0 | 0 | | 50 | 50 | 0 | 0 |
| 5.C.2 Land converted to Grassland | $CO_2$ | 0 | 0 | | 50 | 50 | 0 | 0 |
| 5.D.2. Land converted to Wetlands | $CO_2$ | -280 | -329 | | 38.8 | 38.78 | 0.01 | 0 |
| 5.E.2 Land converted to Settlements | $CO_2$ | 226 | 86 | | 38.5 | 38.54 | 0 | 0 |
| 5G Other - Liming of Forest Land | $CO_2$ | -187 | -331 | | 18.6 | 18.64 | 0 | 0 |
| 5.B.2. Land converted to Cropland | $N_2O$ | 23 | 32 | | 73.6 | 73.58 | 0 | 0 |
| | **Total** | **192 421** | **125 536** | | | | **3.62** | **2.3** |
| | | | | | | | **Level uncertainty** | **Trend uncertainty** |

## 1.8 General assessment of the 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.

### 1.8.1 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 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.

<u>IE (included elsewhere)</u>:

“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.

<u>NE (not estimated)</u>:

“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(a).

# 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.

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

Tab. 2-1 presents a summary of GHG emissions excl. bunkers for the period from 1990 to 2011. 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 1990-2011 excl. bunkers *[Gg $CO_2$ eq.]***

| | $CO_2$ [4] | $CH_4$ [6] | $N_2O$ [6] | HFCs | PFCs | $SF_6$ | Total emissions | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | incl. LULUCF | excl. LULUCF |
| **1990** | 164 812.75 | 17 915.09 | 13 364.89 | NO | NO | 77.68 | 192 421.08 | 196 039.02 |
| **1991** | 154 306.92 | 16 277.58 | 11 587.58 | NO | NO | 77.32 | 173 109.33 | 182 146.60 |
| **1992** | 139 954.47 | 15 339.56 | 10 344.24 | NO | NO | 76.96 | 154 822.06 | 165 608.99 |
| **1993** | 135 893.77 | 14 420.96 | 9 163.61 | NO | NO | 76.60 | 150 003.81 | 159 436.67 |
| **1994** | 126 908.55 | 13 575.80 | 9 007.81 | NO | NO | 76.24 | 142 307.75 | 149 448.82 |
| **1995** | 128 037.89 | 13 395.62 | 9 278.46 | 0.73 | 0.12 | 75.20 | 143 466.34 | 150 676.45 |
| **1996** | 132 486.96 | 13 274.42 | 8 875.16 | 101.31 | 4.11 | 77.52 | 147 059.10 | 154 679.74 |
| **1997** | 129 595.98 | 13 018.90 | 8 955.67 | 244.81 | 0.89 | 95.48 | 145 103.09 | 151 763.94 |
| **1998** | 123 216.89 | 12 571.32 | 8 760.40 | 316.56 | 0.89 | 64.19 | 137 800.88 | 144 798.83 |
| **1999** | 115 636.37 | 11 975.71 | 8 593.51 | 267.47 | 2.55 | 76.98 | 129 276.37 | 136 431.41 |
| **2000** | 125 711.08 | 11 176.34 | 8 697.13 | 262.50 | 8.81 | 141.92 | 138 361.80 | 145 886.05 |
| **2001** | 125 466.64 | 10 886.27 | 8 859.36 | 393.37 | 12.35 | 168.73 | 137 793.77 | 145 671.68 |
| **2002** | 122 126.15 | 10 501.16 | 8 561.65 | 391.29 | 13.72 | 67.72 | 133 906.79 | 141 539.32 |
| **2003** | 125 510.87 | 10 445.75 | 8 060.21 | 590.14 | 24.53 | 101.25 | 138 839.78 | 144 582.43 |
| **2004** | 126 509.64 | 10 155.47 | 8 753.05 | 600.30 | 17.33 | 51.89 | 139 766.55 | 145 949.52 |
| **2005** | 125 744.39 | 10 513.46 | 8 443.31 | 594.21 | 10.08 | 85.88 | 138 573.86 | 145 259.37 |
| **2006** | 127 127.71 | 10 816.51 | 8 277.19 | 872.35 | 22.56 | 83.07 | 143 573.44 | 147 038.10 |
| **2007** | 127 346.27 | 10 470.03 | 8 313.75 | 1 605.85 | 20.16 | 75.85 | 146 897.96 | 147 624.79 |
| **2008** | 122 004.67 | 10 532.74 | 8 436.79 | 1 262.45 | 27.48 | 47.04 | 137 373.51 | 142 146.37 |
| **2009** | 114 427.74 | 10 205.50 | 7 896.25 | 1 020.25 | 27.14 | 49.61 | 126 623.08 | 133 486.19 |
| **2010** | 118 005.01 | 10 412.56 | 7 639.11 | 1 467.85 | 29.43 | 16.22 | 131 934.11 | 137 422.56 |
| **2011** | 114 296.49 | 10 288.77 | 7 782.94 | 1 130.42 | 29.43 | 34.55 | 125 536.29 | 133 495.50 |
| **%** [5] | -30.65 | -42.57 | -41.77 | 1 539.03 | 240.23 | -55.52 | -34.76 | -31.90 |

*Note: Global warming potentials (GWPs) used (100 years time horizon): $CO_2$ = 1; $CH_4$ = 21; $N_2O$ = 310; $SF_6$ = 23 900; HFCs and PFCs consist of different substances, therefore GWPs have to be calculated individually depending on substances*

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

[4] *GHG emissions excluding emissions/removals from LULUCF*

[5] *relative to base year*

decrease has stopped around 140 000 Gg $CO_2$ eq. and continues fluctuating ever since (see Fig. 2-1). From 2010 to 2011 the total GHG emissions (incl. LULUCF) decreased by 4.85 % or 6397.82 Gg $CO_2$ eq. resulting in total emissions of 125 536.29 Gg $CO_2$ eq. The decrease was caused by $CO_2$, $CH_4$, HFC emissions (decreased by 3.14 %; 1.19 %; 22.99 %) despite increase in $N_2O$ and $SF_6$ emissions (raised by 1.88 % and 112.99 % respectively) compared to previous year. The total GHG emissions and removals in 2011 were 34.76 % below the base year level including LULUCF and 31.90 %, when excluding LULUCF.

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 depending 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 2009 some of the industrial subsectors reached its lowest amounts of emitted GHGs according to the whole reported time-series.

Trend of GDP increased between 2009 and 2011, indicating slight recovery from economic/industrial recession yet emissions in 2011 further decreased.

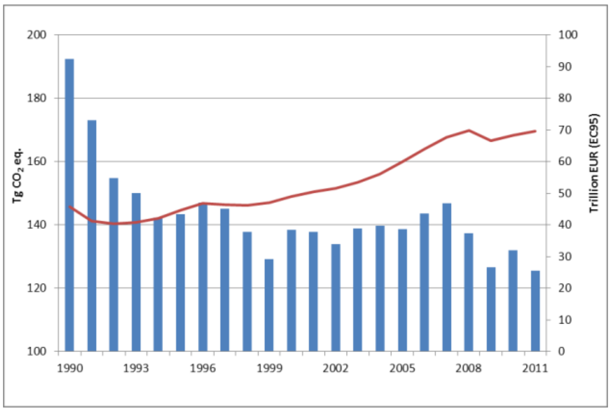
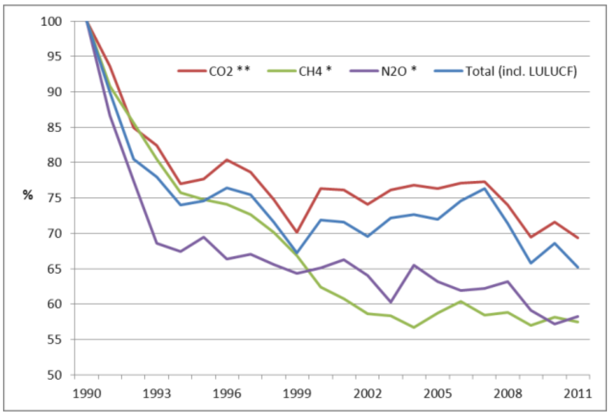



**Fig. 2-1 Total GHG emissions (incl. LULUCF) and GDP in 1995 constant prices (1990-2011) [Gg $CO_2$ eq.]**

## 2.2 Description and interpretation of emission trends by gas

The major greenhouse gas in the Czech Republic is $CO_2$, which represents 84.65 % of total GHG emissions and removals in 2011, compared to 83.9 % in the base year. It is followed by $CH_4$ (8.20 % in 2011, 9.3 % in the base year), $N_2O$ (6.20 % in 2011, 6.7 % in the base year) and F-gases (0.95 % in 2011, 0.04 % in the base year). The trend of individual GHG emissions relative to emissions in the respective base years[6] is presented in Fig. 2-2.



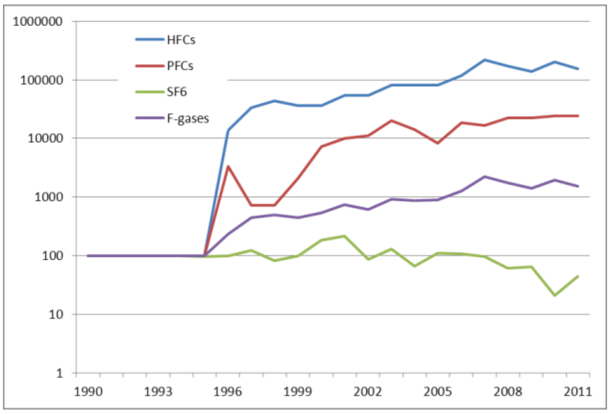




**Fig. 2-2 Trend in $CO_2$, $CH_4$ and $N_2O$ emissions 1990-2011 in index form (base year = 100 %) and Trend in HFCs, PFCs (195 – 2011) and $SF_6$ (1990 – 2011) actual emissions in index form (base year = 100 %)**

### *$CO_2$*

$CO_2$ emissions have been rapidly decreasing in early 90's, after 1994 the emissions have kept at approx. 70-75 % of the amount produced in 1990. Between 2007 and 2009 emissions of $CO_2$ dropped to its lowest value among the whole reported period. Inter-annual increase in $CO_2$ emissions (excl. LULUCF) from 2010 to 2011 by 3.14 % results the total decrease to 30.65 % from 1990 to 2011 (34.02 % decrease incl. LULUCF). Quoting in absolute figures, $CO_2$ emissions and removals decreased from 164 812.75 to 114 296.49 Gg $CO_2$ eq. in the period from 1990 to 2011, mainly due to lower emissions from the *1 Energy* category (mainly *1A2 Manufacturing Industries & Construction*, *1A4a Commercial / Institutional and 1A4b Residential*).

The main source of $CO_2$ emissions is fossil fuel combustion; within the *1A Fuel Combustion* category, *1A1 Energy Industry* and *1A2 Manufacturing Industries & Construction* sub-categories are the most important. $CO_2$ emissions increased remarkably between 1990 and 2011 from the *1A3 Transport* category from 7 576 to 16 564 Gg $CO_2$.

### *$CH_4$*

$CH_4$ emissions share decreased almost steadily during the period from 1990 to 2004, from 2004 methane fluctuated around 58 % of its base year emissions. In 2011 $CH_4$ emissions were 42.57 % below the base year level, mainly due to lower contribution of *1B Fugitive Emissions from Fuels* and emissions from *4 Agriculture* and despite increase from the *6 Waste* category. The main sources of $CH_4$ emissions are *1B Fugitive Emissions from Fuels* (solid fuel), *4 Agriculture* (*4A Enteric Fermentation* and *4B Manure Management*) and *6 Waste* (*6A Solid Waste Disposal on Land* and *6B Waste-water Handling*).

[6] *(index form: 1990 = 100 for $CO_2$, $CH_4$ and $N_2O$ and 1995 = 100 for HFCs, PFCs and $SF_6$)*

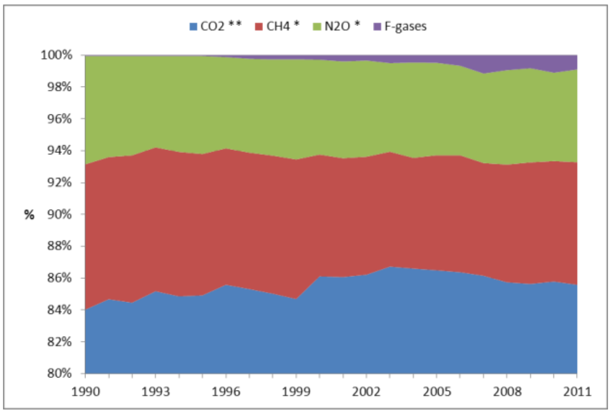



**Fig. 2-3 Percentual share of GHGs (Y-axis begins at 80% - part of $CO_2$ share is hidden)**

### $N_2O$

$N_2O$ emissions strongly decreased from 1990 to 1994 by 34 % over this period and then shows slow decreasing trend with inter-annual fluctuation. $N_2O$ emissions decreased between 1990 and 2011 from 13 365 to 7 783 Gg $CO_2$ eq. In 2011 $N_2O$ emissions were 41.77 % below the base year level, mainly due to lower emissions from *4 Agriculture and 2B Chemical Industry* and despite increase from the *1A3 Transport* category.

The main source of $N_2O$ emission is category *4D Agricultural Soils* (others less important sources are *1A Fossil Fuel Combustion* and *2 Industrial Processes - 2B Chemical Industry*).

### HFCs

HFCs actual emissions increased remarkably between 1995 and 2011 from 0.73 to 1 130.4 Gg $CO_2$ eq. Emissions of HFCs have been rapidly increasing since the base year 1995, when they were started to use. HFC seems to have decreasing trend due economic recession which started after 2007. In 2011, HFCs emissions were more than 2000-times higher than in the base year 1995.

The main sources of HFCs emissions are *Refrigeration* and *Air Conditioning equipment*.

### PFCs

PFCs actual emissions show very similar trend as HFCs emissions but on much lower scale. They increased between 1995 and 2011 from 0.12 to 29.43 Gg $CO_2$ eq. In 2011, 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 75.2 Gg $CO_2$ eq. Between 1995 and 2011 they inter-annually fluctuated with maximum of 168.7 Gg $CO_2$ eq. in 2001 and minimum of 16.22 Gg $CO_2$ eq. in 2010. In 2011 $SF_6$ reached amount of 34.55 Gg, the level was 55.52 % below the base year.

The main sources of $SF_6$ emissions are *Electrical Equipment*; *Semiconductor Manufacture* and *Filling of Insulate Glasses*.

## 2.3 Description and interpretation of emission trends by category

Tab. 2-2 presents a summary of GHG emissions by categories for the period from 1990 to 2011:

Category 1 Energy
Category 2 Industrial Processes
Category 3 Solvent and Other Product Use
Category 4 Agriculture
Category 5 Land Use, Land-Use Change and Forestry
Category 6 Waste

The dominant category is the *1 Energy* category, which caused for 87.24 % of total GHG emissions in 2011 (81.7 % in 1990) excluding LULUCF, followed by the categories *2 Industrial Processes* and *4 Agriculture*, which caused for 9.39 % and 6.42 % of total GHG emissions in 2011 (10.2 % and 8.2 % in 1990, resp.), *6 Waste* category covered 2.91 %, *3 Solvent and Other Product Use* 0.4 % and *5 LULUCF* category removed 7 959.22 Gg $CO_2$ eq. which represents share of 6.34 % of all GHG emissions.

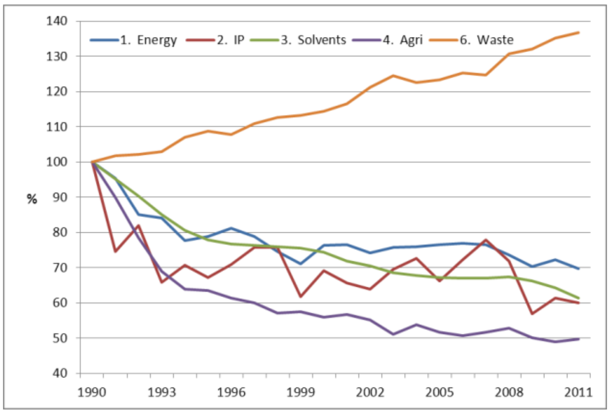
The trend of GHG emissions by categories is presented in Fig. 2-5 (indexed relative to the base year), see also the percentual share of individual sectors (Fig. 2-6).

**Tab. 2-2 Summary of GHG emissions by category 1990-2011 *[Gg $CO_2$ eq.]***

| | 1 Energy | 2 IP | 3 Solvents | 4 Agricultre | 5 LULUCF | 6 Waste |
|---|---|---|---|---|---|---|
| **1990** | 156 764.91 | 19 602.83 | 764.83 | 16 233.28 | -3 617.94 | 2 673.17 |
| **1991** | 149 464.92 | 14 619.03 | 728.05 | 14 611.72 | -9 037.27 | 2 722.88 |
| **1992** | 133 384.03 | 16 069.16 | 690.99 | 12 731.33 | -10 786.93 | 2 733.48 |
| **1993** | 131 908.42 | 12 922.95 | 650.54 | 11 204.85 | -9 432.86 | 2 749.91 |
| **1994** | 121 745.25 | 13 855.70 | 616.05 | 10 372.50 | -7 141.07 | 2 859.32 |
| **1995** | 123 652.36 | 13 188.23 | 596.31 | 10 331.98 | -7 210.11 | 2 907.58 |
| **1996** | 127 351.01 | 13 893.50 | 586.63 | 9 966.29 | -7 620.64 | 2 882.31 |
| **1997** | 123 606.44 | 14 847.10 | 584.76 | 9 758.20 | -6 660.85 | 2 967.44 |
| **1998** | 117 071.61 | 14 850.27 | 580.41 | 9 284.71 | -6 997.96 | 3 011.85 |
| **1999** | 111 370.65 | 12 102.86 | 578.49 | 9 350.12 | -7 155.04 | 3 029.28 |
| **2000** | 119 603.41 | 13 561.11 | 568.56 | 9 094.86 | -7 524.24 | 3 058.11 |
| **2001** | 119 901.74 | 12 885.78 | 549.96 | 9 220.88 | -7 877.91 | 3 113.32 |
| **2002** | 116 255.36 | 12 546.46 | 539.65 | 8 955.86 | -7 632.54 | 3 242.00 |
| **2003** | 118 757.78 | 13 656.01 | 525.16 | 8 314.94 | -5 742.66 | 3 328.53 |
| **2004** | 119 162.73 | 14 239.70 | 519.28 | 8 750.49 | -6 182.96 | 3 277.31 |
| **2005** | 120 084.32 | 12 979.24 | 513.77 | 8 385.03 | -6 685.51 | 3 297.01 |
| **2006** | 120 767.73 | 14 156.44 | 512.93 | 8 249.77 | -3 464.66 | 3 351.23 |
| **2007** | 120 111.99 | 15 264.70 | 512.17 | 8 403.04 | -726.83 | 3 332.89 |
| **2008** | 115 470.97 | 14 085.39 | 515.27 | 8 583.06 | -4 772.86 | 3 491.67 |
| **2009** | 110 163.85 | 11 153.29 | 506.15 | 8 134.29 | -6 863.11 | 3 528.62 |
| **2010** | 113 328.33 | 12 025.82 | 492.05 | 7 964.57 | -5 488.45 | 3 611.79 |
| **2011** | 109 514.58 | 11 790.63 | 469.42 | 8 064.84 | -7 959.22 | 3 656.03 |
| %[7] | -3.37 | -1.96 | -4.60 | 1.26 | 45.02 | 1.22 |
| %[8] | -30.14 | -39.85 | -38.62 | -50.32 | 119.99 | 36.77 |

[7] *Difference relative to previous year*

[8] *Difference relative to base year*



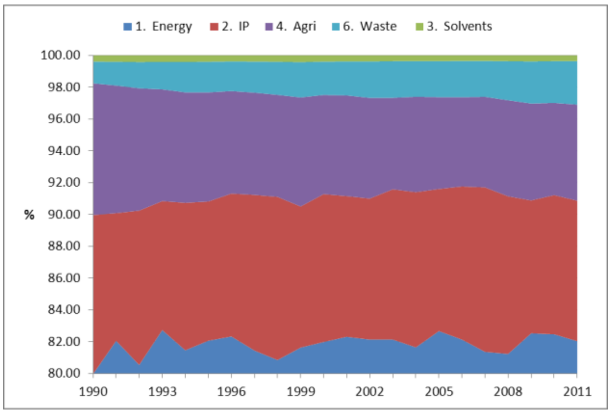




**Fig. 2-4 Emission trends in 1990-2011 by categories in index form (base year = 100) and Fig. 2-5 Percentual share of GHG emissions by categories (y-axis begins at 80% - part of energy share is hidden)**

### *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 2002 – 2007 emissions kept around 120 000 Gg $CO_2$ eq. Total decrease between 1990 and 2011 is 30.14 %. Between 2010 to 2011 emissions from category *1 Energy* slightly *de*creased by 3.37 %.

From the total 109 514.58 Gg $CO_2$ eq. in 2011 99.74 % comes from *1A Fuel Combustion*, the rest are *1B Fugitive Emissions from Fuels* (mainly Solid Fuels). *1B Fugitive Emissions from Fuels* is the largest source for $CH_4$, which represented 31.91 % of all $CH_4$ emissions in 2011. 43.81 % of all $CH_4$ emissions in 2011 originated from *Energy* category.

$CO_2$ emissions from fossil fuels combustion (category *1 Energy*) are the main source in Czech Republic's inventory with a share of 90.88 % in national $CO_2$ emissions (excl. *LULUCF*). $CO_2$ from category *1Energy* contributes for 77.77 % to total GHG emissions, $CH_4$ for 3.38 % and $N_2O$ for 0.85 % in 2011.

### *Industrial Processes (IPCC Category 2)*

GHG emissions from the *2 Industrial Processes* category fluctuated with decreasing trend during the whole period 1990 to 2011. In early 90's emissions decreased rather rapidly, then reached decade minimum in 1999 and subsequently decreased with total minimum in 2009 (successful implementation abatement technology). Between 1990 and 2011 emissions from this category decreased by 39.85 %. In 2011 emissions amounted for 11 791 Gg $CO_2$ eq.

The main categories in the *2 Industrial Processes* category are *2C Metal Production* (48.17 %)*, 2A Mineral Products* (32.46 %), *2B Chemical Industry* (9.24 %) and *2F Consumption of Halocarbons and $SF_6$* (10.13 %) of the sectoral emissions in 2011.

The most important GHG of the *2 Industrial Processes* category was $CO_2$ with 84.81 % of sectoral emissions, followed by F-gases (10.13 %), $N_2O$ (4.35 %), $CH_4$ (0.71 %).

### *Solvent and Other Product Use (IPCC Category 3)*

In 2011, 0.4 % of total GHG emissions (469.42 Gg $CO_2$ eq.) arose from the *3 Solvent and Other Product Use* category. Emissions in this category generally decreases steadily in the period from 1990 to 2011, but has steadily kept its 0.4 % share over all the years. In 2011 GHG emissions from *3 Solvent and Other Product Use* were 38.62 % below the base year. 50.47 % of these emissions were $CO_2$, $N_2O$ emissions contributed by 49.53 %.

### *Agriculture (IPCC Category 4)*

GHG emissions from the category *4 Agriculture* decreased relatively steadily over the period from 1990 to 2003 and then fluctuated. In 2010 emissions reached the minimum level. In 2011 emissions were by 50.32 % below the base year level, only 1.26% above the global minimum of previous year.

Agriculture amounted 8 064.84 Gg $CO_2$ eq. in 2011 which corresponds to 6.04 % of national total emissions (excluding LULUCF). The most important sub-category agricultural soils ($N_2O$ emissions) contributed by 62.24 % to sectoral total in 2011, followed by the enteric fermentation ($CH_4$ emissions, 24.83 %) and manure management ($CH_4$ and $N_2O$ emissions, 4.70 % and 8.23 % respectively).

*4 Agriculture* is the largest source for $N_2O$ and second largest source for $CH_4$ emissions: 73.02 % of all $N_2O$ emissions and 23.15 % of all $CH_4$ emissions in 2011 originated from this category.

### *Land Use, Land-Use Change and Forestry (IPCC Category 5)*

GHG removals from the *5 Land Use, Land-Use Change and Forestry* category vary through the whole time series with minimum of 730 Gg $CO_2$ eq. in 2007 and maximum 10 794 $CO_2$ eq. in 1992. In 2011 removals were by 120 % above the base year level.

Emissions and removals amounted to -7 959.22 Gg $CO_2$ eq. in 2011, which corresponds to -6.34 % to national total emissions. Emissions and removals are calculated from all categories and according to GPG for LULUCF; IPCC 2003.

*LULUCF* category is the largest sink for $CO_2$. Net $CO_2$ removals from this category amounted to 8 026.31 Gg $CO_2$ in 2011. $CH_4$ emissions amounted to 55.11 Gg $CO_2$ eq., $N_2O$ to 11.99 Gg $CO_2$ eq.

### *Waste (IPCC Category 6)*

GHG emissions from category *6 Waste* substantially increased during the whole period. In 2011 emissions amounted for 3 656.03 Gg $CO_2$ eq., which is 36.77 % above the base year level. The increase of emissions is mainly due to higher emissions of $CH_4$ from *6A Solid Waste Disposal on Land* (and partly due to increase of $N_2O$ emissions from *6B Waste-water Handling*), which are the most important categories. As a result of $CH_4$ recovery systems installed in *6B Wastewater Handling* emissions decreased in this category by 37.48 % compared to the base year. The share of category *6 Waste* in total emissions was 2.74 % in 2011 (excluding LULUCF).

The main source is solid *6A Solid Waste Disposal on Land*, which accounted for 84.17 % of sectoral $CH_4$ emissions in 2011, followed by *6B Wastewater Handling* ($CH_4$ - 15.83 % and $N_2O$ - 5.7 %) and 6C Waste Incineration ($CO_2$ – 100.0 % and $N_2O$ - 1.70 %).

89.18 % of all emissions from *Waste* category are $CH_4$ emissions; $CO_2$ contributes by 5.12 % and $N_2O$ by 5.69 %.

## 2.4 Description and interpretation of emission trends of indirect greenhouse gases and $SO_2$

Emission estimates for $NO_X$, CO, NMVOC and $SO_2$ are also reported in the CRF. The following chapter summarizes the trends for these gases.

A detailed description of the methodology used to estimate these emissions should be available in *Czech Informative Inventory Report (IIR) , Submission under the UNECE / CLRTAP Convention*. Indirect greenhouse gases totals correspond under both submissions, the differences between reporting formats (NFR-CRF) are taken into account.

Tab. 2-3 presents a summary of emission estimates for indirect GHGs and $SO_2$ for the period from 1990 to 2011 and the National Emission Ceilings (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 signed this Protocol.

Emissions of indirect greenhouse gases decreased from the period from 1990 to 2011 (NMVOC by 55.09 %, CO by 62.22 % and $NO_X$ by 69.54 %). $SO_2$ emissions decreased by 90.99 % compared to 1990 level.

**Tab. 2-3 Emissions of indirect GHGs and $SO_2$ 1990-2011 [Gg]**

| | $NO_X$ | CO | NMVOC | $SO_2$ |
|---|---|---|---|---|
| **1990** | 742.38 | 1 071.77 | 311.27 | 1 875.52 |
| **1991** | 732.22 | 1 157.56 | 272.97 | 1 772.20 |
| **1992** | 708.26 | 1 162.92 | 257.47 | 1 559.14 |
| **1993** | 690.79 | 1 194.58 | 233.04 | 1 468.85 |
| **1994** | 450.88 | 1 075.83 | 255.31 | 1 290.19 |
| **1995** | 430.23 | 933.51 | 215.35 | 1 095.32 |
| **1996** | 446.74 | 966.67 | 265.16 | 934.45 |
| **1997** | 470.75 | 982.74 | 271.86 | 980.79 |
| **1998** | 414.18 | 813.96 | 267.15 | 442.22 |
| **1999** | 391.14 | 728.03 | 247.17 | 268.92 |
| **2000** | 396.74 | 681.52 | 244.31 | 264.45 |
| **2001** | 332.87 | 688.67 | 219.88 | 250.89 |
| **2002** | 319.45 | 589.18 | 202.86 | 237.39 |
| **2003** | 325.75 | 632.38 | 203.26 | 232.13 |
| **2004** | 333.61 | 624.45 | 198.46 | 227.22 |
| **2005** | 279.19 | 557.96 | 181.70 | 218.63 |
| **2006** | 283.84 | 542.08 | 178.60 | 211.23 |
| **2007** | 285.94 | 584.27 | 173.97 | 216.96 |
| **2008** | 262.81 | 498.36 | 165.66 | 174.34 |
| **2009** | 252.78 | 454.10 | 151.06 | 173.47 |
| **2010** | 240.08 | 455.58 | 150.89 | 170.32 |
| **2011** | 226.09 | 404.89 | 139.79 | 169.01 |
| Trend [%] | -69.54 | -62.22 | -55.09 | -90.99 |
| **NEC[9]** | 286 | - | 220 | 283 |

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

### $NO_X$

$NO_X$ emissions decreased from 742 to 226 Gg during the period from 1990 to 2011. In 2011 $NO_X$ emissions were 69.54 % below the 1990 level. Almost 99 % of $NO_X$ emissions originate from *1 Energy,* mainly subsectors *1A1 Energy Industries, 1A3 Transport* (road), *1A2 Manufacturing Industries and Construction* and *1A5 Other*.

### CO

CO emissions decreased from 1,071 to 405 Gg during the period from 1990 to 2011. In 2011 CO emissions were 62.22 % below the 1990 level. In 2011, approximately 87.03 % of total CO emissions originated from *1 Energy;* subsectors *1A3 Transport (32.87 %), 1A2 Manufacturing Industries and Construction (26.37 %),* and *1A4 Other Sectors (19.96 %)*, followed by *Industrial Processes* (7.3 %) *and LULUCF* (5.67 %).

### NMVOC

NMVOC emissions decreased from 311 to 140 during the period from 1990 to 2011. In 2011 NMVOC emissions were 55.09 % below the 1990 level. There are two main emission source categories, first is *3 Solvent and Other Product Use* (53.92 % of the national total) and second is *1 Energy* (44.5% - mainly subsectors *1A3 Transport (22.84 %),* and *1A4 Other Sectors* (*Commercial / Institutional, Residential, Agriculture / Forestry / Fisheries*) 13.18 %).

### $SO_2$

$SO_2$ emissions decreased from 1 876 to 169.01 Gg during the period from 1990 to 2011. In 2011 $SO_2$ emissions were 90.99 % below the 1990 level. In 2011, 99.09 % of total $SO_2$ emissions originated from *1 Energy;* mainly subsectors *1A1 Energy Industries (62.4 %), 1A4 Other Sectors (17.84 %) and 1A2 Manufacturing Industries and Construction (13.6 %)*.

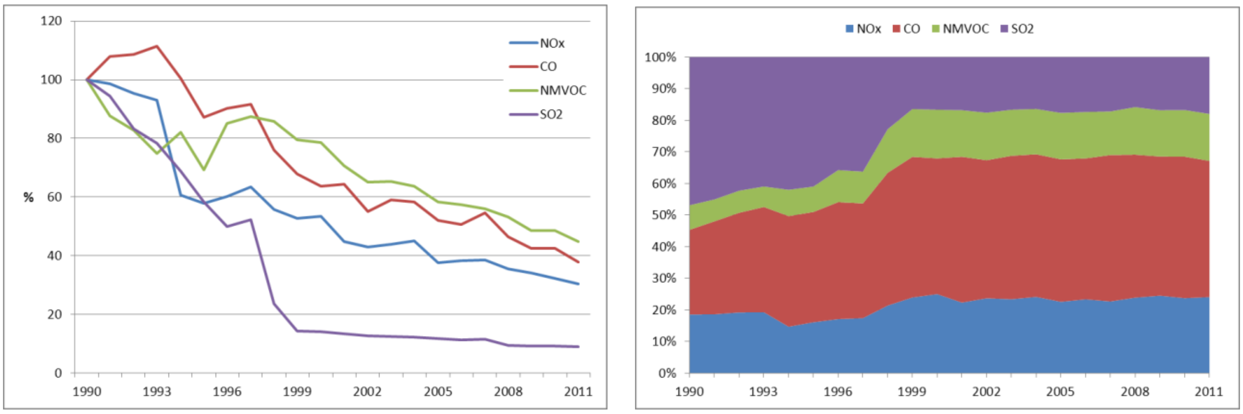



**Fig. 2-6 Indexed emissions of indirect GHGs and $SO_2$ 1990 – 2011 (1990=100 %) and overall trend of their percentual share**

**Tab. 2-4 Indirect GHG emissions in sectors of origin 2011 (Gg)**

| Indirect Greenhouse gas sources | $NO_X$ | CO | NMVOC | $SO_2$ |
|---|---|---|---|---|
| | Gg | Gg | Gg | Gg |
| **Total National Emissions and Removals** | 226.09 | 404.89 | 139.79 | 169.01 |
| **1. Energy** | 222.84 | 352.36 | 62.21 | 167.47 |
| **A. Fuel Combustion** | 222.22 | 352.09 | 61.60 | 159.36 |
| **1. Energy Industries** | 80.65 | 9.94 | 6.43 | 105.47 |
| **2. Manufacturing Industries and Construction** | 27.82 | 106.75 | 1.98 | 22.99 |
| **3. Transport** | 67.04 | 133.09 | 31.93 | 0.57 |
| **4. Other Sectors** | 11.23 | 80.82 | 18.43 | 30.15 |
| **5. Other** | 35.47 | 21.50 | 2.83 | 0.18 |
| **B. Fugitive Emissions from Fuels** | 0.62 | 0.26 | 0.61 | 8.11 |
| **1. Solid Fuels** | 0.03 | 0.07 | 0.15 | 0.09 |
| **2. Oil and Natural Gas** | 0.59 | 0.19 | 0.46 | 8.02 |
| **2. Industrial Processes** | 2.48 | 29.55 | 2.15 | 1.53 |
| **3. Solvent and Other Product Use** | NA, NE | NA, NE | 75.38 | NA, NE |
| **4. Agriculture** | NA,NO | NA,NO | NA,NE,NO | NA |
| **5. Land Use, Land-Use Change and Forestry** | 0.65 | 22.96 | NA,NE,NO | NA,NE |
| **6. Waste** | 0.12 | 0.02 | 0.04 | 0.01 |

## 2.5 Description and interpretation of emission trends for KP-LULUCF inventory

Sinks from Forest Management dominate the emissions and removals estimates of the KP LULUCF activities (see Tab. 2-5). They were positively affected by the absence of disturbances requiring sanitary logging, which significantly reduced sinks in 2007 and partly also in 2008.

**Tab. 2-5 Summary of GHG emissions and removals for KP LULUCF activities [Gg $CO_2$ eq.]**

| Year | Article 3.3 activities | | Article 3.4 activities | | | |
|---|---|---|---|---|---|---|
| | Afforestration and Reforestration | Deforestation | Forest Management* | Cropland Management | Grazing Land Management | Revegetation |
| **2008** | -271.99 | 160.20 | -4 403.99 | NA | NA | NA |
| **2009** | -294.68 | 170.19 | -6 441.15 | NA | NA | NA |
| **2010** | -322.26 | 206.87 | -5 096.22 | NA | NA | NA |
| **2011** | -356.88 | 163.70 | -7 568.71 | NA | NA | NA |

*) Net emissions or removals / accounting quantity

# 3 Energy (CRF Sector 1)

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 *1A Fuel Combustion* and *1B Fugitive Emissions from Fuels*.

Activity data are based on the energy balance of the Czech Republic prepared by the *Czech Statistical Office*. 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. $CO_2$ emissions from mobile sources are calculated from the emission factors, while data on $CH_4$ and $N_2O$ emissions are calculated using the special model developed by Transport research centre (CDV).

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.

Inventories of $CO_2$, $CH_4$ and $N_2O$ emissions are performed using a different procedure in subsector 1A3 Transport and in the other subsectors: combustion of fuels in stationary sources (1A1, 1A2, 1A4) and other mobile sources (1A5). The CDV model is used for mobile sources in subsector 1A3 Transport. A calculation procedure based on the activity data and on the country-specific or default emission factors are used for the other subsectors. Another procedure is used for category 1A1a – Other Fuels, which contains Waste Incineration for energy purposes.

Fugitive emissions in sector 1B are determined by calculation from activity data and country-specific or default emission factors. The activity data are obtained from the sector statistics and annual targeted surveys.

## 3.1 Overview of sector 1A

Combustion processes included in category 1A make a decisive contribution to total emissions of greenhouse gases. Almost all emissions of carbon dioxide, with the exception of decomposition of carbonate materials, occurring, e.g., in cement production, are derived from the combustion of fossil fuels in stationary and mobile sources. Consequently, the greatest attention is paid in the IPCC Guidelines (IPCC, 1997) to inventories of emissions from these categories.

On the whole, 9 key sources have been identified in sector 1A, the most important of which are the first 3 given in Tab. 3-1. This group of sources contributes 72.3 % to total greenhouse gas emissions (without LULUCF).

It is apparent from the table that the first three 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 1A were appropriately completed for the entire required time interval of 1990 to 2011.

**Tab. 3-1 Overview of key categories in Sector 1A (2011)**

| Category | | Character of category | Gas | % of total GHG* |
|---|---|---|---|---|
| 1A | Stationary Combustion - Solid Fuels | KC (LA, TA, LA*, TA*) | $CO_2$ | 48.8 |
| 1A3b | Transport - Road Transportation | KC (LA, TA, LA*, TA*) | $CO_2$ | 12.1 |
| 1A | Stationary Combustion – Gaseous Fuels | KC (LA, TA, LA*, TA*) | $CO_2$ | 11.4 |
| 1A | Stationary Combustion - Liquid Fuels | KC (LA, TA, LA*, TA*) | $CO_2$ | 3.7 |
| 1A5b | Mobile sources in Agriculture and Forestry and Other | KC (LA, LA*) | $CO_2$ | 0.8 |
| 1A3b | Transport - Road Transportation | KC (LA, TA, TA*) | $N_2O$ | 0.5 |
| 1A | Stationary Combustion – Other Fuels (1A2) | KC (TA, TA*) | $CO_2$ | 0.3 |
| 1A | Stationary Combustion - Biomas | KC (TA, TA*) | $CH_4$ | 0.3 |
| 1A | Stationary Combustion – Solid Fuels | KC (TA, TA*) | $CH_4$ | 0.1 |

** 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 CzSO Questionnaires (IEA/OECD, Eurostat, UN Questionnaires) represent the official reports of the Czech Republic, for international purposes, on the consumption of the individual kinds of fuel. They consist in a set of data on Liquid, Solid and Gaseous Fuels in independent datasets. They contain source and consumption parts of the energy balance in a structure that permits processing of activity data in the CRF structure. The use of these reports is advantageous especially because they provide a very similar data structure to CRF. The transition from the final CzSO balance to the use of these reports does not affect the consistency of the time series, as the same data are involved. Each year a number of meetings were held with CzSO, where current problematic issues were resolved. These meetings were just on at the KONEKO - CzSO level, but they contributed positively to the preparation of this submission.

The overall energy balance for 2011 is given in Annex 4 in Tables A4-5 – A4-12.

The fact that only CzSO data were employed constitutes a substantial improvement in the methodology of processing activity data. The data of other institutions and organizations are used for control. These consisted in documents of the Ministry of Industry and Trade (MIT), the Czech Association of the Petroleum Industry (CAPPO), Czech Gas Association (CGA) and other organizations.

Since 2003, the balance of fuel consumption has been supplemented by consumption of Other Fuels and the corresponding greenhouse gas emissions. As this consists exclusively of consumption in cement-plant furnaces, this consumption and emissions were included in category 1A2f.

### *Emissions Trends*

$CO_2$ emissions from the 1A sector decreased by 28.8 % from 146 Tg $CO_2$ in 1990 to 104 Tg $CO_2$ in 2011. Fig. 3-1 indicates overall trend in $CO_2$ emissions in the whole time series.

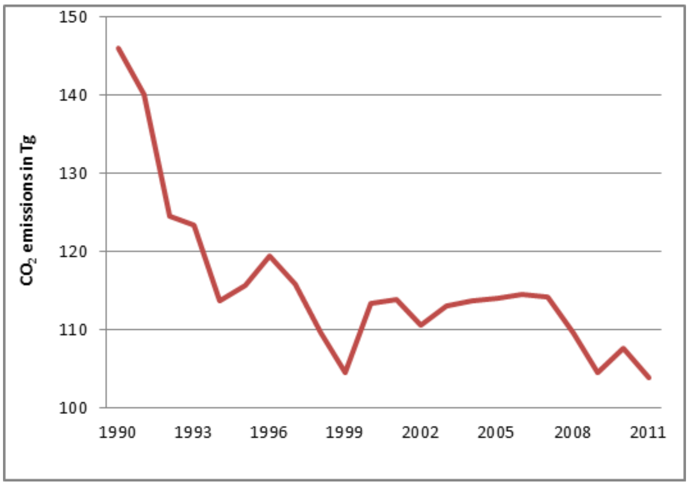



**Fig. 3-1 Trend total $CO_2$ (Sectoral Approach) in period 1990 – 2011**

**Tab. 3-2 Emissions of greenhouse gases and their trend from 1990 – 2011 from IPCC Category 1A Energy**

| | **$CO_2$ [Gg]** | **$CH_4$ [Gg]** | **$N_2O$ [Gg]** |
|---|---|---|---|
| **1990** | 146 022 | 474 | 2.368 |
| **1991** | 140 118 | 410 | 2.251 |
| **1992** | 124 504 | 389 | 2.111 |
| **1993** | 123 412 | 371 | 2.128 |
| **1994** | 113 731 | 349 | 2.088 |
| **1995** | 115 710 | 344 | 2.306 |
| **1996** | 119 474 | 339 | 2.433 |
| **1997** | 115 862 | 332 | 2.467 |
| **1998** | 109 601 | 319 | 2.518 |
| **1999** | 104 525 | 288 | 2.552 |
| **2000** | 113 364 | 256 | 2.766 |
| **2001** | 113 941 | 241 | 2.917 |
| **2002** | 110 672 | 221 | 3.059 |
| **2003** | 113 134 | 218 | 3.376 |
| **2004** | 113 654 | 210 | 3.570 |
| **2005** | 114 119 | 229 | 3.709 |
| **2006** | 114 510 | 242 | 3.768 |
| **2007** | 114 182 | 225 | 3.912 |
| **2008** | 109 584 | 224 | 3.815 |
| **2009** | 104 574 | 211 | 3.733 |
| **2010** | 107 603 | 218 | 3.685 |
| **2011** | 103 873 | 215 | 3.662 |
| **Trend 1990/2011** | **-29 %** | **-55%** | **55%** |

### *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 2011.

The greatest increase in emissions was recorded in subsector 1A3 Transport between 1990 and 2007, when emissions increased by 145%. In absolute values, this corresponded to an increase from 7.5 Tg $CO_2$ in 1990 to 18.5 Tg in 2007. A slight decrease has been apparent since 2008, by 1.9 Tg in 2011. Emissions from subsector 1A1 Energy Industries are almost constant with slight fluctuations over the entire period; the greatest reduction occurred in subsectors 1A2 and 1A4 from 46.5 and 32.2 Tg $CO_2$ in 1990 to 17.8 and 10 Tg $CO_2$ in 2011, respectively.

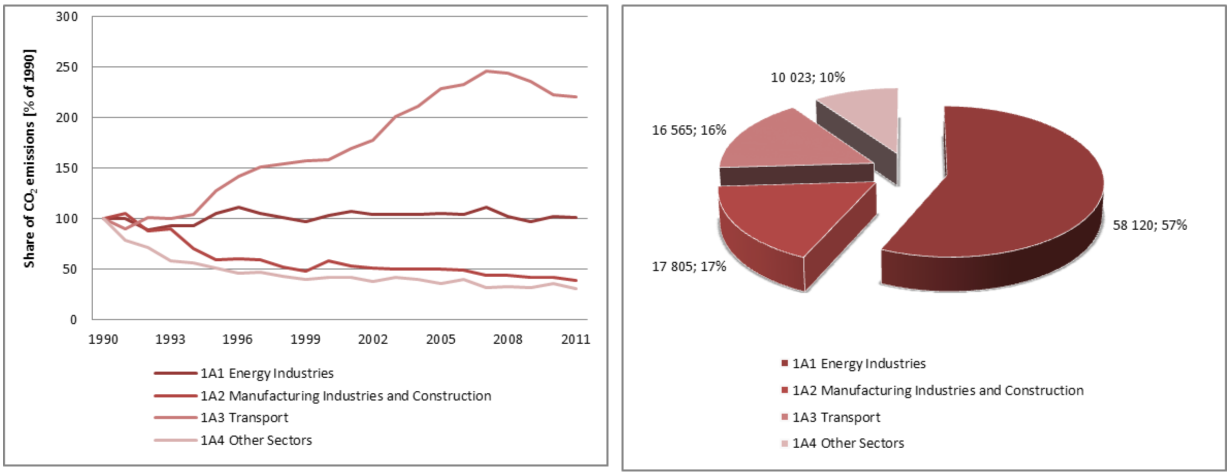



**Fig. 3-2 Share and development of $CO_2$ emissions from 1990 - 2011 in individual sub-sectors; share of $CO_2$ emissions in individual subsectors in 2011 [Gg]**

**Tab. 3-3 Total GHG emissions in [Gg $CO_2$ equivalent] from 1990 – 2011 by sub categories of Energy**

| | 1 | 1A | 1A1 | 1A2 | 1A3 | 1A4 | 1A5 | 1B | 1B1 | 1B2 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1990** | 156 717 | 147 758 | 57 967 | 46 754 | 7 708 | 33 702 | 1 628 | 8 958 | 8 057 | 902 |
| **1991** | 149 416 | 141 509 | 57 658 | 49 298 | 6 889 | 26 231 | 1 432 | 7 907 | 7 136 | 770 |
| **1992** | 133 330 | 125 801 | 51 517 | 41 217 | 7 754 | 23 971 | 1 342 | 7 529 | 6 819 | 710 |
| **1993** | 131 865 | 124 540 | 53 772 | 42 102 | 7 693 | 19 677 | 1 297 | 7 325 | 6 632 | 693 |
| **1994** | 121 715 | 114 750 | 53 955 | 32 703 | 8 061 | 18 725 | 1 306 | 6 964 | 6 285 | 679 |
| **1995** | 123 652 | 116 806 | 60 745 | 27 869 | 9 895 | 17 086 | 1 211 | 6 846 | 6 166 | 681 |
| **1996** | 127 351 | 120 632 | 64 713 | 28 107 | 11 021 | 15 632 | 1 159 | 6 719 | 5 982 | 737 |
| **1997** | 123 606 | 117 011 | 60 702 | 27 616 | 11 745 | 15 739 | 1 209 | 6 596 | 5 871 | 725 |
| **1998** | 117 072 | 110 661 | 58 358 | 24 509 | 12 000 | 14 504 | 1 290 | 6 410 | 5 648 | 762 |
| **1999** | 111 371 | 105 508 | 56 291 | 22 318 | 12 223 | 13 404 | 1 273 | 5 862 | 5 116 | 746 |
| **2000** | 119 603 | 114 437 | 59 570 | 27 285 | 12 364 | 13 955 | 1 262 | 5 166 | 4 457 | 709 |
| **2001** | 119 902 | 115 054 | 61 849 | 24 791 | 13 252 | 13 941 | 1 220 | 4 848 | 4 181 | 667 |
| **2002** | 116 255 | 111 745 | 60 230 | 23 955 | 13 878 | 12 515 | 1 166 | 4 510 | 3 818 | 693 |
| **2003** | 118 758 | 114 354 | 60 187 | 23 439 | 15 758 | 13 886 | 1 084 | 4 403 | 3 767 | 637 |
| **2004** | 119 163 | 114 952 | 60 219 | 23 591 | 16 570 | 13 440 | 1 132 | 4 210 | 3 618 | 592 |
| **2005** | 120 084 | 115 468 | 61 158 | 23 301 | 17 944 | 11 946 | 1 119 | 4 616 | 3 912 | 704 |
| **2006** | 120 768 | 115 942 | 60 612 | 22 697 | 18 280 | 13 254 | 1 098 | 4 826 | 4 111 | 715 |
| **2007** | 120 112 | 115 642 | 64 228 | 20 412 | 19 234 | 10 659 | 1 110 | 4 470 | 3 755 | 715 |
| **2008** | 115 471 | 110 998 | 59 061 | 20 620 | 19 072 | 11 086 | 1 159 | 4 473 | 3 818 | 655 |
| **2009** | 110 164 | 106 016 | 56 192 | 19 412 | 18 498 | 10 771 | 1 143 | 4 148 | 3 454 | 695 |
| **2010** | 113 328 | 109 073 | 58 905 | 19 438 | 17 424 | 12 198 | 1 108 | 4 255 | 3 529 | 726 |
| **2011** | 109 516 | 105 299 | 58 424 | 17 943 | 17 256 | 10 559 | 1 116 | 4 217 | 3 538 | 679 |
| **Trend 1990-2011** | **-30 %** | **-29 %** | **0.8%** | **-62 %** | **124 %** | **-69 %** | **-31 %** | **-53 %** | **-56 %** | **-25 %** |

Tab. 3-3 gives the trends in GHG emissions in $CO_2$ eq. in the individual subcategories of the Energy sector. It is apparent from the table that there was a considerable increase in the area of transport and a substantial reduction in the manufacturing industry and in households, as well as the areas of commercial and institutional and agriculture, forestry and fishing.

## 3.2 Fuel combustion (1A)

Combustion of fuels is in CRF divided into the individual subsectors prescribed by the IPCC methodology. The fuel consumption in the individual subsectors yields the activity data for subsequent calculation of greenhouse gas emissions. The fuel consumption is taken from the energy balance of the Czech Republic and is transformed to the IPCC structure. Transformation of data is described in chapter 3.3 under the descriptions of the individual subsectors. Consumption of the other kinds of fuels (Other fuels) was taken from the national ETS system (ETS, 2012, http://www.svcement.cz/).

According to IPCC methodology (IPCC, 1997), carbon dioxide emissions are calculated in two ways: Sectoral and Reference Approach.

### 3.2.1 Sectoral Approach

The **Sectoral Approach**. This method is considerably more demanding than Reference Approach in relation to input data and requires information on fuel consumption according to type of fuel in the individual consumer sectors. It has an advantage in the possibility of analyzing the structure of the origin of emissions. Since the emission factors employed are specific for each kind of fuel burned, calculations using this method should be more exact.

In Sectoral Approach are $CO_2$ emissions calculated in sectors

- 1A1 Energy industries
- 1A2 Manufacturing Industries and Construction
- 1A3e Other transportation (combustion of part of Natural Gas during its transport in compressors)
- 1A4 Other sectors – excl. mobile sources in the Agriculture/Forestry/Fishing sector
- 1A5 Other – other mobile sources not included elsewhere

In the Sectoral Approach, $CO_2$ emissions are derived from the consumption of the individual kinds of fuel in the individual subcategories using emission and oxidation factors.

### 3.2.2 Reference Approach

The Reference Approach is calculated on the basis of total domestic consumption of the individual fuels. This relatively simple method is based on the assumption that almost all the fuel consumed is burned in combustion processes in energy production. It does not require a large amount of input activity data and the basic values of the sources included in the national energy balance and some supplementary data are sufficient. It provides information only on total emissions without any further classification in the consumer sector. The emission factors are related to those kinds of fuel that enter domestic consumption at the level of sources, without regard to specific kinds of fuel burned in the consumer part of the energy balance. Thus, for Liquid Fuels, this means that the emissions are determined in fact only on the basis of domestic petroleum (Crude Oil) consumption.

### 3.2.3 Comparison of the Sectoral and Reference Approach

The resulting emissions are determined by the Sectoral Approach (SA), while the Reference Approach (RA) is used for control. Comparison of both approaches is given in the Annex 4. It follows from the analysis provided in Annex 4 that the differences in the overall results from these two approaches are insignificant.

### 3.2.4 International bunkers 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, 2012). Tab. 3-4 gives the amount of stored Kerosene Jet Fuel.

**Tab. 3-4 Kerosene Jet Fuel in international bunkers**

| **Year** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **[TJ/year]** | 7 197 | 5 919 | 6 856 | 5 706 | 7 112 | 7 664 | 5 789 | 6 676 | 7 880 | 7 417 | 8 091 |
| **Year** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| **[TJ/year]** | 8 599 | 7 424 | 9 983 | 12 835 | 13 338 | 13 833 | 14 512 | 15 361 | 14 046 | 13 155 | 12 990 |

### 3.2.5 Feedstocks and non-energy use of fuels

The energy balance of the Czech Republic encompasses a number of items that contain information on the consumption of fuel used as a raw material for production of other kinds of fuels. This corresponds mainly to petroleum, which is given in the source part of the energy balance; however, its entire volume undergoes transformation to other kinds of fuel, so that petroleum itself does not enter the fuel balance as activity data in CRF for the calculation of greenhouse gases.

In the energy balance structure, improvement of fuels is included in the Transformation Sector chapter. This chapter contains information on the amounts of fuel used for the production of electric energy and heat and simultaneously also for conversion (improvement) of the original fuels to other kinds (e.g. Coke, Briquettes, Coal Gases, etc.). Fuels from the Transformation Sector chapter employed for the production of electric energy and heat are transferred directly to the CRF structure as activity data to sector 1A1 – Energy Industry. Fuels and other items in the Transformation Sector chapter has to be seen as raw materials for production of the derived fuels and this amount from the energy balance does not enter the CRF structure as activity data, since no greenhouse gases are emitted from them in this stage.

The classification in the energy balance in the Transformation sector is dependent on the kind of fuel.

Tab. 3-5 provides those items of the Transformation sector that correspond to raw material inputs into the improvement processes.

**Tab. 3-5 Transformation sector for Solid and Liquid Fuels**

| Solid Fuels | Liquid Fuels |
|---|---|
| Transformation Sector | Transformation Sector |
| Patent Fuel Plants (Transformation) | Gas Works (Transformation) |
| Coke Ovens (Transformation) | For Blended Natural Gas |
| BKB Plants (Transformation) | Coke Ovens (Transformation) |
| Gas Works (Transformation) | Blast Furnaces (Transformation) |
| Blast Furnaces (Transformation) | Patent Fuel Plants (Transformation) |
| Coal Liquefaction Plants (Transformation) | Non-specified (Transformation) |

Natural Gas is not currently used as a raw material in the Czech Republic. Things were different at the beginning of the 1990's, when Natural Gas was used as a raw material in the production of Coal Gas.

Biofuels are not used in transformation processes.

The decomposition of Petroleum also leads to a number of products that are not used for energy purpose. This corresponds to the production of plastics, Lubrication Oils and other Lubricants, solvents for production of coatings and other uses in the Solvent Use sector, production of Bitumen, etc.

Part of these material fluxes becomes waste, while part is used up irreversibly and this carbon must be considered to be stored permanently.

**Naphtha** - another part of fossil carbon is used as raw material for the manufacture of plastics. Plastics end up in waste incineration plants or in landfills. In incineration plants, the carbon in the plastics is converted to $CO_2$. In managed landfills, plastics very slowly decompose through biochemical processes. For detailed explanations please see relevant chapter for Other Fuels (1A1a).

However, part of plastics stores carbon from petrochemical raw materials for a long time. At the beginning of the monitored period, the fraction of carbon stored for naphtha was estimated at 50 %. This value was obtained by expert estimate of a sectoral expert.

The remaining 50 % of carbon was considered to oxidize to $CO_2$. Recently, plastics have been increasingly recycled. The recycled material obtained is used to manufacture products with considerably long lifetimes. In 2004 was decided to increase the fraction of carbon stored 50 % to the value given in IPCC methodology (IPCC, 1997). The fraction of stored carbon has been gradually increased from a value of 50 % to a value of 80 %. The value of 80 % is default level of carbon stored provided by Revised 1996 Guidelines (IPCC, 1997). Tab. 3-6 depicts the gradual increase.

**Tab. 3-6 Naphtha - fraction of stored carbon**

| 1990 - 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|
| 0.5 | 0.6 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |

Starting in 2007, a constant value of 80 % is used in subsequent years.

**Lubricating oils** and other lubricants are not produced primarily as energy production materials. However, part of the oils is returned to the energy system after the end of their lifetimes as lubricants. They are then converted to alternative fuels and burned. The CRF structure specifies 50 % recovery as fuels over the entire time series from 1990. Value of 50% is given in Revised 1996 methodology (IPCC, 1997).

**Asphalt (Bitumen)** is a product of petroleum processing. As it is used primarily for treating the surfaces of roadways, its entire volume must be considered to be permanently stored carbon that is 100% fixed over the entire time series.

**Coal Tars** are utilized primarily as a raw material for the production of soot as the filler for rubber for production of tires. Part of the Tars is used as additive fuel in energy-production installations for production of electricity and heat. This part has been reported separately in the energy balance since 2003. This permits estimation of the ratio between Tar for energy-production and other uses. Up until 2002, the fraction of Tars for non-energy use was estimated at 75%; since 2003, the fraction has been determined on the basis of information from the CzSO – EUROSTAT – IEA questionnaires (CzSO, 2012) in the following way:

**Tab. 3-7 Coal Tars - fraction of stored carbon [%]**

| 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|
| 71.8 | 74.1 | 69.2 | 85.7 | 85.2 | 82.9 | 74.2 | 73.0 | 73.5 |

*These values were used to complete CRF in the 1AD Feedstocks and non-energy use of fuels chapter.*

### 3.2.6 $CO_2$ capture from flue gases and subsequent $CO_2$ storage

Not performed in the Czech Republic.

### 3.2.7 Country-specific issues

The country-specific conditions in the Czech Republic are determined primarily by the specific properties of the Solid Fuels mined in this country. Specific $CO_2$ emission factors are determined for these kinds of Solid Fuels. Tab. 3-8 provides emission factors, incl. NCV and oxidation factors.

**Tab. 3-8 Average Net caloricic values (NCV), $CO_2$ emission factors and oxidation factors used in the Czech GHG inventory - 2011**

| Fuel (Revised 1996 Guidelines definitions) | NCV | $CO_2$ EF [a)] | Oxidation | $CO_2$ EF [b)] |
|---|---|---|---|---|
| | [TJ/Gg] | [t $CO_2$/TJ] | factor | [t $CO_2$/TJ] |
| **Coking Coal** | 29.2 | 93.24 | 0.98 | 91.38 |
| **Other Bituminous Coal** | 22.7 | 93.24 | 0.98 | 91.38 |
| **Lignite (Brown Coal)** | 12.2 | 99.99 | 0.98 | 97.99 |

*a) Emission factor without oxidation factor*
*b) Resulting emission factor with oxidation factor*

In this submission, the country-specific $CO_2$ emission factor is also used for Natural Gas combustion. Detailed description of the research is given in Annex 2. Tab. A2- 2 lists the emission factors used in the entire time series. Evaluation of the emission factors depends on the net calorific value; in 2011 the net calorific value equalled 34.34 MJ/$m^3$ and the emission factor is then equal to 15.06. Please see the relevant equation in Annex 2.

Other country-specific conditions are employed in sector 1B, where the country-specific emission factors are used in the calculation of $CH_4$ and $CO_2$ emissions from underground mining. In addition, methane emissions in the Natural Gas sector are calculated according to the country-specific approach.

More details are given in chapter 3.9 Fugitive emissions.

All $CO_2$ emissions from metallurgical coke used in blast furnaces are reported under the Industrial processes sector and estimated according to the amount of carbon in the coke (see Chapter 4.4). Most of the blast furnace gas is combusted in the three metallurgical plants and is not used elsewhere. From this reason we consider this method to be right.

In a similar way part of Liquid Fuels are reallocated into 2 Industrial Processes where it is used for production of hydrogen which is used for ammonia production (see Chapter 4.3).

## 3.3 Source category description

### 3.3.1 Energy Industries (1A1)

The fraction of $CO_2$ emissions from sector 1A1 equalled 56% in 2011 in the whole Energy sector.

#### *3.3.1.1 Public Electricity and Heat Production (1A1a)*

Under source category 1A1a the energy balance includes district heating stations and electricity and heat production of public power stations.

This category encompasses all 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 the ČEZ Inc. company, 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.

The fraction of $CO_2$ emissions in subsector 1A1a in $CO_2$ emissions in sector 1A1 equalled 92 % in 2011. It contributed 52 % to $CO_2$ emissions in the whole Energy sector.

In the final energy balance of CzSO (CzSO, 2012), the consumption of the individual kinds of fuels in this sector is reported in section 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 the 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)

Fig. 3-3 presents an overview of development of $CO_2$ emissions in source category 1A1a:

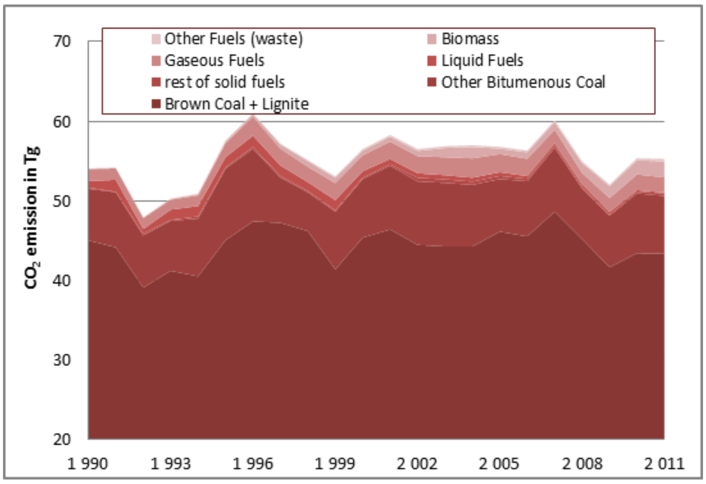



**Fig. 3-3 Development of $CO_2$ emissions in 1A1a category**

$CO_2$ emissions indicate stable trend with only a few oscillations in 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 forces for emissions in this source category. Brown Coal + Lignite are most important, with average consumption of 452 PJ, corresponding to 44 353 kt $CO_2$/year on an average for the whole 1990 – 2011 period. The second largest consumption is indicated for Other Bituminous Coal with an average consumption value of 78 PJ, corresponding to 7 173 kt $CO_2$/year on an average for the whole 1990 – 2011 period. The remaining Solid Fuels do not correspond to any significant consumption in this category.

Since 2007, the country-specific emission factor has been equal to 27.27 t C/TJ for Brown Coal + Lignite; 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. 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 III.

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. Since this submission new country-specific emission factor is used for $CO_2$ emissions. Detailed explanation of development of this EF is given in Annex 2.

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

***Other Fuels (1A1a): 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 6 C waste incineration however based on the suggestion of ERT in 2011 it was reallocated under the energy sector since last submission. This chapter is still prepared by CUEC (Charles University Environment Center) – the organization responsible for the waste sector.

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 significantly. It is due to fact that incinerator in Brno was recently reconstructed and its former annual capacity of 240 Gg of MSW was decreased to 224 Gg of MSW. In reality the new technology actually allowed the facility to be used to the full potential (the old stokers were regularly out of order and the real former capacity of the plant was about one third of the maximum value).

**Tab. 3-9 Capacity of municipal waste incineration plants in the Czech Republic, 2011**

| Incinerator (city) | Capacity (Gg) |
|---|---|
| **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 Gg of waste. This waste is reported under 6C.*

All the parameters and calculations are shown in Tab. 3-10.

The table gives the total amount of incinerated waste, energy content of the waste and all the parameters used in the equation. The lower part of the table gives the results for separate gases. The activity data comes from two sources- ISOH (waste management information system) and the Ministry of Trade and Industry (MTI) - renewable energy statistics. MTI data are used as category data, ISOH data are used as control data for the QA/QC procedure. The data is also checked with the reporting of the incineration companies.

**Tab. 3-10 Parameters and emissions from waste incineration 1990 - 2011**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MSW incinerated (Gg MSW)** | 66 | 58 | 82 | 102 | 156 | 163 | 171 | 174 | 245 | 285 | 334 | 382 | 411 | 408 | 409 | 388 | 392 | 392 | 376 | 360 | 467 | 586 |
| **MSW incinerated (TJ NCV)** | 656 | 577 | 822 | 1018 | 1564 | 1631 | 1710 | 1741 | 2332 | 2686 | 3190 | 3701 | 3987 | 3749 | 4231 | 3957 | 3779 | 4157 | 4052 | 3744 | 4900 | 5574 |
| **Waste heating value (GJ/t)** | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 9.5 | 9.4 | 9.6 | 9.7 | 9.7 | 9.2 | 10.3 | 10.2 | 9.6 | 10.6 | 10.8 | 10.4 | 10.5 | 9.5 |
| **Biogenic (TJ)** | 393 | 346 | 493 | 611 | 939 | 979 | 1026 | 1045 | 1399 | 1612 | 1914 | 2221 | 2392 | 2250 | 2539 | 2374 | 2268 | 2494 | 2431 | 2247 | 2940 | 3345 |
| **Fossil (TJ)** | 262 | 231 | 329 | 407 | 626 | 652 | 684 | 697 | 933 | 1074 | 1276 | 1480 | 1595 | 1500 | 1692 | 1583 | 1512 | 1663 | 1621 | 1498 | 1960 | 2230 |
| | | | | | | | | | | | | | | | | | | | | | | |
| **Amount of carbon fraction** | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| **Fosil carbon fraction** | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| **Combust efficiency fraction** | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| **C-$CO_2$ ratio** | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 | 3.7 |
| **Avrg. Emission factor Gg $CH_4$/Gg** | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 | 2E-07 |
| **Avrg. Emission factor Gg $N_2O$/Gg** | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 |
| | | | | | | | | | | | | | | | | | | | | | | |
| **Total $CO_2$ emissions (Gg $CO_2$) Fossil** | 36.5 | 32.2 | 45.8 | 56.7 | 87.2 | 90.9 | 95.3 | 97.0 | 136.3 | 158.6 | 185.9 | 212.9 | 228.8 | 227.3 | 228.1 | 216.4 | 218.4 | 218.3 | 209.8 | 200.9 | 260.3 | 326.5 |
| **Total $CO_2$ emissions (Gg $CO_2$) Biogenic** | 54.8 | 48.2 | 68.7 | 85.1 | 130.8 | 136.4 | 143.0 | 145.6 | 204.4 | 238.0 | 278.9 | 319.4 | 343.2 | 340.9 | 342.2 | 324.6 | 327.7 | 327.4 | 314.7 | 301.3 | 390.4 | 489.7 |
| **Total $CH_4$ emissions (Gg $CH_4$) Fossil** | 5E-06 | 5E-06 | 7E-06 | 8E-06 | 1E-05 | 1E-05 | 1E-05 | 1E-05 | 2E-05 | 2E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 3E-05 | 4E-05 | 5E-05 |
| **Total $CH_4$ emissions (Gg $CH_4$) Biogenic** | 8E-06 | 7E-06 | 1E-05 | 1E-05 | 2E-05 | 2E-05 | 2E-05 | 2E-05 | 3E-05 | 3E-05 | 4E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 5E-05 | 4E-05 | 6E-05 | 7E-05 |
| **Total $N_2O$ emissions (Gg $N_2O$) Fossil** | 0.001 | 0.001 | 0.002 | 0.002 | 0.003 | 0.003 | 0.003 | 0.003 | 0.005 | 0.006 | 0.007 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 | 0.007 | 0.009 | 0.012 |
| **Total $N_2O$ emissions (Gg $N_2O$) Biogenic** | 0.002 | 0.002 | 0.002 | 0.003 | 0.005 | 0.005 | 0.005 | 0.005 | 0.007 | 0.009 | 0.010 | 0.011 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.011 | 0.011 | 0.014 | 0.018 |
| | | | | | | | | | | | | | | | | | | | | | | |
| **Total $CO_2$ emissions (Gg $CO_2$ eq)** | 36.5 | 32.2 | 45.8 | 56.7 | 87.2 | 90.9 | 95.3 | 97.0 | 136.3 | 158.6 | 185.9 | 212.9 | 228.8 | 227.3 | 228.1 | 216.4 | 218.4 | 218.3 | 209.8 | 200.9 | 260.3 | 326.5 |
| **Total $CH_4$ emissions (Gg $CO_2$ eq)** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total $N_2O$ emissions (Gg $CO_2$ eq)** | 1.0 | 0.9 | 1.3 | 1.6 | 2.4 | 2.5 | 2.7 | 2.7 | 3.8 | 4.4 | 5.2 | 5.9 | 6.4 | 6.3 | 6.3 | 6.0 | 6.1 | 6.1 | 5.8 | 5.6 | 7.2 | 9.1 |

### *3.3.1.2 Petroleum Refining (1A1b)*

This category includes all facilities that process raw petroleum imported into this country as their primary raw material. Domestic petroleum constitutes approximately 3.5 % of the total amount. 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 *1B2 Fugitive Emissions from Fuels - Oil.*

The fraction of $CO_2$ emissions in subsector 1A1b in $CO_2$ emissions in sector 1A1 equalled 2 % in 2011. It contributed 1 % to $CO_2$ emissions in the whole Energy sector.

In the CzSO Questionnaire (CzSO, 2012), 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

Greenhouse gas emissions in this subcategory are calculated using the default emission factors for Liquid Fuels and country- specific emission factor for Natural Gas – see Tab. 3-11- Tab. 3-13.

Fig. 3-4 shows an overview of emissions trends in source category 1A1b:

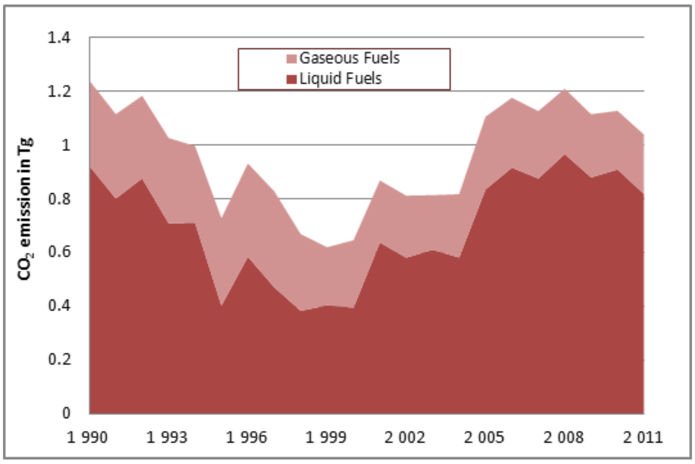



**Fig. 3-4 Development of $CO_2$ emissions in 1A1b category**

No consumption of Solid Fuels occurred in this category.

Liquid Fuels are of the greatest importance and exhibit a decreasing trend at the beginning and increasing trend at the end of the period. The fluctuations that have occurred over the years can be explained as resulting from differences in production quantities. The maximum production equal to 968 kt $CO_2$ occurred in 2008, followed by a value of 923 kt $CO_2$ in 1990. Thereafter, production decreased to the resulting level of 819 kt $CO_2$ in 2011.

The second greatest role is played by Natural Gas, with emissions in the range between 203 kt $CO_2$ in 2003 and 357 kt $CO_2$ in 1997 and resulting with 221 kt $CO_2$ in 2011.

### *3.3.1.3 Manufacture of Solid Fuels and Other Energy Industries (1A1c)*

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 interest in the Czech Republic.

The fraction of $CO_2$ emissions in subsector 1A1c in $CO_2$ emissions in sector 1A1 equalled 7 % in 2011. It contributed only 4 % to $CO_2$ emissions in the whole Energy sector.

In the CzSO Questionnaire (CzSO, 2012), 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)

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. 3-5 provides an overview of emission trends in source category 1A1c:

The figure clearly shows the increase in emissions in 1995 – 2011 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).

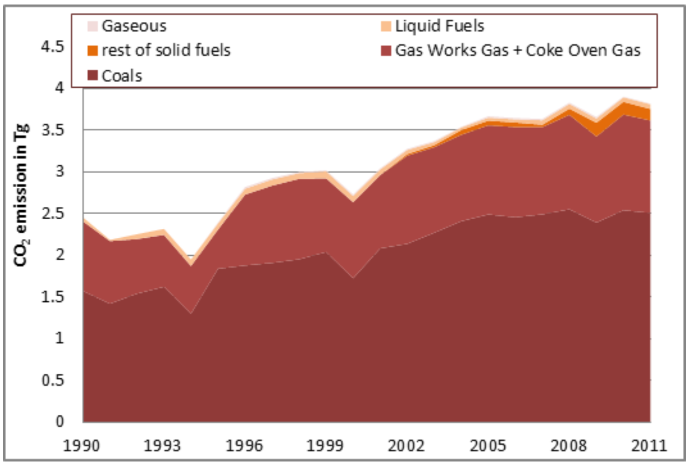



**Fig. 3-5 Development of $CO_2$ emissions in 1A1c category**

In this submission the reallocation of Lignite between 1A1c and 1A2 categories were performed. Detailed description please see in chapter 3.7.

Coke Oven Gas is produced in the Ostrava area where the Coke Plants operating.

### 3.3.2 Manufacturing Industries and Construction (1A2)

The fraction of $CO_2$ emissions in sector 1A2 in $CO_2$ emissions in the Energy sector equalled 17 % in 2011.

This source category consists of several sub-source categories defined in close harmony with the IPCC categorisations (CRF) and includes all stationary combustion emission sources that are not included in categories 1A1 and 1A4. It is described in detail via the relevant sub-chapters.

The consumption of Solid Fuels in this category is now affected by reallocation of Lignite between categories 1A1c and 1A2. For a detailed description see chapter 3.7.

Transition to the new format of source data (CzSO, 2012) permitted utilization of the data for more detailed classification in this subcategory.

- 1A2a Iron and steel
- 1A2b Non-ferrous metals
- 1A2c Chemicals
- 1A2d Pulp, paper and print
- 1A2e Food processing, beverages and tobacco
- 1A2f Other

Fig. 3-6 shows developments in $CO_2$ emission trends in source category 1A2:

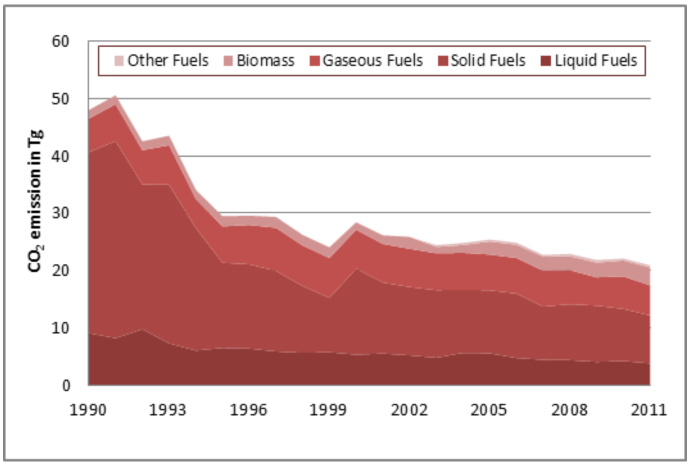



**Fig. 3-6 Development of $CO_2$ emissions in 1A2 category**

It is clearly visible on the figure that Solid Fuels played the main role in emissions at the beginning of the period; however, the importance of Solid Fuels decreased over time. Currently, they are still of the greatest importance, but do not play such a dominant role in comparison with other fuels. Liquid Fuels indicate steady trend over the whole period – there is only a slight decrease at the beginning of the period. Natural Gas is also an important fuel in category 1A2.

#### *3.3.2.1 Iron and Steel (1A2a)*

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, 2012), 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.

Important facility belongs to this category is ArcelorMittal Ostrava, a.s. The fraction of $CO_2$ emissions in subsector 1A2a in $CO_2$ emissions in sector 1A2 equalled 19 % in 2011. It contributed only 3 % to $CO_2$ emissions in the whole Energy sector.

#### *3.3.2.2 Non-Ferrous Metals (1A2b)*

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, 2012), 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 1A2b in $CO_2$ emissions in sector 1A2 equalled 0.6 % in 2011. It contributed only 0.1 % to $CO_2$ emissions in the whole Energy sector.

#### 3.3.2.3 Chemicals (1A2c)

This subcategory includes all the processes in the organic and inorganic chemical industry and all related processes, incl. petrochemistry.

In the CzSO Questionnaire (CzSO, 2012), 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 1A2c in $CO_2$ emissions in sector 1A2 equalled 38 % in 2011. It contributed 7 % to $CO_2$ emissions in the whole Energy sector.

#### 3.3.2.4 Pulp, Paper and Print (1A2d)

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 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, 2012), 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 1A2d in $CO_2$ emissions in sector 1A2 equalled 4 % in 2011. It contributed 0.7 % to $CO_2$ emissions in the whole Energy sector.

#### 3.3.2.5 Food Processing, Beverages and Tobacco (1A2e)

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.

In the CzSO Questionnaire (CzSO, 2012), 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 1A2e in $CO_2$ emissions in sector 1A2 equalled 6 % in 2011. It contributed 1 % to $CO_2$ emissions in the whole Energy sector.

#### *3.3.2.6 1A2f Other*

This subcategory includes the remaining enterprises in the processing industry not included in subcategories 1A2a to 1A2e. This is an energy-demanding branch with high fuel consumption, such as the cement industry, lime production, the glass industry, production of ceramic materials, 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, 2012), the consumption of the individual kinds of fuels in this sector is reported in the section Industry Sector under the item:

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

There are embodied the fuels of economic part according to NACE Rev. 2 Other: NACE Divisions 05 – 09, 13 – 16, 21 – 23, 25 – 33 and 41 – 43.

In this year's submission, this subcategory also includes the combustion of other kinds of fuel (Other Fuels). Activity data and data on $CO_2$ production were taken from the national ETS system (ETS, 2012), while $CH_4$ and $N_2O$ emissions were calculated using the default emission factors for Solid and Liquid Fuels. The fraction of $CO_2$ emissions in subsector 1A2f in $CO_2$ emissions in sector 1A2 equalled 32 % in 2011. It contributed 6 % to $CO_2$ emissions in the whole ENERGY sector. Overall emissions indicate decrease since 1990. Solid Fuels had at the beginnig of the period major importance, which constantly decrease untill 2011. Liquid fuels also constatnly descrease since 1990. Natural Gas has also apparent importance in this category.

### 3.3.3 1A3 Mobile Combustion

***Source category description***

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:

#### *3.3.3.1 1A3a Civil Aviation*

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

#### *3.3.3.2 1A3b Road Transportation*

- motorcycles,
- passenger and light duty gasoline vehicles conventional,
- passenger and light duty gasoline vehicles with EURO 1 limits,
- passenger and light duty gasoline vehicles with EURO 2 limits,
- passenger and light duty gasoline vehicles with EURO 3 limits,
- passenger and light duty gasoline vehicles with EURO 4 limits,
- passenger and light duty diesel vehicles conventional,
- passenger and light duty diesel vehicles with EURO 1 limits,
- passenger and light duty diesel vehicles with EURO 2 limits,
- passenger and light duty diesel vehicles with EURO 3 limits,
- passenger and light duty diesel vehicles with EURO 4 limits,
- passenger cars using LPG, CNG and biofuels (separately),
- heavy duty diesel vehicles and buses, conventional,
- heavy duty diesel vehicles and buses, with EURO 1 limits,
- heavy duty diesel vehicles and buses, with EURO 2 limits,
- heavy duty diesel vehicles and buses, with EURO 3 limits,
- heavy duty diesel vehicles and buses with EURO 4 limits,
- heavy duty diesel vehicles and buses using LPG, CNG and biofuels (separately).

#### *3.3.3.3 1A3c Railways*

- diesel locomotives

#### *3.3.3.4 1A3d Navigation*

- ships with diesel engines

#### *3.3.3.5 1A3e Other Transportation*

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, 2012) 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.

### 3.3.4 1A4 Other Sectors

This category includes all the combustion processes in the sub categories described below. They can be generally defined as heat production processes for internal consumption.

The fraction of $CO_2$ emissions in sector 1A4 in $CO_2$ emissions in the Energy sector equalled 10 % in 2011.

Fig. 3-7 depicts $CO_2$ emission trends in category 1A4:

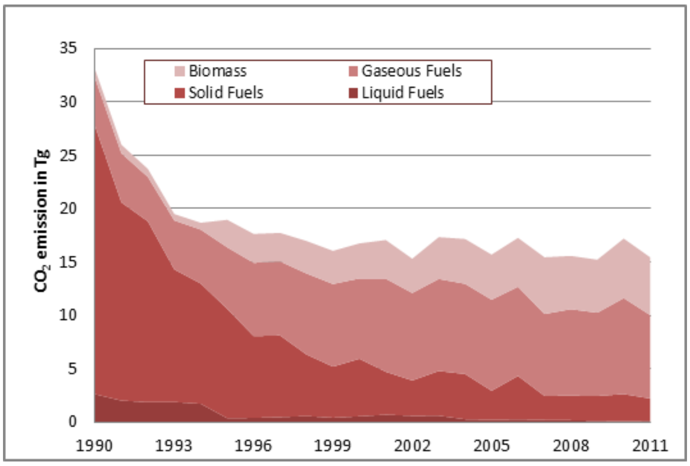



**Fig. 3-7 Development of $CO_2$ emissions in 1A4 category**

The main driving force for $CO_2$ emissions in category 1A4 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, which constantly decreases in time, is apparent in the figure. 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.

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 is beginning to be used more than Solid Fuels. The same trend appears in the institutional sphere. The number of households and institutions using biomass for heating (biomass boilers) in the Czech Republic has increased in the last few years. This trend is also apparent in the figure.

The winter of 2006 was colder than in other years, which also affected the consumption of fuels. Higher consumption of fuels for heating in households and institutions is apparent in this year. Significantly lower temperatures were recorded in the winter months in 2006 than in other years. The same trend is apparent in 2011.

#### *3.3.4.1 1A4a Commercial/Institutional*

This 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, 2012), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Commercial and Public Services

Where fuel consumption is reported here under the item:

- Non-specified (Other)

It is included under 1A4a 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 1A1a and 1A3e, 36 – 39, 45 – 99 excluding 1A3e and 1A5a.

The fraction of $CO_2$ emissions in subsector 1A4a in $CO_2$ emissions in sector 1A4 equalled 33 % in 2011. It contributed 3 % to $CO_2$ emissions in the whole Energy sector.

#### *3.3.4.2 1A4b Residential*

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, 2012), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Residential

The fraction of $CO_2$ emissions in subsector 1A4b in $CO_2$ emissions in sector 1A4 equalled 65 % in 2011. It contributed 6 % to $CO_2$ emissions in the whole Energy sector.

Since this submission are also emissions from charcoal use accounted. Detailed description is given in chapter 3.7.

#### *3.3.4.3 1A4c Agriculture/Forestry/Fisheries*

This subcategory contains combustion sources at stationary facilities for heating buildings, breeding and other operational facilities. The subcategory does not include fuel consumption for powering off-road means of transport and machinery. They are reported in category 1A5b Mobile - Agriculture, Forestry and Fishing.

In the CzSO Questionnaire (CzSO, 2012), the consumption of the individual kinds of fuels in this sector is reported in capture Industry Sector under the item:

- Agriculture/Forestry
- Fishing

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 1A4c in $CO_2$ emissions in sector 1A4 equalled 2 % in 2011. It contributed 0.2 % to $CO_2$ emissions in the whole Energy sector.

### 3.3.5 1A5 Other

The fraction of $CO_2$ emissions in sector 1A5 in $CO_2$ emissions in the Energy sector equalled 1 % in 2011.

#### *3.3.5.1 1A5b Other – mobile sources*

For reporting consumption of motor fuels, that was not report in sector 1A3 Transport and could not be reported in the other sectors as consumption of fuels in stationary sources is in CRF used this subcategory.

## 3.4 Methodological issues

### 3.4.1 Stationary combustion

The original data on the final national energy balance from CzSO (series of data in the 1990 – 1995 time series) were taken for the CRF structure directly in TJ. The time series from 1995 was constructed on the basis of data from the CzSO Questionnaire (CzSO, 2012), where the data on fuel consumption are given 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 (2011) is given in Annex 4, Tables A4-5 – A4-12.

Since 2012 submission net calorific values for Liquid Fuels for the whole time series are available. These are now assumed to be right (agreed by CzSO) and therefore used for conversion of activity data from natural units to energy units.

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 storage.

***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 A4-5 – A4-12; 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.

***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.

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.

The working files shall also contain a compulsory “Activity Data” Sheet. The Activity Data Sheet shall contain:

- complete division of the data into IPCC (SA) sectors and subsectors or individual fuels
- RA, in structure compatible with CRF
- complete time series
- the units in which the activity data balance is drawn up.

The conversion shall be performed in two separate sets for the Sectoral Approach (SA) and Reference Approach (RA). If the data conversion requires recalculation from natural units to energy units (i.e. for Solid and Liquid Fuels), the calorific values of the individual kinds of fuels used is included in the calculation. Used calorific values are stored.

### *Calculations of emissions*

These values are given in the following sheets of the working files, which also contain the “Emission Factors” sheet, the “Oxidation Factors” sheet and calculation sheets for the individual GHG gases. The necessary aggregations for transfer of the data to the CRF reporter are included.

Original activity data are given in kilotons. It means that it is necessary to convert these values to energy units – terajoules. For this conversion are used calorific values. Tab. 3-11 gives the calorific values used for calculations of the 2011 emissions.

**Tab. 3-11 Net caloricic values used in the Czech GHG inventory – 2011**

| NCV [TJ/Gg] | 1A1a | 1A1b | 1A1c | 1A2 | 1A4a | 1A4b | 1A4c | 1A5 |
|---|---|---|---|---|---|---|---|---|
| Refinery Gas | | 42.23 | | | | | | |
| LPG | | | | 43.81 | 43.81 | 43.81 | 43.81 | |
| Naphtha | | | | 43.97 | | | | |
| Gasoline | | | | | | 43.40 | | 43.40 |
| Kerosene Jet Fuel | | | | 43.30 | 43.30 | | | 43.30 |
| Other kerosene | | | | | 42.80 | | | |
| Diesel Oil | | | 42.59 | 42.59 | | | | 42.59 |
| Heating and Other Gasoil | | | 42.60 | 42.60 | 42.60 | | 42.60 | |
| Fuel Oil - Low Sulphur | 39.52 | 39.52 | | 39.52 | 39.52 | | 39.52 | |
| Fuel Oil - High Sulphur | 39.43 | 39.43 | | 39.43 | | | | |
| Lubricants | | | | 40.19 | | | | |
| Other Oil | | 40.19 | | 40.19 | | | | |
| Anthracite | | | | 29.81 | | | | |
| Coking Coal | | | | | | | | |
| Other Bituminous Coal | 22.72 | | | 24.28 | 28.47 | 28.47 | 28.47 | |
| Brown Coal + Lignite | 12.19 | | 12.20 | 12.20 | 11.08 | 11.08 | 11.08 | |
| Coke | 22.33 | | | 27.99 | 28.10 | | 28.10 | |
| Coal Tars | 37.00 | | 37.00 | 37.00 | | 37.00 | | |
| Brown Coal Briquettes | 0.00 | | | | | | | |
| Charcoal | | | | | | 30.00 | | |

Coke Oven Gas, Gas Works Gas and biofuels are given directly in terajoules in the CzSO Questionnaires (CzSO, 2012), 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, 2012) in thousand $m^3$ and in TJ; however, the data in TJ is determined using the gross caloric value. The values were then divided by a coefficient of 1.11 for recalculation from the gross caloric value to the net caloric value.

Information on the average values of the gross caloric value and the net caloric value of Natural Gas are given in Tab. 3-12.

Recalculation of volume units to mass units for Natural Gas was performed using the density 0.69 kg/$m^3$ (t = 15 °C, p = 101.3 kPa).

**Tab. 3-12 Average values of the gross caloric value and the net caloric value of Natural Gas – Questionnaire IEA – CzSO (CzSO, 2012), 2011**

| [MJ/$m^3$] | GCV | NCV | GCV/NCV |
|---|---|---|---|
| Indigenous Production | 38.64 | 34.77 | 1.11 |
| Associated Gas | 38.64 | 34.78 | 1.11 |
| Non-Associated Gas | 38.63 | 34.76 | 1.11 |
| Total Imports (Balance) | 38.14 | 34.33 | 1.11 |
| Total Exports (Balance) | 38.19 | 34.37 | 1.11 |
| Stock Changes (National Territory) | 38.16 | 34.35 | 1.11 |
| Inland Consumption (Calculated) | 38.15 | 34.34 | 1.11 |
| Inland Consumption (Observed) | 38.15 | 34.34 | 1.11 |
| Opening Stock Level (National Territory) | 38.30 | 34.47 | 1.11 |
| Closing Stock Level (National Territory) | 38.24 | 34.42 | 1.11 |

**Tab. 3-13 Net caloricic values (NCV), $CO_2$ emission factors and oxidation factors used in the Czech GHG inventory – 2011**

| Fuel (Revised 1996 Guidelines definitions) | NCV [TJ/Gg] | $CO_2$ EF [a] [t $CO_2$/TJ] | Oxidation factor | $CO_2$ EF [b] [t $CO_2$/TJ] |
|---|---|---|---|---|
| Crude Oil | 43.97 | 73.33 | 0.99 | 72.60 |
| Gas / Diesel Oil | 42.59 | 74.07 | 0.99 | 73.33 |
| Residual Fuel Oil | 39.47 | 77.37 | 0.99 | 76.59 |
| LPG | 43.81 | 63.07 | 0.995 | 62.75 |
| Naphtha | 43.97 | 73.33 | 0.99 | 72.60 |
| Bitumen | 40.19 | 80.67 | 0.99 | 79.86 |
| Lubricants | 40.19 | 73.33 | 0.99 | 72.60 |
| Petroleum Coke | 37.50 | 100.83 | 0.98 | 98.82 |
| Other Oil | 40.19 | 73.33 | 0.99 | 72.60 |
| Coking Coal [d] | 29.21 | 93.24 | 0.98 | 91.38 |
| Other Bituminous Coal [d] | 25.16 | 93.24 | 0.98 | 91.38 |
| Lignite (Brown Coal) [d] | 11.83 | 99.99 | 0.98 | 97.99 |
| Brown Coal Briquettes | 20.82 | 94.60 | 0.98 | 92.71 |
| Coke Oven Coke | 27.95 | 108.17 | 0.98 | 106.00 |
| Coke Oven Gas (TJ/mill. $m^3$) | 15.62 | 47.67 | 0.995 | 47.43 |
| Natural Gas (TJ/Gg) | 57.23 | 55.23 | 0.995 | 54.95 |
| Natural Gas (TJ/mill. $m^3$) | 34.34 | 55.23 | 0.995 | 54.95 |

*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*
*e) Oxidation factors values used for national inventory of greenhouse gases are 0.995 for Gaseous Fuels, 0.99 for Liquid Fuels and 0.98 for Solid Fuels*

The greenhouse gas emissions were calculated as the product of the activity data and the relevant emission factor. A survey of the emission factors employed for $CO_2$ is given in Tab. 3-13. The experimentally determined country-specific values of the emission factors were used for Coal and Lignite (Fott, 1999) and for Natural Gas (please see Annex 2); for the rest of fuels, the default emission factors from the IPCC methodology (IPCC, 1997) were used. Oxidation factors used in the national inventory are the default values taken from the IPCC methodology (IPCC, 1997).

Methane emissions from fuel combustion from stationary sources do not constitute key sources. Relatively the largest contribution comes from fuel combustion in local heating units.

The means of determining methane emissions is similar in many respects to the method of the individual consumption categories for carbon dioxide emissions. The simplest level (Tier 1) (IPCC, 1997) includes only summary fuel categories:

- coal-type Solid Fuels
- Gaseous Fuels
- Liquid Fuels
- wood fuel (biomass)
- other biomass.

Tab. 3-14 provides $CH_4$ emission factors used for computation of $CH_4$ emissions.

**Tab. 3-14 $CH_4$ emission factors in the individual sectors used in the Czech GHG inventory (1990 – 2011)**

| [kg $CH_4$/TJ] | 1A1 | 1A2*) | 1A3e | 1A4a | 1A4b | 1A4c |
|---|---|---|---|---|---|---|
| **Liquid Fuels** | 3 | 2 | | 10 | 10 | 10 |
| **Solid Fuels** | 1 | 10 | | 10 | 300 | 300 |
| **Gaseous Fuels** | 1 | 5 | 5 | 5 | 5 | 5 |
| **Biomass** | 30 | 30 | | 300 | 300 | 300 |
| **Charcoal** | 200 | 200 | | 200 | 200 | 200 |

**) The emission factors are also valid for the other kinds of fuels (Other Fuels).*

$N_2O$ emissions from stationary sources do not belong amongst key sources in the CR. Tab. 3-15 provides $N_2O$ emission factors (used uniformly for the entire sector of stationary combustion sources).

**Tab. 3-15 $N_2O$ emission factors in the individual sectors used in the Czech GHG inventory (1990 – 2011)**

| | |
|---|---|
| **Liquid Fuels** | 0.6 kg $N_2O$/TJ |
| **Solid Fuels** | 1.4 kg $N_2O$/TJ |
| **Gaseous Fuels** | 0.1 kg $N_2O$/TJ |
| **Biomass** | 4.0 kg $N_2O$/TJ |
| **Charcoal (1A4)** | 1.0 kg $N_2O$/TJ |

A considerable part of the non-energy consumption consists in non-energy consumption of petroleum (lubricating and special oils, asphalt and particular petrochemical raw materials used for the production of plastic materials, etc.). Non-energy products formed from Bituminous Coal in Coke plants and from Brown Coal in the production of coal gas (historical) and energy gas (fuel for the combined steam-gas cycle) are also important.

In this context, emphasis is placed on the correct determination of the fraction of stored (fixed) carbon in the non-energy use of fossil fuels. Calculation of its amount is based on the assumption that a certain amount of the carbon contained non-energy raw materials remains fixed in the long term and is not released as $CO_2$. In the energy balance CzSO (CzSO, 2012), this consists in:

- petrochemical raw materials (Naphtha) mainly used for the production of plastic materials
- lubricating oils (Lubricants)
- Coal Tars from coking of Bituminous Coal and from gasification of Brown Coal
- asphalt (Bitumen)

Part of the intermediate products from pyrolysis of petrochemical raw materials is used directly as heating gases and oils, part of the final products (plastic materials) are also burned after use in municipal waste incinerators, but part ends up in land-fills. Thus, a considerable part of the input carbon remains bonded for a longer time in plastic materials. As plastic materials are being increasingly recycled, the fraction of carbon stored in plastics has been gradually increased from 50 % to 80 % between 2003 and 2006 (in period 1990 - 2002 this fraction was considered constant, 50 %).

In addition, most lubricating and special oils are finally used as heating oils or are burned during their use (lubricating oils for combustion motors). Part of the oils is used for production of alternative fuels and part is burned in incinerators, but at least half remains permanently anchored in lubricants. Consequently, a fraction of stored carbon of 50 % is used in the balance.

Coal Tars have a similar fate and are also used for impregnation of roofing materials and for soot (additive in the production of rubber). Consequently, a value of stored carbon fraction of 75 % is used.

Practically one hundred percent fixation is assumed for asphalt.

Allocation of emissions from coke and oil between 1A2 and 2B, 2C is explained above (Chapter 3.2.7).

Data on the consumption of Other Fuels are used in the Czech greenhouse gas inventory. Information on the consumption of Other Fuels was taken from the national ETS database (ETS, 2012) and is related only to the use of these fuels in cement production. Data on consumption of Other Fuels (1A2f) were employed as provided by the Czech Cement Association (Czech Cement Association, 2012). The database contains detailed information on consumption of the individual kinds of alternative fuels, their calorific values and emission factors. The same data source was also employed for processing data for 2011 (Czech Cement Association, 2012). The default emission factors were employed for calculation of the $CH_4$ and $N_2O$ emissions according to the character of the relevant fuel.

**Tab. 3-16 Consumption and EF – Other Fuels in the cement industry (1A2f) in 2011**

| Kind of | Consumption | EF | | |
|---|---|---|---|---|
| Fuel | [TJ/year] | [t $CO_2$/TJ] | [kg $CH_4$/TJ] | [kg $N_2O$/TJ] |
| Solid | 3 884.9 | 84.07 | 10 | 1.4 |
| Liquid | 661.3 | 76.63 | 2 | 0.6 |

**Tab. 3-17 $CO_2$, $CH_4$ and $N_2O$ emissions from use of Other Fuels in the cement industry (1A2f) in 2011**

| Kind of | Emission [kt/year] | | |
|---|---|---|---|
| Fuel | $CO_2$ | $CH_4$ | $N_2O$ |
| Solid | 326.6 | 0.0388 | 0.00544 |
| Liquid | 50.7 | 0.0013 | 0.00040 |
| Total | 377.3 | 0.0402 | 0.00584 |

***Other Fuels (1A1a)***

This category follows Tier 1 methodology for emissions from waste incineration. Consistent with the Revised 1996 Guidelines (IPCC, 1997), only $CO_2$ emissions resulting from oxidation, during incineration and open burning of carbon in waste of fossil origin (e.g., plastics, certain textiles, rubber, liquid solvents, and waste oil) are considered in the net emissions and are included in the national $CO_2$ emissions estimate.

Estimation of $CO_2$ emissions from waste incineration is based on the Tier 1 approach (IPCC, 2000). It assumes that total fossil carbon dioxide emissions are dependent on the amount of carbon in waste, on the fraction of fossil carbon and on the combustion efficiency of the waste incineration. As no country-specific data were available for the necessary parameters, the default data for the calculation were taken from the Good Practice Guidance (IPCC, 2000). All parameters and calculations are shown in Tab. 3-10.

***1A3e Other Transportation***

Country specific $CO_2$ emission factor is used since this submission. For detailed information please see Annex 2.

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

### 3.4.2 1A3 - Mobile Combustion

***$CO_2$ 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 LPG, 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.

For the first time, emissions of carbon dioxide from transport recorded a decrease in 2008, starting a downward trend which continued until 2011 (Jedlicka et al., 2012). The reduction in carbon dioxide emissions was a result primarily 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 in fuel consumption is evaluated very favourably from viewpoint of greenhouse gases.

The fuel consumption decreased in 2011, continuing the downward trend from 2010. However, the persistent downward trend might no longer be a consequence of the economic crisis. This phenomenon could be caused by cross-boarder purchase of gasoline and especially diesel oil. The price of diesel oil in the Czech Republic is higher than in neighbouring countries. The increase in fuel prices is related to the excise tax laid down by the Czech legislation. 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 has fluctuated around 2 mil. tons since 2002, but from 2010 it started to decline significantly. It even reached a value 1684 tons in 2011. This decline is caused especially by a downward trend in the fuel consumption of 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 FAME as renewable resource in diesel oil reached a value 6 % in 2010; neither value will change in the coming years. These facts (reduction in consumption and increase in 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 of the army and the consumption of the domestic transport (estimated on the basis of the number of flights, distances between destinations and the specific consumption of fuels per the unit of distance in the LTO regime and the cruise itself) were subtracted from the total kerosene consumption. The remaining kerosene consumption is related to the international air transport.

Carbon dioxide emissions for the 2000 – 2006 time series were recalculated in 2008. The reasons for the recalculation and more detailed information are given in the chapter 10.

**Tab. 3-18 $CO_2$ emissions calculation from mobile sources in 1990 – 2011 [Gg $CO_2$]**

| | Aviation (without Bunkers) | Road Transportation | Railways | Navigation | Other Transport Pipeline transport | Other Mobile Agric. and others | Total |
|---|---|---|---|---|---|---|---|
| | 1A3a | 1A3b | 1A3c | 1A3d | 1A3e | 1A5b | 1A3 + 1A5 |
| 1990 | 145.9 | 6 239 | 651.5 | 56.4 | 435.2 | 1 601 | 9 188 |
| 1991 | 40 | 5 616 | 580.2 | 56 | 441.5 | 1 409 | 8 203 |
| 1992 | 40.7 | 6 494 | 492.4 | 54.6 | 482.0 | 1 321 | 8 950 |
| 1993 | 24.8 | 6 610 | 413.6 | 54.1 | 389.8 | 1 276 | 8 821 |
| 1994 | 22.9 | 7 147 | 333.4 | 53.3 | 275.2 | 1 285 | 9 154 |
| 1995 | 14 | 9 180 | 332.7 | 55 | 35.8 | 1 191 | 10 809 |
| 1996 | 15.9 | 10 227 | 328 | 45.8 | 87.0 | 1 141 | 11 847 |
| 1997 | 10.4 | 10 997 | 282.1 | 38.4 | 74.7 | 1 189 | 12 593 |
| 1998 | 10.2 | 11 167 | 354.6 | 37.7 | 57.8 | 1 264 | 12 892 |
| 1999 | 13.2 | 11 391 | 329.5 | 22 | 61.8 | 1 245 | 13 064 |
| 2000 | 11.3 | 11 521 | 326.4 | 15.7 | 57.6 | 1 235 | 13 168 |
| 2001 | 8.2 | 12 375 | 304.4 | 25.1 | 58.9 | 1 194 | 13 967 |
| 2002 | 11.1 | 12 966 | 295 | 12.6 | 61.1 | 1 140 | 14 487 |
| 2003 | 11.4 | 14 759 | 288.7 | 12.6 | 57.7 | 1 061 | 16 192 |
| 2004 | 12.3 | 15 520 | 285.6 | 18.8 | 55.6 | 1 107 | 17 000 |
| 2005 | 9.2 | 16 840 | 288.7 | 15.7 | 68.0 | 1 094 | 18 317 |
| 2006 | 9.8 | 17 146 | 301.2 | 18.8 | 72.9 | 1 074 | 18 624 |
| 2007 | 9.8 | 18 029 | 298.1 | 15.7 | 118.1 | 1 085 | 19 558 |
| 2008 | 8.6 | 17 826 | 329.5 | 12.6 | 145.0 | 1 133 | 19 457 |
| 2009 | 8 | 17 290 | 298.1 | 15.7 | 150.7 | 1 117 | 18 882 |
| 2010 | 9.1 | 16 268 | 288.7 | 12.6 | 150.4 | 1083 | 17 814 |
| 2011 | 4.8 | 16 124 | 282.4 | 9.4 | 144.4 | 1091 | 17 656 |

### *$CH_4$ 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 in Chapter 3.3.3 1A3 Mobile Combustion.

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 2005. 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 IV standard). The greatest problems are associated with the slow renewal of the freight transport fleet. There has been almost no 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).

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 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).

Emissions of $CH_4$ from mobile sources are given in Tab. 3-19.

**Tab. 3-19 $CH_4$ emissions calculation from mobile sources in 1990 – 2011 [Mg $CH_4$]**

| | Aviation (without Bunkers) | Road Transportation | Railways | Navigation | Other Transport Pipeline transport | Other Mobile Agric. and others | Total |
|---|---|---|---|---|---|---|---|
| | 1A3a | 1A3b | 1A3c | 1A3d | 1A3e | 1A5b | 1A3 + 1A5 |
| **1990** | 28.58 | 1 260 | 40.86 | 3.54 | 44.29 | 335.7 | 1 712.98 |
| **1991** | 7.8 | 1 098 | 36.39 | 3.51 | 44.92 | 291.9 | 1 482.55 |
| **1992** | 7.92 | 1 318 | 30.89 | 3.43 | 49.04 | 270.1 | 1 679.33 |
| **1993** | 4.79 | 1 336 | 25.95 | 3.39 | 39.65 | 262.0 | 1 671.79 |
| **1994** | 4.38 | 1 449 | 20.91 | 3.34 | 28.00 | 264.0 | 1 769.58 |
| **1995** | 2.71 | 1 638 | 20.87 | 3.45 | 3.27 | 242.8 | 1 911.08 |
| **1996** | 3.2 | 1 798 | 20.57 | 2.87 | 7.96 | 221.0 | 2 053.61 |
| **1997** | 1.92 | 1 883 | 17.69 | 2.41 | 6.83 | 191.0 | 2 102.86 |
| **1998** | 1.88 | 1 851 | 22.24 | 2.36 | 5.28 | 144.7 | 2 027.48 |
| **1999** | 2.48 | 1 839 | 20.67 | 1.38 | 5.65 | 98.6 | 1 967.75 |
| **2000** | 2.16 | 1 716 | 20.47 | 0.98 | 5.27 | 84.6 | 1 829.47 |
| **2001** | 1.55 | 1 739 | 19.9 | 1.57 | 5.38 | 82.0 | 1 849.37 |
| **2002** | 2.13 | 1 630 | 18.5 | 0.79 | 5.58 | 81.3 | 1 738.33 |
| **2003** | 2.18 | 1 681 | 18.11 | 0.79 | 5.27 | 74.1 | 1 781.43 |
| **2004** | 2.32 | 1 598 | 17.91 | 1.18 | 5.09 | 78.3 | 1 702.81 |
| **2005** | 1.72 | 1 610 | 18.11 | 0.98 | 6.22 | 77.9 | 1 714.94 |
| **2006** | 1.82 | 1 517 | 18.9 | 1.18 | 6.65 | 75.0 | 1 620.56 |
| **2007** | 1.82 | 1 517 | 18.7 | 0.98 | 10.77 | 78.3 | 1 627.53 |
| **2008** | 1.61 | 1 462 | 20.67 | 0.79 | 13.22 | 81.4 | 1 579.65 |
| **2009** | 1.52 | 1 393 | 18.7 | 0.98 | 13.72 | 81.2 | 1 509.10 |
| **2010** | 1.7 | 1 224 | 18.11 | 0.79 | 13.68 | 76.4 | 1 334.71 |
| **2011** | 0.89 | 1 168 | 17.71 | 0.59 | 13.14 | 76.4 | 1 276.75 |

### *$N_2O$ 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 2011, $N_2O$ emissions still continued to decrease, similar to carbon dioxide emissions.

Road transport was identified as a key source of $N_2O$ emissions over the past 4 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 big differences between national $N_2O$ measurement results and values recommended in IPCC methodology, the special verification including the statistical evaluation has been performed. The resulted values of $N_2O$ emission factors from mobile sources are approaching to 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, 1997) 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 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 years. These corrections brought the results closer to those obtained using IPPC emission factors than 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. 3-20.

**Tab. 3-20 $N_2O$ emissions calculation from mobile sources in 1990 – 2011 [Mg $N_2O$]**

| | Aviation (without Bunkers) | Road Transportation | Railways | Navigation | Other Transport Pipeline transport | Other Mobile Agric. and others | Total |
|---|---|---|---|---|---|---|---|
| | **1A3a** | **1A3b** | **1A3c** | **1A3d** | **1A3e** | **1A5b** | **1A3 + 1A5** |
| **1990** | 20.19 | 425 | 37.37 | 3.24 | 0.89 | 63.2 | 549.89 |
| **1991** | 5.53 | 377.5 | 33.28 | 3.21 | 0.90 | 55.0 | 475.45 |
| **1992** | 5.63 | 479.9 | 28.25 | 3.13 | 0.98 | 51.1 | 568.99 |
| **1993** | 3.43 | 522.9 | 23.73 | 3.1 | 0.79 | 50.0 | 603.96 |
| **1994** | 3.17 | 610.3 | 19.12 | 3.6 | 0.56 | 49.7 | 686.44 |
| **1995** | 1.93 | 759.1 | 19.9 | 3.16 | 0.07 | 46.3 | 830.49 |
| **1996** | 2.19 | 875.5 | 18.81 | 2.63 | 0.16 | 44.9 | 944.17 |
| **1997** | 1.44 | 954.4 | 16.18 | 2.2 | 0.14 | 53.7 | 1028.02 |
| **1998** | 1.41 | 1049.8 | 20.34 | 2.16 | 0.11 | 75.6 | 1149.38 |
| **1999** | 1.83 | 1161.9 | 18.9 | 1.26 | 0.11 | 81.0 | 1265.05 |
| **2000** | 1.56 | 1255.5 | 18.72 | 0.9 | 0.11 | 82.6 | 1359.41 |
| **2001** | 1.14 | 1408.5 | 17.46 | 1.44 | 0.11 | 80.0 | 1508.63 |
| **2002** | 1.53 | 1588.5 | 16.92 | 0.72 | 0.11 | 78.2 | 1685.93 |
| **2003** | 1.58 | 1893.1 | 16.56 | 0.72 | 0.11 | 71.8 | 1983.85 |
| **2004** | 1.7 | 2059.6 | 16.38 | 1.8 | 0.10 | 75.5 | 2155.07 |
| **2005** | 1.27 | 2203.4 | 16.56 | 0.9 | 0.12 | 74.9 | 2297.17 |
| **2006** | 1.36 | 2234.8 | 17.28 | 1.8 | 0.13 | 72.7 | 2328.06 |
| **2007** | 1.36 | 2338.1 | 17.1 | 0.9 | 0.22 | 74.9 | 2432.54 |
| **2008** | 1.18 | 2299.7 | 18.9 | 0.72 | 0.26 | 78.0 | 2398.73 |
| **2009** | 1.1 | 2258.9 | 17.1 | 0.9 | 0.27 | 77.4 | 2355.71 |
| **2010** | 1.26 | 2140.0 | 16.56 | 0.72 | 0.27 | 73.7 | 2300.96 |
| **2011** | 0.66 | 2 129.5 | 16.2 | 0.54 | 0.26 | 74.1 | 2221.23 |

### *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 as to vehicle category, fuel used and EURO standard. The second table contains information about the emission factors of non-road transportation, particularly railways, navigation and civil aviation. Civil 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 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 last missing emission factors for nitrous oxide for LPG and CNG (IPCC, 2006) were added in 2010 and 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. 3-21 Emission factors of $CO_2$, $N_2O$ and $CH_4$ from road transport in 2011 [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 | 3 183 | 0.06 | 4.10 |
| PC+LDV | Gasoline | PRE-EURO | 3 183 | 0.31 | 0.90 |
| PC+LDV | Gasoline | EURO I and EURO II | 3 183 | 0.70 | 0.40 |
| PC+LDV | Gasoline | EURO III and higher | 3 183 | 0.90 | 0.10 |
| PC+LDV | Diesel Oil | PRE-EURO | 3 138 | 0.10 | 0.08 |
| PC+LDV | Diesel Oil | EURO I and EURO II | 3 138 | 0.20 | 0.08 |
| PC+LDV | Diesel Oil | EURO III and higher | 3 138 | 0.25 | 0.08 |
| PC+LDV | LPG | PRE-EURO and higher | 3 030 | 0.01 | 1.02 |
| PC+LDV | CNG | PRE-EURO and higher | 2 709 | 0.15 | 0.20 |
| PC+LDV | Biomass | PRE-EURO and higher | 3 021 | 0.35 | 0.06 |
| HDV | Diesel Oil | PRE-EURO | 3 138 | 0.10 | 0.60 |
| HDV | Diesel Oil | EURO I and EURO II | 3 138 | 0.20 | 0.20 |
| HDV | Diesel Oil | EURO III and higher | 3 138 | 0.25 | 0.15 |
| HDV | CNG | PRE-EURO and higher | 2 709 | 0.15 | 0.20 |
| HDV | Biomass | PRE-EURO and higher | 3 021 | 0.35 | 0.06 |
| Bus | Diesel Oil | EURO II and older | 3 138 | 0.18 | 0.60 |
| Bus | Diesel Oil | EURO III and higher | 3 138 | 0.10 | 0.15 |
| Bus | CNG | PRE-EURO and higher | 2 709 | 0.15 | 0.20 |
| Bus | Biomass | PRE-EURO and higher | 3 021 | 0.35 | 0.06 |

**Tab. 3-22 Emission factors of $CO_2$, $N_2O$ and $CH_4$ from non-road transport in 2011 [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 | 3 138 | 0.18 | 0.20 |
| Navigation | Diesel Oil | 3 138 | 0.18 | 0.20 |
| Civil Aviation - LTO | Aviation Gasoline | 3 211 | 0.44 | 0.63 |
| Civil Aviation - Cruise | Aviation Gasoline | 3 211 | 0.44 | 0.63 |
| Civil Aviation - LTO | Kerosene | 3 230 | 0.44 | 0.53 |
| Civil Aviation - Cruise | Kerosene | 3 211 | 0.44 | 0.53 |

### *Activity data*

The important information about recalculation of International Bunkers and Domestic Aviation category was verified in NIR 2011. The request and response from 2012 Saturday Paper are presented below.

The ERT noted that there is a big difference (3,137.1 per cent) in jet kerosene consumption for civil aviation in the CRF Tables (36 TJ) compared to IEA data (1,161 TJ). Moreover, the ERT noted that a comparison of jet kerosene consumption for aviation bunkers between CRF (13,387 TJ) and IEA data (13,029 TJ) only leads to a difference of 358 TJ (2.7 per cent). The ERT notes that this could lead to a possible underestimation of total jet kerosene fuel consumption in the CRF Tables. The identified inventory problem may be related to a lack of transparency in the activity data.

The Czech Republic responded, that the Kerosene data was recalculated, because there were several discrepancies and inconsistency between years relating to the consumption of Kerosene in aviation (ERT foundation). The total consumption of Kerosene in the Czech Republic was divided into five categories (Civil Aviation, Aviation Bunkers, Army, Industry and Commercial and Public Services). The Kerosene consumption as well as relevant emissions from categories Army, Industry, Commercial and Public Services is not reported in CRF Reporter in Transport sector 1A3 (or International Bunkers 1C1), but in sectors 1A5bi, 1A2f and 1A4a. Other two categories (Civil Aviation 1A3a and Aviation Bunkers 1C1a) were divided on the basis of expert judgment in the whole time period if the main criteria were passengers transport (now only one regular domestic line between Prague and Ostrava airports) and transport of goods (MoT, 2000; MoT, 2006; MoT, 2011). The regular domestic flights (36 TJ) using Kerosene in comparison with international flights (13 387 TJ) are represented in the Czech Republic by a very small percentage. In IEA data (1 161 TJ) is included in the category Civil Aviation also Kerosene consumption from categories Army, Industry, Commercial and Public Services and that is not used for aviation or transport at all. The following table shows the distribution of Kerosene consumption in 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. 3-23 Distribution of Jet Kerosene consumption in CRF Reporter and IEA data in 2010**

| **CRF Reporter** | | | |
|---|---|---|---|
| | | [kt] | [TJ] |
| **Total** | | 330 | 14 289 |
| **Civil Aviation** | 1A3a | 0.83 | 35.9 |
| **Aviation Bunkers** | 1C1a | 309.17 | 13 387 |
| **Army** | 1A5bi | 15.00 | 649.5 |
| **Industry** | 1A2f | 2.00 | 86.6 |
| **Commercial and Public Services** | 1A4a | 3.00 | 129.9 |
| **IEA data** | | | |
| | | [kt] | [TJ] |
| **Total** | | 330.00 | 14 289 |
| **Domestic Aviation** | | 27.00 | 1 169.1 |
| **International Aviation** | | 303.00 | 13 120.0 |

## 3.5 Uncertainties and time-series consistency

### 3.5.1 Stationary combustion

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 1.7, Tables 1-3, 1-4 and 1-5. Tab. 3-24 furthermore lists source of expert judgement provided for uncertainty analysis for each category.

***Activity data***

Information on fuel consumption is taken from CzSO (CzSO, 2012).

Uncertainties:

a) 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.

b) 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

a) 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. 3-24. The uncertainty values for the default emission factors are based on the 2006 Guidelines (IPCC, 2006).

b) 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. 3-24 Uncertainty data from Energy sector (stationary combustion) for uncertainty analysis**

| Gas | Source category | AD uncertainty [%] | EF uncertainty [%] | Origin of actual level of uncertainty |
|---|---|---|---|---|
| $CO_2$ | 1A Stationary combustion – Solid Fuels | 4 | 3 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CO_2$ | 1A Stationary combustion – Gaseous Fuels | 3 | 2.5 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CO_2$ | 1A Stationary combustion– Liquid Fuels | 5 | 3 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CO_2$ | 1A Stationary combustion – Other Fuels – 1A2 | 10 | 15 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CO_2$ | 1A3e Other Transportation | 4 | 3 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CO_2$ | 1A5b Mobile sources in agriculture and forestry | 7 | 3 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A Stationary combustion – Solid Fuels | 5 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A Stationary combustion – Gaseous Fuels | 4 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A Stationary combustion – Liquid Fuels | 5 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A Stationary combustion – Biomass | 8 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A5b Mobile sources in agriculture and forestry | 7 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A3e Other Transportation | 4 | 50 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A Stationary combustion – Solid Fuels | 5 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A Stationary combustion – Gaseous Fuels | 4 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A Stationary combustion – Liquid Fuels | 5 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A Stationary combustion – Biomass | 8 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A Stationary combustion – Other Fuels – 1A2 | 10 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A3e Other Transportation | 4 | 60 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A5b 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 1A2c 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 1A2c to 1A1a.*

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 (1A1a) - Uncertainties and time-series consistency***

The time series is consistent, as it comes from a single data source – time-series produced by MTI. There are no country-specific uncertainties yet, as all the factors but activity data used in the equations are default IPCC factors. In upcoming inventories, we plan to have the uncertainty in the activity data checked by expert questionnaires.

### 3.5.2 1A3 Mobile Combustion – 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 |
|---|---|---|---|---|
| $CO_2$ | 1A3a Civil Aviation | 4 | 3.73 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $CO_2$ | 1A3b Road Transportation | 3 | 2.36 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $CO_2$ | 1A3c Railways | 5 | 1.48 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $CO_2$ | 1A3d Navigation | 5 | 1.5 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A3a Civil Aviation | 4 | 21.5 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A3b Road Transportation | 3 | 100 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A3c Railways | 5 | 100 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1A3d Navigation | 5 | 50 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A3a Civil Aviation | 4 | 40 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A3b Road Transportation | 3 | 100 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A3c Railways | 5 | 100 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |
| $N_2O$ | 1A3d Navigation | 5 | 90 | J. Tichy, J. Jedlicka, AD and EF unc. in line with 2006 Guidelines |

## 3.6 Source-specific QA/QC and verification

### 3.6.1 Stationary combustion

The general QA/QC plan was formulated since the last submission and is presented in the Chapter 1.5. 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 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 (Tier 1)
- ensures QC procedure (Tier 2) 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
- is responsible for the compliance of all QA/QC procedures with the IPCC Good Practice Guidance (GPG) and QA/QC plan.

- ensures data input in the CRF Reporter
- carries out auto-control (1st step of QC procedure, Tier 1)
- ensures and is responsible for the storing of documents

The QC procedures at the Tier 1 are related to the processing, manipulation, documentation, storing and transmission of information. The first step of the control (auto-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 (other colleague who is familiar with problematic). At this control level (Tier 1) individual steps are controlled according to the table 8.1 (IPCC, 2000).

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.

QC procedures at the Tier 2 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.

In the last year the QC was performed using the REZZO database. Some discrepancies were detected, resulting in reallocation of Brown Coal + Lignite between categories 1A1c and 1A2. For a detailed description please see Chapter 3.7.

Also external employees of KONEKO familiar with the assessed topic participate in the QC procedures (Tier 2). 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.

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.

Fig. 3-8 shows the correlation of fuel consumption in category 1A1a and total electricity production. Electricity production should have a similar trend to consumption in category 1A1a. Very good correlation can be seen at the end of the period, where the same change is apparent since 2005. Overall, the correlation after 2000 can be considered as very good agreement. Some changes are apparent in the previous period, however the trend is also considered to be similar.

It also indicates the correlation of $CO_2$ emissions in category 1A1b and $CO_2$ emissions from Crude Oil in the Reference Approach. These two features should have same trend and this is visible in the figure. The same trend is apparent in both categories at the end of the period; there is a peak in 2008 and the same shape of the curves between 2004 and 2006. At the beginning of nineties there were a great many technical innovations provided in refineries. The older technological facilities from the previous period were reconstructed, resulting in a decrease of energy intensity. This decrease in the energy intensity is connected with lower consumption of fuels even when the amount of processed oil was increasing.

Fig. 3-8 shows also the correlation of fuel consumption in category 1A2a Iron and Steel and production of pig iron (*source: hz.cz*). Obviously these two features should be correlated. A dissimilar trend is apparent at the beginning of the period, probably caused by inaccuracy in the activity data. In the next submission, we will exert an effort to improve these data. On the other hand, is apparent that the curve has the same shape in 1999, indicating good correlation.

The correlation of fuel consumption in category 1A2c Chemicals and production of chemicals – *source DEVELOPMENT OF OVERALL AND SPECIFIC CONSUMPTION OF FUELS AND ENERGY IN RELATION TO PRODUCT* provided by CzSO. These two features should be correlated. There are also some dissimilarity in the trends, which we will try to correct in future submissions. The figure shows good agreement of both features after 2002. The last two pictures in the Fig. 3-8 indicate correlations for 1A2e and 1A2f. Correlation of fuel consumption in category 1A2e Food processing, beverages and tobacco and production of food and beverages - *source DEVELOPMENT OF OVERALL AND SPECIFIC CONSUMPTION OF FUELS AND ENERGY IN RELATION TO PRODUCT* provided by CzSO. These two quantities apparently exhibit similar development over the whole time series. Correlation of fuel consumption in 1A2f with production of cement and lime shows the correlation of fuel consumption in category 1A2f with production of cement and lime - *source DEVELOPMENT OF OVERALL AND SPECIFIC CONSUMPTION OF FUELS AND ENERGY IN RELATION TO PRODUCT* provided by CzSO.

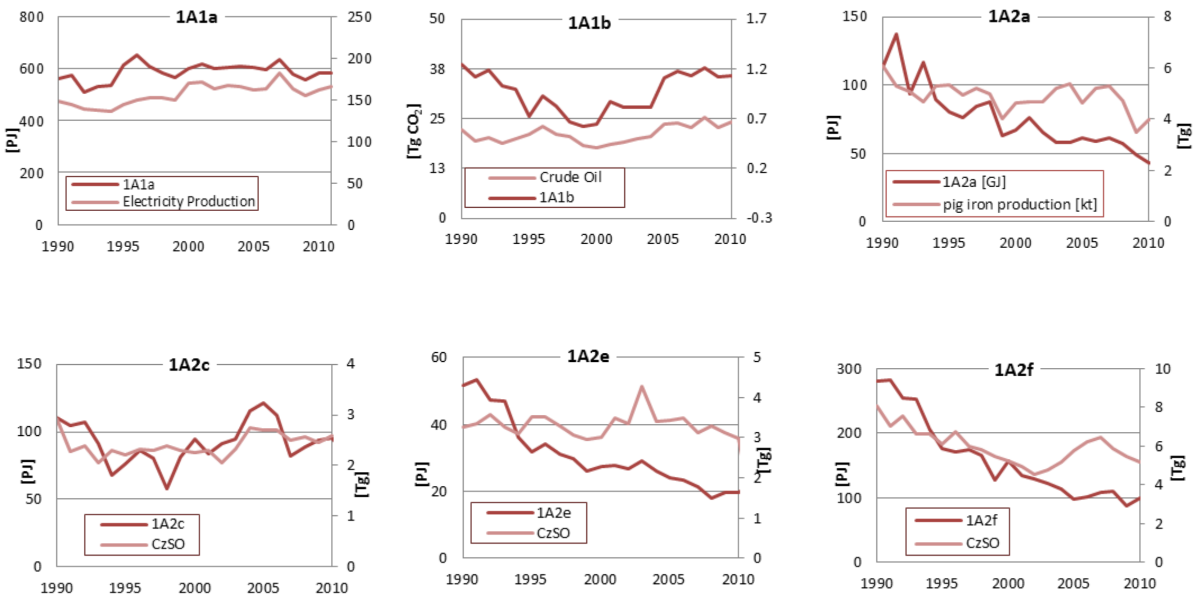



**Fig. 3-8 Comparison of trends of indicators of different categories**

Attention was also focused on checking sources from inter-sector boundaries (Energy, Industrial Processes) 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 experts from CHMI, who are responsible for the Industrial Processes sector. Identical control was carried out for $CO_2$ emissions from coke used in blast furnaces, which is not considered in Energy sector.

***Other Fuels (1A1a) - QA/QC and verification***

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.

### 3.6.2 1A3 Mobile Combustion - 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 Good Practice Guidance (IPCC, 2000),
- provides for the QC procedure (Tier 2) and is responsible for its implementation.

Sectoral administrator, Jakub Tichy:

- performs the emission calculations for the transport in emission model,
- provides for data import in the 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. Jakub Tichy and Head of the Infrastructure and Environment Department, Mr. Jiri Jedlicka. Mr. Tichy implements the calculations and is responsible for all the work with the 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.

## 3.7 Source-specific recalculations, changes in response to the review process

### 3.7.1 Stationary combustion

***Recalculation of 1A Energy based on ERT recommendation (Revised 1996 Gl. $CO_2$ EF)***

According to the recommendation of ERT raised during the Centralised review, which took place in September 2012, the $CO_2$ emissions from 1A Stationary combustion were recalculated using EF from the Revised 1996 Guidelines (IPCC, 1997) for the 1995 - 2010 period. The ERT recommended recalculating only Liquid Fuels, but the party is convinced that this would lead to inconsistencies in reporting and therefore the emission factors given in the Revised 1996 Guidelines (IPCC, 1997) were used for Biomass. Country-specific emission factors are used for Coking Coal, Other Bituminous Coal and for Brown Coal + Lignite; the remaining Solid Fuels were calculated on the basis of the default emission factors given in the Revised 1996 Guidelines (IPCC, 1997). Since this submission, the country-specific emission factor is also used for gaseous fuels. Because the 2006 Guidelines (IPCC, 2006) emission factors were used for the 1995-2010 period, the emissions in 1990-1994 remain the same before and after this recalculation. Since emission factors given in the Revised 1996 Guidelines (IPCC, 1997) and in the 2006 IPCC Guidelines (IPCC, 2006) not differ much, the distinction between the original estimates and the corrected/recalculated estimates is not very significant. The differences are apparent from Tab. 3-26.

**Tab. 3-26 Comparison of emission estimates before and after recalculation using Revised 1996 Guidelines (IPCC, 1997) emission factors**

| year | original estimate Gg $CO_2$ | corrected estimate Gg $CO_2$ |
|---|---|---|
| **1990** | 145 893.92 | 145 893.92 |
| **1991** | 140 063.18 | 140 063.18 |
| **1992** | 124 431.60 | 124 431.60 |
| **1993** | 123 371.42 | 123 371.42 |
| **1994** | 113 653.39 | 113 653.39 |
| **1995** | 115 462.71 | 115 635.36 |
| **1996** | 119 294.50 | 119 461.86 |
| **1997** | 115 698.41 | 115 863.28 |
| **1998** | 109 440.37 | 109 589.65 |
| **1999** | 104 419.79 | 104 558.55 |
| **2000** | 113 232.44 | 113 376.53 |
| **2001** | 113 805.04 | 113 969.03 |
| **2002** | 110 521.69 | 110 676.04 |
| **2003** | 113 000.32 | 113 157.71 |
| **2004** | 114 029.53 | 114 175.45 |
| **2005** | 115 105.90 | 115 260.48 |
| **2006** | 115 807.16 | 115 976.74 |
| **2007** | 115 313.18 | 115 494.52 |
| **2008** | 110 997.99 | 111 193.95 |
| **2009** | 105 726.36 | 105 891.26 |
| **2010** | 109 181.21 | 109 353.56 |

### *Recalculation of 1A Energy – country specific $CO_2$ emission factor for Gaseous Fuels*

Extensive research was performed last year with aim to develop country-specific emission factor for Natural Gas combustion. New country-specific emission factors are used starting with this submission. The recalculation was performed for the whole time series. Annex 2 provides a detailed description of the research. Fig. 3-9 indicates comparison of emission estimates based on the Revised 1996 Guidelines (IPCC, 1997) default emission factor and on the updated country specific emission factor. It is apparent that the default emission factor slightly overestimates the emission estimates.

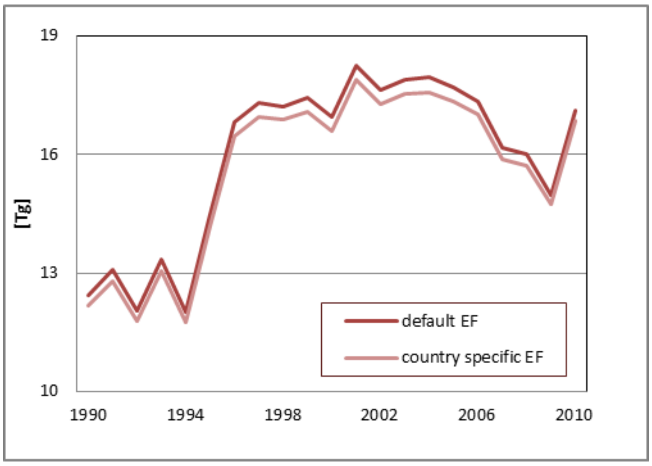



**Fig. 3-9 Comparison of emission estimates from Natural Gas combustion based on the default emission factor and on the country specific emission factor**

### *Recalculation /reallocation of Solid Fuels between 1A1c and 1A2*

One discrepancy in reporting of Solid Fuels was found during the QC procedure last year. The official Energy balance provided by CzSO divides the consumption of fuels in the structure similar to the Revised 1996 Guidelines (IPCC, 1997) structure. Until 2010, the consumption of fuels reported in "Autoproducers" was divided in sector 1A2 proportionally into each subcategory 1A2a – 1A2f. During the QC procedure, the data provided by the database of the Register of sources and emissions were compared with data reported in CRF. Comparison of category 1A1c showed far less Solid Fuels in CRF. Detailed analysis indicated that this is the consumption of Brown Coal - Lignite in Sokolovska Uhelna, Ltd. which also operates a combined heating and power plant. Brown Coal – Lignite is used there for production of Gas Works Gas, which is reported in category 1A1c. However the consumption of Brown Coal was reported under autoproducers (i.e. 1A2). This research led to the reallocation of Brown Coal – Lignite in this submission. The consumption of Brown Coal reported in the Register of sources and emissions database is allocated in 1A1c and this consumption of Brown Coal is subtracted from the consumption reported under autoproducers. The remaining autoproducers consumption is then divided according to same key as in the last submission. This recalculation takes place in 1995-2010 period; for the 1990 – 1994 period were these data allocated correctly. Fig. 3-10 gives a comparison of the current state after reallocation of Brown Coal and the state before this reallocation. It is apparent, that after reallocation the consumption of Solid Fuels in 1A1c follows a more logical trend.

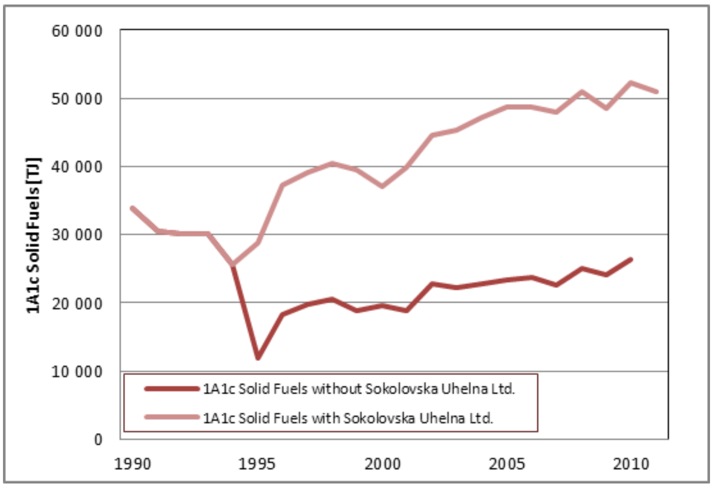



**Fig. 3-10 Situation of Solid Fuels reported in 1A1c**

***Recalculation of 1A2c Chemicals (EU ESD team recommendation)***

In the last submission, part of the naphtha used as feedstock was accidentally included under Liquid Fuels in category 1A2c, but instead of taking 20 %, we had mistakenly taken 70 % (in 2005) or 80 % (in 2008-2010) of the naphtha as oxidised. These estimates were corrected in this submission.

***Recalculation of 1A4b – Biomass (charcoal use)***

According to the recommendation of ERT raised during the Centralised review in September 2012, the $CH_4$ and $N_2O$ emissions associated with charcoal use in category 1A4b Residential were calculated using EF provided by the Revised 1996 Guidelines (Table 1-7 in Volume 3 for $CH_4$, Table 1-8 in Volume 3 for $N_2O$) (IPCC, 1997). The apparent consumption of charcoal was calculated from the available data on imports and exports and was then used for the activity data. Final emissions from charcoal use were then included in emissions from biomass in category 1A4b. The $CO_2$ emissions were also calculated to ensure consistency in reporting. Since neither the Revised 1996 Guidelines (IPCC, 1997) nor the 2006 Guidelines (IPCC, 2006) provide the emission factor, it was determined based on the elementary composition of charcoal. The $CO_2$ emission factor equalled 28.72 kg C/TJ (105.3 kg $CO_2$/TJ).

### 3.7.2 Other Fuels (1A1a) – Recalculations

No recalculations were performed this year.

### 3.7.3 1A3 Mobile Combustion - Source-specific recalculations

There was one recalculation for $CO_2$ emission data in the road transport sector for the 1990 – 2010 time period, because the $CO_2$ country specific emission factor was determined for Natural Gas (CNG) in the whole Energy sector. The detailed calculation methodology is described in Annex 2.

Another recalculation was performed for 1A3b Road Transportation category – Diesel Oil. QA/QC procedures identified typographic error in this category - $N_2O$ emissions, 2010. This issue has been rectified.

## 3.8 Source-specific planned improvements

### 3.8.1 Stationary combustion

The planned improvement consists primarily in a further increase in cooperation with CzSO. As mentioned in the introduction, a new addendum was created for the agreement between the Ministry of the Environment and CzSO. In the framework of this addendum, the parties agreed to hold regular meetings at least 3x annually to deal with coordination of work on the national energy balance, so that this is in accordance with the requirements on processing of activity data for greenhouse gas emission inventories.

Attention is constantly devoted to obtaining data from the ETS national database for use in performing QA/QC procedures. At the present time, the creation of this database is included in the plan of the Ministry of the Environment. As a certain part of the reports on the individual enterprises are currently available only in printed form, the data cannot be converted as distortion could occur.

It is assumed, that following systematic comparison of activity data obtained in various ways, it will be possible to refine the national GHG inventories in the ENERGY sector using “bottom-up” data, or at least to use this data for the QA/QC procedures.

Another improvement is planned for QA procedures. QA should be performed by an independent expert who does not participate in processing the National Inventory of Greenhouse Gases. It is intended to establish a “working group”, which will consist of independent experts from different branches of industry and energy production. Members of the group should be officially named by a letter of appointment from CHMI as the coordination workplace.

### 3.8.2 1A3 Mobile Combustion

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.

## 3.9 Fugitive emissions from Solid Fuels and Oil and Natural Gas (1B)

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, distribution, storage and distribution are less important.

The current inventory includes $CH_4$ emissions for the following categories:

- 1B1 Solid fuels
- 1B2 Oil and Natural Gas

In *1B Fugitive Emissions from Fuels* category, especially *1B1a Coal Mining and Handling* was evaluated as a *key category* (Tab. 3-27). Category 1B2 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. 3-11 depicts methane emissions trends from selected categories from the sector *1B Fugitive Emissions from Fuels*.

**Tab. 3-27 Overview of significant categories of sources in this sector (2011)**

| Category | Character of category | Gas | % of total GHG* |
|---|---|---|---|
| **1B1a Fugitive Emissions from Coal Mining and Handling** | KC (LA, TA, LA*, TA*) | $CH_4$ | 2.5 |
| **1B2 Fugitive Emissions from Oil & Gas operations** | KC (LA, LA*) | $CH_4$ | 0.5 |

** assessed without considering LULUCF (without * means considering LULUCF)*
*KC: key category, LA: identified by level assessment, TA: identified by trend assessment*

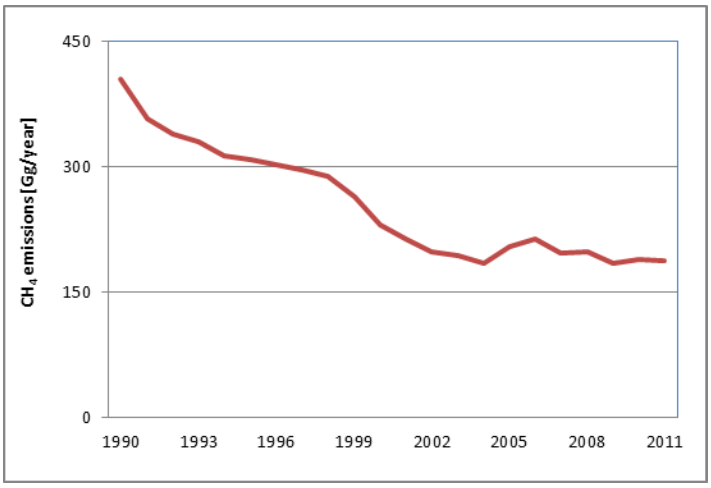



**Fig. 3-11 Methane emissions trends from the sector Fugitive Emissions from Fuels [Gg $CH_4$]**

### 3.9.1 Solid Fuels (1B1)

The source category *1B1 Solid Fuels* consists of three sub – source categories: source category *1B1a Coal mining and Handling*, source category *1B1b Coal transformation* and source category *1B1c Other*. The main process that emits more than 80 % of methane emissions from the category *1B1 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.

Fig. 3-12 shows the trend of methane emissions in the whole time series.

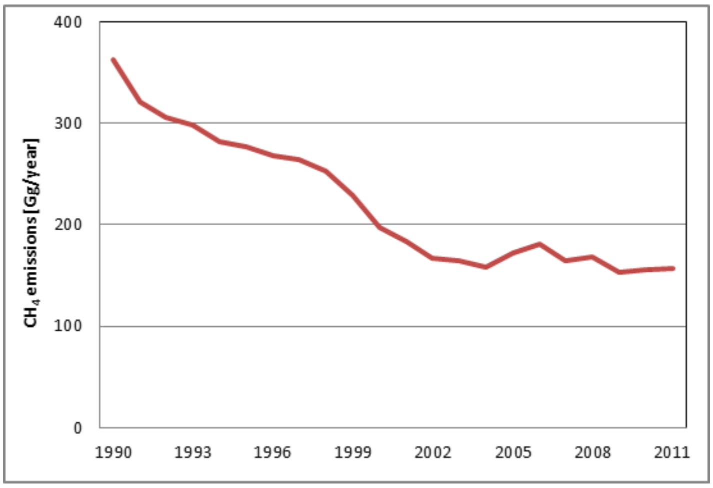



**Fig. 3-12 Methane emissions trends from the sector Fugitive Emissions from Solid Fuels *[Gg $CH_4$]***

***Abandoned mines***

In the Czech Republic there are also abandoned mines occurring. All of them have $CH_4$ recovery systems. There is company, which has established mining areas for mining of fire-damp in Ostrava-Karviná area. In the abandoned mines there are automatic suction devices and firedamp stations. Firedamp arises from abandoned mining pits and surface boreholes into abandoned areas. Mined firedamp is used at the place of mining in autonomous cogeneration units (aggregate for electricity energy production with an ignition combustion engine)( http://www.dpb.cz/).

### *3.9.1.1 Source category description*

***Coal Mining and Handling (1B1a)***

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 Mines (1B1a1)***

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 *1B1a2 Surface Mines*.

*Mining Activities (1B1a11)*

The data of CzSO in the report CZECH_COAL.xls (CzSO, 2012) can be used for control purposes.

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 (1B1a12)*
The activity data are the same as in category *1B1a11 Mining Activities*. It is assumed that the entire mined volume undergoes manipulation during which residual methane is released.

***Surface Mines (1B1a2)***

*Mining Activities (1B1a21)*

Brown Coal and Lignite are mined in surface mines in the Czech Republic. Brown Coal is mined primarily in the Northern Bohemia area, while Lignite mines are located in Southern Moravia.

*Post-Mining Activities (1B1a22)*

The activity data are the same as in category *1B1a21 Mining Activities*. It is assumed that the entire mined volume undergoes treatment during which residual methane is released.

***Solid Fuel Transformation (1B1b)***
The subcategory includes

*a) production of Coke from Coking Coal*

Fugitive methane emissions from coal treatment prior to the actual coking process are listed under *1B1a12 Post-Mining Activities.* Emissions from the actual production of Coke are given under 2. Industry.

*b) production of briquettes from Brown Coal*

Fugitive methane emissions from coal treatment prior to the actual briquetting process are listed under *1B1a22 Post-Mining Activities.* $CO_2$ emissions from the actual production of briquettes are included in subcategory 1A2f.

*c) production of charcoal*

$CH_4$ emissions from charcoal production were estimated by using EF provided by the Revised 1996 Guidelines (IPCC, 1997); the value of 1000 kg/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 activity data to the energy units. Resulting $CH_4$ emissions please see in the Tab. 3-28.

**Tab. 3-28 $CH_4$ emissions from charcoal production**

| 1B1b Solid Fuel Transformation | | | |
|---|---|---|---|
| | Production | Production | $CH_4$ emissions |
| | Gg/year | TJ/year | Gg/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 |

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 Revised 1996 Guidelines (IPCC, 1997) do not provide default emission factor.

***Other (1B1c)***

No other subcategory of fugitive methane emissions is known in the Czech Republic.

### *3.9.1.2 Methodological issues*

***Underground Mines (1B1a1)***

*Mining Activities (1B1a11)*

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. 3-29, see (Takla and Nováček, 1997).

**Tab. 3-29 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 |
| **1990** | 20.6 | 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 deep 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).

The emission factors given in Tab. 3-31 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.

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.

**Tab. 3-30 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 |

This information was used to calculate the emission factors and to determine the average emission factor, which is used for the period after 2000-2008.

**Tab. 3-31 Calculation of emission factors from OKD mines for period 2000 onwards**

| year | OKD mining | $CH_4$ emissions | EF |
|---|---|---|---|
| | [kt/year] | [t/year] | [t/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 |
| **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. 3-31 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 III – 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 21$^{st}$ 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/kt of mined coal and this emission factor is country specific – Tier III 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/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. 3-32.

**Tab. 3-32 Emission factors and emissions from deep mining of hard coal**

| year | production OKD | emission factor | emission of $CO_2$ |
|---|---|---|---|
| | [kt/year] | [t/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 |
| **2011** | 11 265 | 22.68 | 255.4 |

*Post-Mining Activities (1B1a12)*

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 1B1a11 Mining Activities.

Tab. 3-33 contains a summary of fugitive methane emissions during the actual underground mining of Hard Coal and during post-mining operations.

**Tab. 3-33 Used emissions factors and calculation of $CH_4$ emissions from underground coal mining in 2011**

| | Amount of Coal Produced *[million t]* | Emission Factor *[kg $CH_4$/t]* | Methane Emissions *[Gg $CH_4$]* |
|---|---|---|---|
| *OKR*) (tier III)* | 11.265 | 8.8 | 98.6 |
| *Other - tier I* | 0.000 | 6.7 | 0.0 |
| **Mining (tier III)** | **11.001** | **8.8** | **98.6** |
| *OKR*) (tier I)* | 11.265 | 1.6 | 18.5 |
| *Other - tier I* | 0.000 | 0.6 | 0.0 |
| **Post-Mining (tier I)** | **11.265** | **1.6** | **18.5** |
| **Total sub-sector 1B1a1** | **11.265** | **10.4** | **117.1** |

** Ostrava-Karviná coal-mining area*

### *Surface Mines (1B1a2)*

*Mining Activities (1B1a2)*

Data from the source part of the questionnaire completed in the CzSO Questionnaire (CzSO, 2012), 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).

Tab. 3-34 illustrates the calculation of fugitive emissions of methane from surface coal mining activities.

**Tab. 3-34 Emission factors employed and calculation of $CH_4$ emissions from surface coal mining in 2011**

| | **Amount of Coal Produced** *[million t]* | **Emission Factor** *[kg $CH_4$/t]* | **Methane Emissions** *[Gg $CH_4$]* |
|---|---|---|---|
| **Mining (tier I)** | 46.639 | 0.77 | 35.9 |
| **Post-Mining (tier I)** | 46.639 | 0.07 | 3.1 |
| **Total sub-sector 1B2a1** | **46.639** | **0.84** | **39.1** |

### *3.9.1.3 Uncertainty 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 2011. 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 deep 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** |
|---|---|---|---|---|
| **$CO_2$** | 1B1a Coal Mining and Handling | 4 | 25 | E. Krtkova, V. Neuzil, AD unc. in line with 2006 Guidelines, EF unc. expert judgement |
| **$CH_4$** | 1B1a Coal Mining and Handling | 4 | 13 | E. Krtkova, V. Neuzil, AD unc. in line with 2006 Guidelines, EF unc. expert judgement |

### *3.9.1.4 Source 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. Comparison of the emission factors used in the

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.

#### *3.9.1.5 Source-specific recalculations*

***Solid Fuels Transformation Charcoal production- ERT recommendation***

According to the recommendation of ERT the calculation of $CH_4$ emissions from charcoal production were performed by using EF provided by the Revised 1996 Guidelines (IPCC, 1997); the value of 1000 kg/TJ of charcoal produced were 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 activity data to the energy units. Resulting $CH_4$ emissions please see in the Tab. 3-28.

#### *3.9.1.6 Source-specific planned improvements*

No improvements are planned at the present.

### 3.9.2 Oil and Natural Gas (1B2)

Source category 1B2 Oil and Natural Gas consists of four source subcategories: source category *1B2a Oil*, source category *1B2b Natural Gas*, *1B2c Venting and Flaring* and source subcategory *1B2d Other*.

Approximately 10 % 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 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 IPCC methodology.

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 (Alfeld, 1998).

The graph in Fig. 3-13 gives an overview of the trend in emissions in this category in the time series since 1990.

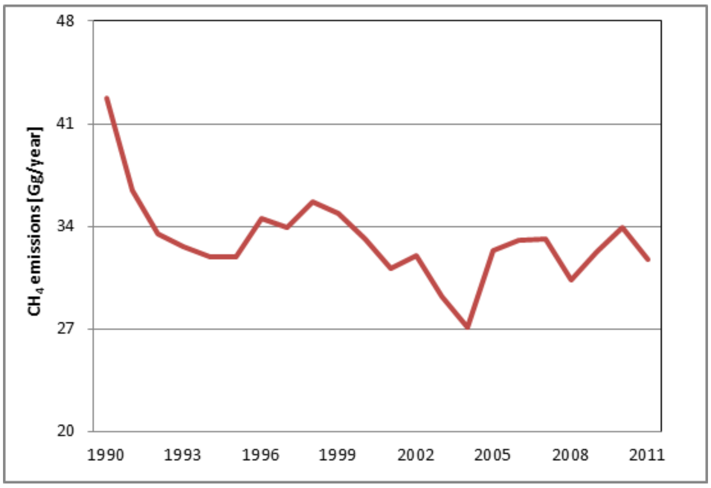



**Fig. 3-13 Methane emissions trends from the sector Fugitive Emissions from Oil and Natural Gas *[Gg $CH_4$]***

### 3.9.2.1 Source category description

***Oil (1B2a)***

$CH_4$ 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 *1A1b Crude Oil Refining.*

***1B2a1 Exploration***

Exploration is not systematically performed in the Czech Republic.

***1B2a2 Production***

Crude Oil is mined in the Czech Republic in Southern Moravia. The following table gives the amount of mined Crude Oil in the territory of the Czech Republic.

**Tab. 3-36 Crude Oil mining in the CR in 2000 – 2011**

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [kt/year] | 175 | 183 | 265 | 317 | 306 | 313 | 265 | 246 | 242 | 222 | 176 | 165 |

***1B2a3 Transport***

Transport of Crude Oil in the territory of the Czech Republic is performed only in closed systems (pipeline transport). So far, emissions from this subsector have not been evaluated. In the context of internal control procedures, this fact was identified as an inadequacy and thus default emission factors were used to calculate fugitive $CH_4$ and $CO_2$ emissions in this subsector.

***1B2a4 Refining / Storage***

Crude Oil is processed in the territory of the Czech Republic in two main refinery facilities. Tab. 3-37 gives the total volume of Crude Oil processed in the Czech Republic.

**Tab. 3-37 Total Crude Oil input to rafineries in CR in 2000 – 2009 [kt/year]**

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Refinery Intake | 5 871 | 6 072 | 6 238 | 6 573 | 6 704 | 7 746 | 7 866 | 7 394 | 8 249 | 7 376 | 7 901 | 7 098 |

### 1B2a5 Distribution of oil products

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.

### 1B2a6 Other

No other operations are considered.

**Tab. 3-38 Summarizes the activity data and emission factors used, including calculation of total methane emissions in this subcategory**

| Category | Tier | A | B | C | D |
|---|---|---|---|---|---|
| | | Activity | Emission Factors | $CH_4$ Emissions | Emissions $CH_4$ |
| | | | | (kg $CH_4$) | (Gg $CH_4$) |
| | | | | C = (A x B) | D = (C/10$^6$) |
| **Production - OIL** | | *PJ oil produced* | *kg $CH_4$/PJ* | | |
| ***domestic production*** | 3 | 7.00 | 5 288 | 36 991 | 0.037 |
| **Transport** | | *PJ oil refined* | *kg $CH_4$/PJ* | | |
| ***transport of Crude oil*** | | 300.7 | 146 | 43 938 | 0.044 |
| **Refining** | | *PJ oil refined* | *kg $CH_4$/PJ* | | |
| ***processing of Crude oil*** | 1 - 2 | 300.7 | 1 150 | 345 854 | 0.346 |
| | | | | **$CH_4$ from Oil** | **0.427** |

### 1B2b Natural Gas

### 1B2b1 Exploration

Emissions formed at exploratory boreholes are reported in this subcategory. This activity is not performed in the Czech Republic, or is completely random.

### 1B2b2 Production

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 Tab. 3-39 gives the amount of extracted Natural Gas in the territory of the Czech Republic.

**Tab. 3-39 Extraction of Natural Gas in the CR in 2000 - 2011**

| Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [mill. $m^3$/year] | 219 | 160 | 153 | 168 | 215 | 201 | 194 | 201 | 199 | 178 | 203 | 184 |

*This subcategory contains estimations of emissions formed during the actual technical operations during mining, with the exception of venting and flaring.*

### 1B2b3 Transmission

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 2,455 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 tanks to centers of consumption. In 2011, the high-pressure gas pipelines had an overall length of 16 610 km.

This length is gradually increasing. 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.

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.

### *1B2b4 Distribution*

Emissions from distribution gas pipelines, with an overall length in 2011 of 60 425 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.

### *1B2b5 Other Leakage – 1B2b51 at industrial plants and power stations*

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 2 435 mil. $m^3$ in 2011.

### *1B2b5 Other Leakage – 1B2b52 in residential and commercial sectors*

No emissions were identified in subcategory *1B2b52 Other leakage in the residential and commercial sectors* in the Czech Republic and thus the notation NO is employed.

Activity data, emission factors and the resultant emission data are given in Tab. 3-40 for the entire *1B2b Natural Gas* sector.

**Tab. 3-40 Calculation of $CH_4$ emissions from Gas in 2011 in structure IPCC**

| Category | Tier | A | B | C | D |
|---|---|---|---|---|---|
| | | Activity | Emission Factors | $CH_4$ Emissions | $CH_4$Emissions |
| | | | | (kg $CH_4$) | (Gg $CH_4$) |
| | | | | C = (A x B) | D = (C/$10^6$) |
| **GAS** | | | | | |
| **Production/Processing** | | *PJ gas produced* | *kg $CH_4$/PJ* | | |
| ***(domestic production NG)*** | 3 | 6.27 | 39 354 | 246 560 | 0.247 |
| **Transmission and Distribution** | | *PJ gas transported* | *kg $CH_4$/PJ* | | |
| ***(transit transport and high pressure pipeline)*** | 2 | 1 362.0 | 7 931 | 10 802 348 | 10.80 |
| **Distribution** | | *PJ gas distribeted* | *kg $CH_4$/PJ* | | |
| ***(low pressure pipeline)*** | | 162.7 | 116 408 | 18 936 594 | 18.94 |
| **Other Leakage** | | *PJ gas stored* | *kg $CH_4$/PJ* | | |
| ***(underground storage)*** | 3 | 82.89 | 14 758 | 1 223 336 | 1.22 |
| | | **TOTAL $CH_4$ from Gas** | | | **31.21** |

### *1B2c Venting and Flaring*

In this category the default EFs from the Good Practice Guidance (IPCC, 2000) (table 2.16, pages 2.86-2.87) were used. The EF value of 2.7 E-04 Gg per 103 $m^3$ was used for conventional oil production, which was taken from the “Oil Production, Conventional Oil, Fugitives” part of table. Owing to the fact that activity data are required in kg/PJ, the value was converted to 7 327.9 kg/PJ by using the typical value of density for crude oil of 880 kg/t and NCV = 41.87 MJ/kg (this value was calculated as the weighted average for the 1990 – 2008 period from the CzSO questionnaires for IEA).

In addition, 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 Good Practice Guidance (IPCC, 2000)(see table 2.16, page 2.86). In this case the following EFs were taken (from the part of the table for "Oil Production, Conventional Oil, Venting and Oil Production, Conventional Oil, Flaring"):

1. B. 2. c. Venting

$CH_4$: 6.2E-05 to 270E-05 Gg per 103 $m^3$ conventional oil production
$CO_2$: 1.2E-05 Gg per 103 $m^3$ conventional oil production

1. B. 2. c. Flaring

$CH_4$: 0.5E-05 to 27E-05 Gg per 103 $m^3$ conventional oil production
$CO_2$: 6.7E-02 Gg per 103 $m^3$ conventional oil production
$N_2O$: 6.4E-07 Gg per 103 $m^3$ conventional oil production

Like in the previous case (1.B.2.a.ii), the EFs were converted to kg/PJ by using the same values for the oil density and NCV.

For $CH_4$, only the minimum and maximum values of the EF range are given. Taking into account that the range is rather wide, we assumed lognormal distribution; see 2006 Guidelines (IPCC, 2006), Vol. 1: General Guidance and Reporting, Chapter 3.2.2.4 Good Practice Guidance (IPCC, 2000) for selecting probability density functions, p. 3.23. Therefore, the average of the logarithms was used for evaluation of the EFs for venting and flaring:

1. B. 2. c. Venting

$CH_4$: 11 104 kg/PJ
$CO_2$: 325.7 kg/PJ

1. B. 2. c. Flaring

$CH_4$: 997.2 kg/PJ
$CO_2$: 1 818 399 kg/PJ
$N_2O$: 17.4 kg/PJ

Tab. 3-41 gives the $CH_4$ and $CO_2$ emissions from Venting for domestic extraction of petroleum; $N_2O$ emissions are not included in this subcategory since no emission factor is available for their calculation. Tab. 3-41 further contains $CH_4$, $CO_2$ and $N_2O$ emissions from Flaring in domestic extraction of petroleum.

**Tab. 3-41 Emissions of $CH_4$, $CO_2$ and $N_2O$ from Venting and Flaring in 1990 – 2011**

| | Venting - emissions [t/year] | | Flaring - emissions [t/year] | | |
|---|---|---|---|---|---|
| | $CH_4$ | $CO_2$ | $CH_4$ | $CO_2$ | $N_2O$ |
| **1990** | 23.4 | 0.688 | 2.1 | 3 839 | 0.037 |
| **1991** | 31.5 | 0.924 | 2.8 | 5 162 | 0.049 |
| **1992** | 37.7 | 1.107 | 3.4 | 6 180 | 0.059 |
| **1993** | 51.0 | 1.495 | 4.6 | 8 346 | 0.080 |
| **1994** | 59.4 | 1.744 | 5.3 | 9 735 | 0.093 |
| **1995** | 67.5 | 1.974 | 6.1 | 11 022 | 0.105 |
| **1996** | 70.3 | 2.055 | 6.3 | 11 476 | 0.110 |
| **1997** | 75.4 | 2.204 | 6.8 | 12 306 | 0.118 |
| **1998** | 82.7 | 2.419 | 7.4 | 13 505 | 0.129 |
| **1999** | 85.2 | 2.490 | 7.6 | 13 904 | 0.133 |
| **2000** | 81.6 | 2.385 | 7.3 | 13 317 | 0.127 |
| **2001** | 85.2 | 2.492 | 7.7 | 13 911 | 0.133 |
| **2002** | 123.6 | 3.614 | 11.1 | 20 176 | 0.193 |
| **2003** | 147.6 | 4.316 | 13.3 | 24 099 | 0.230 |
| **2004** | 142.2 | 4.159 | 12.8 | 23 220 | 0.222 |
| **2005** | 145.5 | 4.254 | 13.1 | 23 751 | 0.227 |
| **2006** | 123.5 | 3.612 | 11.1 | 20 168 | 0.193 |
| **2007** | 114.9 | 3.361 | 10.3 | 18 764 | 0.179 |
| **2008** | 112.9 | 3.300 | 10.1 | 18 425 | 0.176 |
| **2009** | 103.5 | 3.037 | 9.3 | 16 902 | 0.161 |
| **2010** | 82.9 | 2.430 | 7.4 | 13 570 | 0.130 |
| **2011** | 77.7 | 2.278 | 7.0 | 12 682 | 0.121 |

### *3.9.2.2 Methodological issues*

#### *1B2a Oil*

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, 1997) 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.

### *1B2a1 Exploration*

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.

### *1B2a2 Production*

Activity data for determining $CH_4$ 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 5,287 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).

### *1B2a3 Transport*

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 Good Practice Guidance (IPCC, 2000) Table 2.16, page 2.87 are employed to calculate the $CH_4$ and $CO_2$ emissions.

EF $CH_4$ – 0.00015 kt/PJ, EF $CO_2$ – 0.00001 kt/PJ. These emission factors were used to calculate fugitive emissions for the years since 1990.

### *1B2a4 Refining / Storage*

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 1,150 kg/PJ.

The IPCC method does not give any EF for $CO_2$ or $N_2O$. Consequently, the notation key NE is used in CRF.

### *1B2a5 Distribution of oil products*

The available IPCC methodology does not provide any EF for $CO_2$, $CH_4$ or $N_2O$ – notation key – NE. 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.

### *1B2a6 Other*

Activity data: notation key: NO; $CH_4$ and $CO_2$ emissions – notation key NO.

### *1B2b Natural Gas*

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, 2000), 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 (Alfeld, 1998). 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 1B2 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.

#### *1B2b1 Exploration*

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.

- 1B2b2 Production
- 1B2b3 Transmission
- 1B2b4 Distribution
- 1B2b5 Other Leakage – 1B2b51 storage of Natural Gas

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. 3-42 Model calculation of $CH_4$ emissions in the Natural Gas sector (2011)**

| | EF | | Activity data | | Emissions |
|---|---|---|---|---|---|
| | value | units | value | units | mil.$m^3$/year |
| **production** | 0.20 | % vol. | 184.0 | mil. $m^3$ | 0.368 |
| **high pressure pipelines** | 600 | $m^3$/km.year | 16 610 | km | 9.966 |
| **compressors** | | | | | 6.157 |
| **storage** | 0.075 | % vol. | 2 435 | mil. $m^3$ | 1.826 |
| **regulation stations** | 1 000 | $m^3$/station | 4 421 | pcs | 4.421 |
| **distribution network** | 300 | $m^3$/km.year | 60 425 | km | 18.127 |
| **final comsumption** | 2 | $m^3$/consumer | 2 857 591 | pcs | 5.715 |
| **Total** | | | | | 46.580 |
| | Emissions in Gg (0.67 kg/$m^3$) | | | | 31.2 |

*Emissions calculated in this model are then transformed to the structure of the sectors and subsectors according to the IPCC methodology.*

### *3.9.2.3 Uncertainty 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 1B2 Oil and Natural Gas is estimated to equal 75 %.

Summary of uncertainty values provides Tab. 3-43.

**Tab. 3-43 Uncertainty estimates for fugitive emissions from Oil and Natural Gas**

| Gas | Source category | AD uncertainty [%] | EF uncertainty [%] | Origin of actual level of uncertainty |
|---|---|---|---|---|
| $CO_2$ | 1B2 Oil and Natural Gas | 7 | 75 | E. Krtkova, V. Neuzil, AD and EF unc. in line with 2006 Guidelines |
| $CH_4$ | 1B2 Oil and Natural Gas | 7 | 75 | E. Krtkova, V. Neuzil, AD unc. in line with 2006 Guidelines, EF unc. expert judgement |

#### *3.9.2.4 Source 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, 2012) 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.

#### *3.9.2.5 Source-specific recalculations*

No recalculations were performed in this submission.

#### *3.9.2.6 Source-specific planned improvements*

Specific attention will be paid to uncertainty determination and assessment.

# 4 Industrial Processes (CRF Sector 2)

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 1A2f). 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 2011, the total aggregate GHG emissions from industrial processes were 11 773.99 Gg of $CO_2$ equivalents, which represent decrease of 2 % compared to the previous year. Emissions decreased by 40 % 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 2C1 Iron and Steel Production and 2A Mineral Products.

$N_2O$ emissions coming from 2B Chemical Industry and F-gas emissions and consumption are less significant. Iron and steel, Cement production, F-gases Use, Limestone and Dolomite Use, Lime production and Nitric acid production can be considered to be *key categories* (KC) according to Good Practice Guidance (IPCC, 2000, IPCC, 2003). Tab. 4-1 gives a summary of the main sources of direct greenhouse gases in this sector, shows share of national emissions in 2011 and lists type of key category analysis for key categories.

**Tab. 4-1 Overview of main categories in sector Industrial Processes (2011)**

| Category | Character of category | Gas | % of total GHG* |
|---|---|---|---|
| 2C1 Iron and Steel Production | KC (LA, TA, LA*, TA*) | $CO_2$ | 4.2 |
| 2A1 Cement Production | KC (LA, LA*) | $CO_2$ | 1.3 |
| 2F1-6 F-gases Use - ODS substitutes | KC (LA, TA, LA*, TA*) | HFCs, PFCs | 0.9 |
| 2A3 Limestone and Dolomite Use | KC (LA, TA, LA*, TA*) | $CO_2$ | 0.9 |
| 2A2 Lime Production | KC (LA, LA*) | $CO_2$ | 0.5 |
| 2B1 $NH_3$ Production | Non-KC | $CO_2$ | 0.4 |
| 2B2 Nitric Acid Production | KC (TA, TA*) | $N_2O$ | 0.3 |

** 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.

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 the economic crisis. A brief description of the relevant category trends is provided for all the categories in the following chapters.

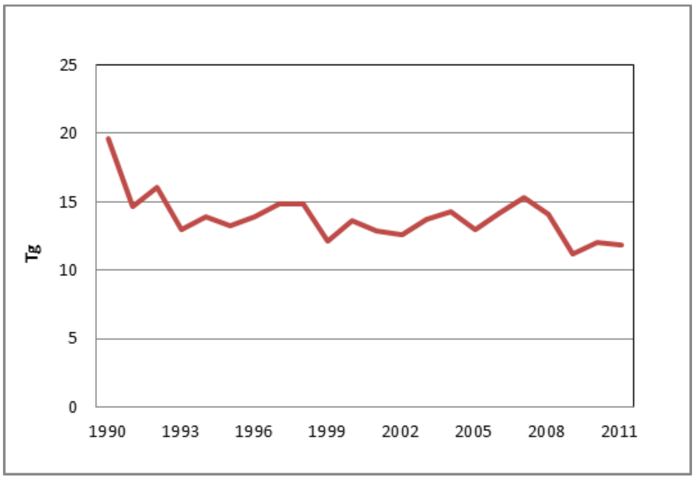



**Fig. 4-1 GHG emissions trend from Industrial Processes, 1990 – 2011 [Tg $CO_2$ eq.]**

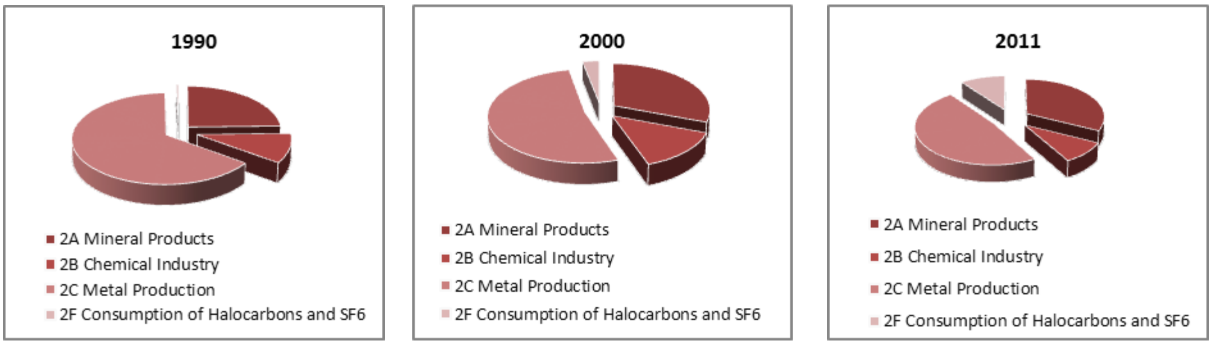



**Fig. 4-2 Share of GHG emissions from individual subcategories on the whole sector of Industrial Processes in 1990, 2000, 2011 [Gg $CO_2$ eq.]**

Category 2A Mineral Products includes practically only emissions of $CO_2$ as well as category 2C Metal Production. $CO_2$ emissions from the 2B Chemical Industry comes from 2B1 Ammonia Production, while $N_2O$ emissions originate from 2B2 Nitric Acid Production. Industrial $CH_4$ emissions are insignificant. Emissions from the use of F-gases (category 2F) are classified in greater detail in the following figure.

## 4.2 Mineral Products (2A)

This category describes GHG emissions from the non-combustion processes from the following categories: 2A1 Cement Production, 2A2 Lime Production, 2A3 Limestone and Dolomite Use, 2A4 Soda Ash Production and Use and 2A7 Other.

Fig. 4-3 depicts the share of $CO_2$ emissions in this category. The major share (44 %) belongs to 2A1 Cement Production, 30 % belongs to 2A3 Limestone and Dolomite Use production and 18 % to 2A2 Lime Production. Tab. 4-2 lists the $CO_2$ emissions in the individual subcategories in 2A Mineral Products in 2011.

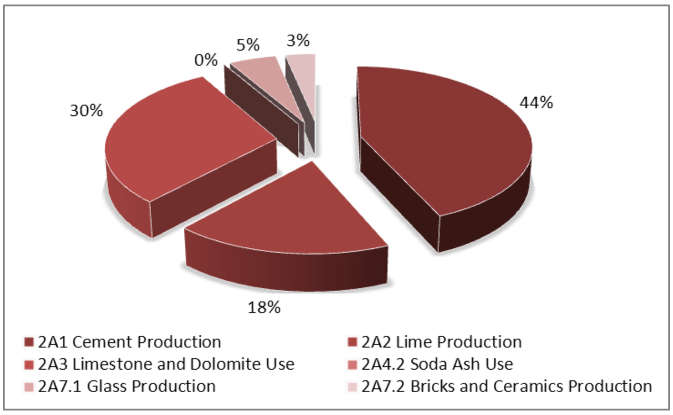



**Fig. 4-3 The share of individual categories in $CO_2$ emissions from category 2A Mineral Products in 2011 [Gg $CO_2$]**

**Tab. 4-2 $CO_2$ emissions in individual subcategories in 2A Mineral Products category in 1990 – 2011**

| | Category 2A - $CO_2$ emissions [Gg] | | | | | |
|---|---|---|---|---|---|---|
| | 2A1 Cement Production | 2A2 Lime Production | 2A3 Limestone and Dolomite Use | 2A4.2 Soda Ash Use | 2A7.1 Glass Production | 2A7.2 Bricks and Ceramics Production |
| **1990** | 2 489.18 | 1 336.65 | 677.51 | NO | 173.12 | 153.37 |
| **1991** | 2 308.92 | 844.66 | 605.37 | NO | 148.43 | 127.93 |
| **1992** | 2 468.42 | 831.46 | 282.51 | NO | 146.46 | 123.12 |
| **1993** | 2 194.55 | 778.67 | 251.37 | NO | 142.06 | 147.18 |
| **1994** | 2 208.38 | 806.53 | 290.97 | NO | 153.60 | 150.98 |
| **1995** | 2 005.01 | 817.53 | 519.03 | NO | 116.48 | 144.39 |
| **1996** | 2 116.49 | 830.73 | 662.96 | NO | 122.50 | 175.76 |
| **1997** | 2 083.36 | 852.73 | 750.60 | NO | 135.80 | 213.49 |
| **1998** | 2 067.65 | 797.00 | 909.35 | NO | 141.68 | 271.46 |
| **1999** | 1 962.91 | 787.47 | 975.24 | NO | 145.88 | 210.67 |
| **2000** | 1 936.86 | 828.53 | 1 007.85 | NO | 167.58 | 225.50 |
| **2001** | 1 628.84 | 827.06 | 1 033.10 | 0.1031 | 168.42 | 201.58 |
| **2002** | 1 403.48 | 815.33 | 1 043.28 | 0.2098 | 188.86 | 151.81 |
| **2003** | 1 484.85 | 808.00 | 1 032.65 | 0.3266 | 198.24 | 161.55 |
| **2004** | 1 626.76 | 808.73 | 1 044.81 | 0.4359 | 232.68 | 160.78 |
| **2005** | 1 624.53 | 762.82 | 1 055.00 | 0.4682 | 231.56 | 181.00 |
| **2006** | 1 748.45 | 758.02 | 1 069.05 | 0.3458 | 245.00 | 153.92 |
| **2007** | 2 043.08 | 794.07 | 1 105.73 | 0.5016 | 236.32 | 184.36 |
| **2008** | 1 996.15 | 742.01 | 1 017.32 | 0.5597 | 212.69 | 161.32 |
| **2009** | 1 566.08 | 625.43 | 944.84 | 0.4129 | 186.10 | 126.25 |
| **2010** | 1 469.27 | 670.89 | 1 021.32 | 0.8604 | 143.15 | 119.73 |
| **2011** | 1 664.53 | 691.42 | 1 151.23 | 1.0620 | 193.31 | 122.14 |

Tab. 4-3 gives an overview of the emission factors used for computations of emissions in category 2A Mineral Products in 2011.

**Tab. 4-3 $CO_2$ emission factors used for computations of 2011 emissions in category 2A**

| | Emission factor $CO_2$ | unit | Source or type of EF |
|---|---|---|---|
| **2A1 Cement Production** | 0.5314 | t $CO_2$ / t sinter | EU ETS |
| **2A2 Lime Production** | 0.7884 | t $CO_2$ / t CaO | CS |
| **2A3 Limestone and Dolomite Use** *from use in sintering plants* | 0.08 | t $CO_2$ / t sinter | EU ETS |
| **2A4 Soda Ash Use** | 0.415 | t $CO_2$ / t soda ash | IEF |
| **2A7.1 Glass Production** | 0.14 | t $CO_2$ / t glass | EMEP/CORINAIR |
| **2A7.2 Bricks and Ceramics Production** | 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 |

*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 (2A1)

$CO_2$ emissions from cement production have decreased since 1990 by 33 %. 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 decarbonization 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 1A2f. Limestone (and dolomite) 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 *2A1 Cement production* can be calculated according to the 2000 GPG (IPCC, 2000) from the production of cement (Tier 1) or clinker (Tier 2). The Tier 1 approach was employed towards 2006 submission. The cement production statistic was available and default emission factor from the Revised 1996 Guidelines (IPCC, 1997), i.e. 0.4985 t $CO_2$/t cement, was used for estimating of $CO_2$ emissions from cement production throughout the nineties.

2006 Guidelines (IPCC, 2006) describes an approach based on direct data from individual operators of cement kilns (Tier 3). Since 2006 submission methodology equal to the 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 cement kiln operators is available for years 1990, 1996, 1998 - 2002 and 2005 - 2011. For these years, the emission factor value was derived from individual installation data collected for EU ETS (emissions) and from CCA 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 (Vyhláška 12/2009 o stanovení postupu zjišťování, vykazování a ověřování množství emisí skleníkových plynů / Decree 12/2009 establishing a procedure for identifying, reporting and verifying emissions of greenhouse gases) 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, 2012), 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 0.5267 to 0.5534 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 - 2011**

| | unit | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Clinker production** | **kt** | 4 726 | 4 368 | 4 653 | 4 122 | 4 134 | 3 740 | 3 934 | 3 829 | 3 758 | 3 547 | 3 537 |
| **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 | 0.548 |
| **Emissions $CO_2$** | **Gg** | 2 489 | 2 309 | 2 468 | 2 195 | 2 208 | 2 005 | 2 116 | 2 083 | 2 068 | 1 963 | 1 937 |

| | unit | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Clinker production** | **kt** | 2 954 | 2 549 | 2 725 | 3 017 | 3 045 | 3 288 | 3 837 | 3 759 | 2 923 | 2 748 | 3 132 |
| **EF $CO_2$** | **t $CO_2$/t clinker** | 0.551 | 0.551 | 0.545 | 0.539 | 0.533 | 0.532 | 0.532 | 0.531 | 0.536 | 0.535 | 0.531 |
| **Emissions $CO_2$** | **Gg** | 1 629 | 1 403 | 1 485 | 1 627 | 1 625 | 1 748 | 2 043 | 1 996 | 1 566 | 1 469 | 1 665 |

#### *4.2.1.3 Uncertainty and time-series consistency*

Last year the research was conducted in order to develop new uncertainty estimates. The uncertainties for this category are based on the 2006 Guidelines (IPCC, 2006). Since the Tier 3 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 1.7.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2011.

#### 4.2.1.4 Source-specific QA/QC and verification


**Fig. 4-4 Comparison of clinker production data provided by CzSO and CCA**

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.

#### 4.2.1.5 Source-specific recalculations

One recalculation was performed for this category in this submission. A discrepancy in $CO_2$ emission calculations caused by a computational error in the 2003 - 2005 emissions was discovered during the QC procedure. These errors were corrected in this submission. This inconsistency became also apparent by verification of implied emission factor which now indicates more accurate course. Fig. 4-5 indicates the difference between the preliminary and “recalculated” implied emission factor. It clearly depicts a more reliable course after the recalculation.

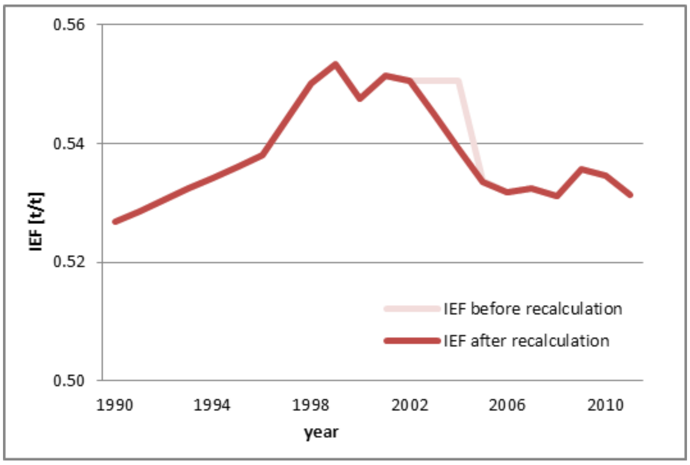



**Fig. 4-5 Comparison of IEF $CO_2$ before and after recalculation**

#### 4.2.1.6 *Source-specific planned improvements*

Since the Tier 3 method is used for emission calculations in this category, no significant improvements are planned.

### 4.2.2 Lime Production (2A2)

$CO_2$ emissions from lime production have decreased considerably since 1990 by 48 %. 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 2009 the production dropped to a minimum for the whole period of 853 kt. In 2011 the lime production slightly increases in comparison with previous year to 943 kt which introduce the change of 3 % in $CO_2$ emissions in this category.

#### 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 leading to decomposition (i.e. calcination) of $CaCO_3/MgCO_3$ to the lime (CaO, CaO·MgO) and $CO_2$ which is released to the atmosphere.

#### 4.2.2.2 *Methodological issues*

Emissions from lime production are calculated in line with 2000 GPG (IPCC, 2000). 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 1A2f. National EF reflects the production of lime and quick lime (0.7884 t $CO_2$ / t lime) (Vácha, 2004). Furthermore, it is taken into account the average purity (93 %) (Vácha, 2004) of lime produced in the Czech Republic.

Activity data are based on statistics from the Czech Lime Association (CLA, 2012), which publishes data on pure lime production. These data were considered to be more accurate than data provided by CzSO which do not differentiate between lime and hydrated lime.

Tab. 4-5 shows comparison of $CO_2$ emissions calculated according to IPCC methodology and process-related emissions reported for EU ETS. ETS data closely corresponds to the IPCC methodology and national circumstances. Two lime producers are not included in the EU ETS data.

**Tab. 4-5 Comparison of $CO_2$ emissions from lime production 2005 – 2011**

| | Lime produced [t / year] | Process-specific $CO_2$ emissions [Gg] | |
|---|---|---|---|
| | | IPCC methodology | EU ETS |
| **2005** | 1 040 | 763 | 738 |
| **2006** | 1 034 | 758 | 748 |
| **2007** | 1 083 | 794 | 772 |
| **2008** | 1 012 | 742 | 717 |
| **2009** | 853 | 625 | 596 |
| **2010** | 915 | 671 | 646 |
| **2011** | 943 | 691 | 676 |

Tab. 4-6 lists activity data for lime production, emission factors and $CO_2$ emissions for the whole time series.

**Tab. 4-6 Activity data, $CO_2$ emission factor and $CO_2$ emissions in 2A2 Lime Production category in 1990 - 2011**

| | unit | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lime production** | **kt** | 1 823 | 1 152 | 1 134 | 1 062 | 1 100 | 1 115 | 1 133 | 1 163 | 1 087 | 1 074 | 1 130 |
| **EF $CO_2$** | **t $CO_2$/t $CaCO_3$** | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 |
| **Emissions $CO_2$** | **Gg** | 1 337 | 845 | 831 | 779 | 807 | 818 | 831 | 853 | 797 | 787 | 829 |

| | unit | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Lime production** | **kt** | 1 128 | 1 112 | 1 102 | 1 103 | 1 040 | 1 034 | 1 083 | 1 012 | 853 | 915 | 943 |
| **EF $CO_2$** | **t $CO_2$/t $CaCO_3$** | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 | 0.788 |
| **Emissions $CO_2$** | **Gg** | 827 | 815 | 808 | 809 | 763 | 758 | 794 | 742 | 625 | 671 | 691 |

### *4.2.2.3 Uncertainty and time-series consistency*

Last year the research was conducted in order to develop new uncertainty estimates. The uncertainties for this category are in line with the 2006 Guidelines (IPCC, 2006). Since activity data are based on the CLA statistics, 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 1.7.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2011.

### *4.2.2.4 Source-specific QA/QC and verification*

Since the last submission, a sector-specific QA/QC plan was formulated, closely related to the QA/QC plan of the National Inventory System. The plan includes a table of personal responsibilities which has changed slightly in this submission due to personal changes at CHMI.

The calculations in the lime production category are based on data taken from the Czech Lime Association and EU ETS data 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

No recalculations are applicable for this year.

#### 4.2.2.6 Source-specific planned improvements

The Tier 2 methodology is used for computation of emissions in this category. Currently, this method is considered to be sufficient. However an effort will be made to use Tier 3.

### 4.2.3 Limestone and Dolomite Use (2A3)

$CO_2$ emissions in category *2A3 Limestone and Dolomite Use* are emitted from sulphur removal using limestone and emissions from limestone and dolomite use in sintering plants. Emissions from sulphur removal have increased since 1996, when the first sulphur-removal unit came into operation. All Czech thermal power plants have been equipped with sulphur-removal units since 1999.

Since 1999 $CO_2$ emissions have slightly varied around 1000 Gg $CO_2$ according to electricity production from thermal (brown coal) power plants. Emissions from limestone and dolomite use in sintering plants have fluctuated and were influenced by the transition from a planned economy to a market economy, and restructuring and modernization of the iron and steel industry. The decrease in emissions in 2008 and 2009 was caused by the economic crisis. In 2010 and 2011 a slight improvement in the economy followed by an increase in emissions was observed.

#### 4.2.3.1 Source category description

From the chemical point of view sulphur removal from combustion products from coal using limestone is source of $CO_2$ emissions. Here, it holds that one mole of $SO_2$ removed releases one mole of $CO_2$ without regard to the sulphur-removal technology employed and the stoichiometric excess. Limestone and dolomite are added to sinter where they are calcined, the products subsequently acting as slag formers in blast furnaces.

Emissions from limestone and dolomite which are used for cement production are reported under cement production, similarly to lime and glass production. There is no other known production or process which uses limestone and/or dolomite and produces $CO_2$ emissions in the CR.

#### 4.2.3.2 Methodological issues

$CO_2$ 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 which cover the years 1999 – 2005. The EU ETS data form has been used since 2006. The methodology used for estimation of the $CO_2$ emissions must be in accordance with the national legislation (Vyhláška 12/2009 o stanovení postupu zjišťování, vykazování a ověřování množství emisí skleníkových plynů / Decree 12/2009 establishing a procedure for identifying, reporting and verifying emissions of greenhouse gases) 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. 4-7 lists data for this category.

Emissions from limestone and dolomite use in sintering plants were new source, in 2006 submission, which was identified in the process of preparation of the EU Emission Trading Scheme. Only 2 sintering plants have existed in the CR in recent times. $CO_2$ emissions from this category are calculated on the basis of data from statistics (The Steel Federation, Inc. - production of agglomerate / sinter) and the EF value, which was derived from EU ETS $CO_2$ emission data based on the limestone and dolomite compositions and consumptions (0.08 t $CO_2$ / t sinter). Tab. 4-7 lists data for this category.

In the CRF Tables emissions and activity data for sulphur removal with limestone and emissions from limestone and dolomite use in sintering plants are reported together in the category 2A3 Limestone and Dolomite Use.

**Tab. 4-7 $CO_2$ emissions from Limestone and Dolomite Use in desulphurization unit, sinter plant, in 1990 – 2011 [Gg]**

| | $CO_2$ emissions from desulfurization | $CO_2$ emissions from sinter plant | | $CO_2$ emissions from desulfurization | $CO_2$ emissions from sinter plant |
|---|---|---|---|---|---|
| **1990** | NO | 678 | **2001** | 551 | 482 |
| **1991** | NO | 605 | **2002** | 551 | 492 |
| **1992** | NO | 283 | **2003** | 560 | 473 |
| **1993** | NO | 251 | **2004** | 551 | 494 |
| **1994** | NO | 291 | **2005** | 589 | 467 |
| **1995** | NO | 519 | **2006** | 587 | 483 |
| **1996** | 76 | 587 | **2007** | 614 | 492 |
| **1997** | 241 | 510 | **2008** | 607 | 411 |
| **1998** | 417 | 492 | **2009** | 600 | 345 |
| **1999** | 537 | 438 | **2010** | 651 | 370 |
| **2000** | 540 | 468 | **2011** | 739 | 412 |

#### *4.2.3.3 Uncertainty and time-series consistency*

Last year, research was conducted in order to develop new uncertainty estimates. The uncertainty for the activity data is in line with Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and was determined at the level of 5 %. The uncertainty for the emission factor is in line with the 2006 Guidelines (IPCC, 2006) and was determined at the level of 4 %. Overall uncertainty data are given in Chapter 1.7.

Time series consistency is ensured for the limestone and dolomite use in sintering plants as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2011.

#### *4.2.3.4 Source-specific QA/QC and verification*

Since the last submission, a sector-specific QA/QC plan was formulated, closely related to the QA/QC plan of the National Inventory System. The plan includes a table of personal responsibilities which has changed slightly in this submission due to personal changes at CHMI.

The calculations in the limestone and dolomite use category are based on data taken from CzSO and EU ETS. The EU ETS data are verified by independent verifiers. CzSO has its own verification procedures employed before data is published.

#### 4.2.3.5 Source-specific recalculations

No recalculations are applicable for this year.

#### 4.2.3.6 Source-specific planned improvements

Since country-specific method is used for computation in this category, there is no significant improvement planned in this category.

### 4.2.4 Soda Ash Production and Use (2A4)

#### 4.2.4.1 Source category description

$CO_2$ emissions from Soda Ash Production and Use (2A4) category come only from soda ash use. Soda ash is not produced in the Czech Republic. Except 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 Gg $CO_2$) compared to the other categories. The maximum value of the emissions reported in this category is 1.06 Gg $CO_2$ in 2011.

#### 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 about the amount and purity of the soda ash used were obtained directly from the installation operator.

#### 4.2.4.3 Uncertainty and time-series consistency

Last year, research was conducted in order to develop new uncertainty estimates. Since no default uncertainty data was found in the methodology, the uncertainties in this category are still based on the expert judgment, i.e. 5 % for the activity data and 10 % for the emission factor. Overall uncertainty data are given in Chapter 1.7.

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 2011.

#### 4.2.4.4 Source-specific QA/QC and verification

Since the last submission, a sector-specific QA/QC plan was formulated, closely related to the QA/QC plan of the National Inventory System. The plan includes a table of personal responsibilities which has changed slightly in this submission due to personal changes at CHMI.

The calculations are based on data provided directly by the operators, who verify the data annually.

#### *4.2.4.5 Source-specific recalculations*

During QC performed directly by the operator, the activity data were verified for 2009 and 2010. This verification introduced simple recalculation of the activity data and $CO_2$ emissions in this submission. Following recalculation, there is just little difference of 4% for 2009, while the difference is 22 % for 2010.

#### *4.2.4.6 Source-specific planned improvements*

Since plant-specific data and simple stoichiometry are used for computation in this category there is no significant improvement planned in this category.

### 4.2.5 Other (2A7)

The *2A7 Other* category summarizes in Czech Republic emissions from *Glass Production (2A7.1 – $CO_2$)* and from *Brick and Ceramics Production (2A7.2 – $CO_2$ and $CH_4$)*. $CO_2$ emissions from *2A7.1 Glass production* equalled 193 Gg in 2011. $CO_2$ emissions from *Brick and Ceramics Production (2A7.2)* amounted to 122 kt $CO_2$ in 2011.

#### *4.2.5.1 Source category description*

$CO_2$ emissions from *Glass Production (2A7.1)* are derived particularly from the decomposition of alkaline carbonates added to glass-making sand. $CO_2$ and $CH_4$ emissions from Brick and Ceramics Production are derived particularly from the decomposition of alkaline carbonates, fossil and biogenic carbon based substances included in the raw materials.

#### *4.2.5.2 Methodological issues*

The emission factor value of 0.14 t $CO_2$ / t glass was taken from the new version of the guidebook (EMEP / CORINAIR Atmospheric Emission Inventory Guidebook, 1999). Activity data were collected and published by the Association of the Glass and Ceramic Industry of the Czech Republic in previous years. Beginning with this submission, the activity data are available from CzSO.

Emissions from *2A7.2 Brick and Ceramics Production* 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 individual installation data collected for EU ETS (emissions) and from CzSO (production). The calculation is based on the total production of ceramic products (fine ceramics, tiles, roofing tiles, and bricks) and the EF value.

#### *4.2.5.3 Uncertainty and time-series consistency*

Last year, research was conducted in order to develop new uncertainty estimates. The uncertainties for this category are in line with the 2006 Guidelines (IPCC, 2006), i.e. at the level of 5 % for the activity data and 10 % for the $CO_2$ emission factor. The uncertainty for the $CH_4$ emission factor was determined at the level of 50 %. Overall uncertainty data are given in Chapter 1.7.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2011.

#### *4.2.5.4 Source-specific QA/QC and verification*

Since the last submission, a sector-specific QA/QC plan was formulated, closely related to the QA/QC plan of the National Inventory System. The plan includes a table of personal responsibilities, which has changed slightly in this submission due to personal changes at CHMI.

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.

#### *4.2.5.5 Source-specific recalculations*

A slight error in $CO_2$ emissions in category 2A7.1 Glass Production for 2005 was found during the QC procedure. This error was corrected in this submission.

#### *4.2.5.6 Source-specific planned improvements*

It is planned to verify emission estimates with data from the EU ETS system and other available sources.

## 4.3 Chemical Industry (2B)

Of the categories of sources classified under the Chemical industry (2B), categories 2B1, 2B2 and 2B5 are relevant for the Czech Republic, while adipic acid (2B3) and carbides (2B4) are not produced here.

### 4.3.1 Ammonia production (2B1)

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 2011 equalled 553.0 Gg of $CO_2$, corresponding to approx. 0.5 % of total greenhouse gas emissions without LULUCF. These emissions decreased by 31.5 % compared to 1990; however, emissions in period 2005 - 2011 are almost constant, with slight fluctuations. Ammonia production ($CO_2$ emissions) was not identified as a key category this year (in contrast to some previous years). However, it remains just under the threshold value in the determination by level assessment.

#### *4.3.1.1 Source category description*

Industrial ammonia production is based on the catalytic reaction between nitrogen and hydrogen:

$$N_2 + 3H_2 = 2NH_3$$

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 technologically-specific emission factor 2.40 Gg $CO_2$ / Gg $NH_3$ (Markvart and Bernauer, 2005 - 2011). This emission factor was derived from the relevant technical literature - *Ullman's Encyclopedia* (Wiley, 2005) corresponding to the ammonia production employed in the Czech Republic, including information required for deriving the carbon dioxide emission factor: 56.25 t $NH_3$ are produced from 44 t of residual oil containing 84.6 % C. Simple stoichiometric calculation yields the value of the emission factor EF $CO_2$ = 2.402 t $CO_2$/t $NH_3$. This emission factor includes the efficiency of the conversion of carbon contained in the starting material to carbon dioxide, equal to 99 % (i.e. an oxidation factor of 0.99).

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. 4-8 Activity data and $CO_2$ emissions from ammonia production in 1990 – 2011.

**Tab. 4-8 Activity data and $CO_2$ emissions from ammonia production in 1990 – 2011**

| Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| **Residual fuel oil used for $NH_3$ product., *[TJ]*** | 11 113 | 10 770 | 11 104 | 10 383 | 11 593 | 10 235 | 11 015 | 10 095 |
| **Ammonia produced, *[kt]*** | 335.9 | 325.5 | 335.6 | 313.8 | 350.4 | 309.3 | 332.9 | 305.1 |
| **$CO_2$ from 2B1, *[Gg]*** | 806.8 | 781.9 | 806.1 | 753.8 | 841.6 | 743.0 | 799.7 | 732.9 |

| Year | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|
| **Residual fuel oil used for $NH_3$ product., *[TJ]*** | 10 407 | 8 864 | 10 144 | 8 538 | 7 449 | 9 696 | 9 721 | 8 478 |
| **Ammonia produced, *[kt]*** | 314.5 | 267.9 | 306.6 | 258.0 | 225.1 | 293.0 | 290.8 | 253.6 |
| **$CO_2$ from 2B1, *[Gg]*** | 755.5 | 643.6 | 736.5 | 619.9 | 540.8 | 703.9 | 698.7 | 609.3 |

| Year | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| **Residual fuel oil used for $NH_3$ product., *[TJ]*** | 8 086 | 7 575 | 8 487 | 8 739 | 8 510 | 7 616 |
| **Ammonia produced, *[kt]*** | 241.9 | 226.6 | 256.5 | 264.1 | 257.2 | 230.2 |
| **$CO_2$ from 2B1, *[Gg]*** | 581.1 | 544.4 | 616.3 | 634.4 | 617.8 | 553.0 |

#### 4.3.1.3 Uncertainty and time consistency

Uncertainty estimates of activity data and emission factors have so far been based mainly on expert judgment.

This year, estimates of the uncertainty parameters were again verified in the study (Markvart and Bernauer, 2012) which, in addition to an expert opinion, also takes into account data given in the 2006

Guidelines (IPCC, 2006). The uncertainty in the activity data 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 2011.

#### *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*

No recalculations were employed in this category in this submission.

#### *4.3.1.6 Source-specific planned improvements*

No improvement is planned for the next submission.

### 4.3.2 Nitric acid production (2B2)

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 2011 equalled 1.35 Gg $N_2O$, corresponding to approx. 0.4 % of total greenhouse gas emissions without LULUCF. These emissions have decreased by 63% 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 2011, 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 by the classical method by 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 *2B2 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. 4-9. The emission factors for the basic process (without DENOX 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. 4-9 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 DENOX** | -- | 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 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 emissions factors is given below.

**Tab. 4-10 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** |
|---|---|---|---|---|
| **DENOX 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 - 2011, the mitigation unit described above was utilized in a more effective way, see (Markvart and Bernauer, 2007 - 2012). 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. 4-11.

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. 4-11).

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 $N_2O$ could be approximately close to 1.3 kg $N_2O$/ t $HNO_3$ (100 %).

YARA's catalyst, which was also used in 2011, exhibits excellent stability with respect to $N_2O$ conversion and the catalyst efficiency was practically constant during the last two years in the high-pressure (0.7 MPa) nitric acid unit.

**Tab. 4-11 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** |
|---|---|---|---|---|---|---|---|---|
| **EF, kg $N_2O$ / t $HNO_3$ (100 %)** | 7.8 | 7.02 | 5.94 | 4.37 | 4.82 | 2.85 | 1.29 | 1.30 |
| **Effectiveness of mitigation, %** | - | 10 | 23.9 | 43.9 | 38.2 | 63.4 | 83.4 | 83.3 |

*[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, 2000) in the Tab. 4-12.

**Tab. 4-12 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 |
|---|---|---|
| Canada<br>Plants without NSCR<br>Plants with NSCR | <br>8.5<br><2 | (IPCC, 2000) |
| USA<br>Plants without NSCR<br>Plants with NSCR | <br>9.5<br>2 | (IPCC, 2000) |
| Norway<br>Process-integrated $N_2O$ destruction<br>Atmospheric pressure plant<br>Medium pressure plant | <br><2<br>4–5<br>6–7.5 | (IPCC, 2000) |
| Other countries<br>Dual-pressure plant (European design)<br>Older plants (pre-1975), without NSCR | <br>8–10<br>10–19 | (IPCC, 2000) |
| Czech Republic<br>Atmospheric pressure plants<br>Medium pressure plants with SCR<br>Medium pressure plants with NSCR<br>High pressure plants SCR (no $N_2O$ decomposition)<br>High pressure plants SCR (with $N_2O$ decomposition) | <br>9.05<br>4.9<br>1.09<br>7.8<br>4.82 – 1.29 | (Markvart and Bernauer, 2009, 2010) |

Tab. 4-13 gives the $N_2O$ emissions from production of nitric acid, including the production values.

**Tab. 4-13 Emission trends for $HNO_3$ production and $N_2O$ emissions**

| | Production of $HNO_3$, *[Gg $HNO_3$ (100 %)]* | Emissions of $N_2O$ *[Gg $N_2O$]* from $HNO_3$ production | Implied Emission Factor IEF *[Mg $N_2O$/ Gg $HNO_3$]* |
|---|---|---|---|
| **1990** | 530.0 | 3.63 | 6.86 |
| **1991** | 349.6 | 2.37 | 6.78 |
| **1992** | 439.4 | 2.98 | 6.77 |
| **1993** | 335.9 | 2.27 | 6.77 |
| **1994** | 439.8 | 2.94 | 6.68 |
| **1995** | 498.3 | 3.37 | 6.68 |
| **1996** | 484.8 | 3.06 | 6.68 |
| **1997** | 483.1 | 3.33 | 6.92 |
| **1998** | 532.5 | 3.59 | 6.74 |
| **1999** | 455.0 | 2.95 | 6.49 |
| **2000** | 505.0 | 3.36 | 6.65 |
| **2001** | 505.1 | 3.32 | 6.57 |
| **2002** | 437.1 | 2.87 | 6.57 |
| **2003** | 500.6 | 2.86 | 5.72 |
| **2004** | 533.7 | 3.27 | 6.13 |
| **2005** | 532.2 | 3.09 | 5.80 |
| **2006** | 543.1 | 2.76 | 5.09 |
| **2007** | 554.2 | 2.28 | 4.11 |
| **2008** | 507.0 | 2.14 | 4.21 |
| **2009** | 505.2 | 1.63 | 3.23 |
| **2010** | 441.7 | 1.21 | 2.73 |
| **2011** | 561.8 | 1.35 | 2.40 |

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. 4-9 and

Tab. 4-10, 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. 4-11) 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, 2012), which takes into account the data in the 2006 Guidelines (IPCC, 2006). The uncertainty in the activity data following adjustment equalled 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 2011.

#### *4.3.2.4 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 Recalculations*

No recalculations in the 2B2 category were employed in this submission.

#### *4.3.2.6 Source-specific planned improvements*

No improvement is planned for the next submission.

### 4.3.3 Other (2B5)

#### *4.3.3.1 Source category description*

This category includes methane emissions from the production of carbon black, ethylene, dichloroethylene, styrene, methanol and $N_2O$ emissions from the production of caprolactam. These are all less important sources.

#### *4.3.3.2 Methodological issues*

Default emissions from the IPCC methodology (IPCC, 1997) are employed to determine methane emissions from the production of carbon black, ethylene, dichloroethylene and styrene.

***$CH_4$ emissions from the production of carbon black***

The nominal capacity is currently 300 t p.a. Exact information on activity data is not available for the individual years; thus, the data were taken as the expert estimates mentioned in the study (Markvart and Bernauer, 2012), taking into account the increase in carbon black consumption in the rubber industry:

1990-2000 200 t carbon black p.a.

2001-2005 250 t carbon black p.a.

2006-2011 300 t carbon black p.a.

The emission factor taken from the IPCC method equals 0.011 kt $CH_4$/kt carbon black, so that the highest value of methane emissions over the past few years is practically insignificant (0.0033 Gg).

***$CH_4$ emissions from the production of ethylene***

Reliable data for the production of ethylene are available from CzSO. The IPCC methodology yields a value of 0.001 kt/kt for the default emission factor for methane. In 1990 – 2011, methane emissions varied between 0.3 and 0.5 Gg $CH_4$ (emissions equalled 0.412 Gg $CH_4$ in 2011).

***$CH_4$ emissions from the production of dichloroethylene***

While CzSO does not publish information on the amount of dichloroethylene produced, it does give data on the amount of PVC produced. The study (Markvart and Bernauer, 2011) recommends multiplying the amount of PVC produced by a coefficient of 1.23 derived from the stoichiometry. The IPCC methodology yields a value of 0.0004 kt/kt for the default emission factor for methane. Because of the low emission factor value, the values of methane emissions varied in 1990 – 2011 between 0.04 and 0.06 Gg $CH_4$ – and this is thus a not very significant value. Emissions equalled 0.049 Gg $CH_4$ in 2011.

***$CH_4$ 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.

2005-2009 150 kt styrene p.a.

from 2010 170 kt styrene p.a.

These estimates of data on the amount of styrene produced, mentioned in the study (Markvart and Bernauer, 2011), are based on the data given in the article (Dvořák and Novák, 2010). The emission factor taken from the IPCC methodology equals 0.004 kt $CH_4$/kt styrene. In 1990 – 2011, methane emissions varied between 0.3 and 0.7 Gg $CH_4$ (emissions equalled 0.68 Gg $CH_4$ in 2011).

Methanol is not produced in the Czech Republic and thus the notation key “NO” applies to the entire time period from 1990.

***Production of caprolactam***

As mentioned in the references (Markvart and Bernauer, 2004 – 2012), 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 Markvart and Bernauer (Markvart and Bernauer, 2004 – 2012), based on a study in the production factory, yields an approximate value of 0.27 Gg $N_2O$ for the period to 2005 and, following 2006, a value of 0.305 Gg $N_2O$, based on increased production capacity. More exact data should be available in the coming years, when the $N_2O$ emissions from the production of caprolactam will be continuously measured from 2012 as a consequence of inclusion of the production in the emission trading scheme (EU ETS) and thus recording in the relevant register.

#### 4.3.3.3 Uncertainties and time-series consistency

In relation to the relatively insignificant greenhouse gas emissions from category 2B5, 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; the numerical values are given in Tab. 1-3, Tab. 1-4 and Tab. 1-5.

#### 4.3.3.4 QA/QC and verification

In relation to the relatively unimportant greenhouse gas emissions from category 2B5, only QC, Tier 1 procedures were used, in accordance with the QA/QC plan.

#### 4.3.3.5 Recalculations

In submissions prior to the 2011 submission, $CH_4$ emissions were reported for the production of carbon black, dichloroethylene and styrene only following 2008 because of the lack of the activity data required for determining emissions. However, the authors of the study (Markvart, Bernauer, 2011) recently managed to obtain the data required for determining $CH_4$ emissions from 1990 (see the “Methodical Issues” section). The newly determined values (replacing symbol “NE”) must be seen as recalculations. This increase of completeness of the inventory has resolved the repeated recommendations of the international inspection team over the past years. In this submission (2013 submission) no recalculation was carried out.

#### *4.3.3.6 Source-specific planned improvements*

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 in 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 improvement is planned for methane emissions in this category.

## 4.4 Metal Production (2C)

### 4.4.1 Source category description

This category includes mainly $CO_2$ emissions from *2C1 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.

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).

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. 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.

### 4.4.2 Methodological issues

$CO_2$ emissions were determined for category 2C1 using a procedure corresponding to Tier 1 of the Good Practice Guidance for 2C1. This calculation was based on the amount of coke consumed in blast furnaces. The calculation was carried out using NCV = 27.77 MJ/kg in 2011 (NCV interval for period 1990 - 2011 is (27.9 - 28.8 MJ/kg) and using the carbon emission factor for coke, 29.5 t C / TJ, which is the IPCC default value (IPCC, 1997). As the final products in metallurgical processes are mostly steel and iron with very low carbon contents, the relevant correction for the amount of carbon remaining in the steel or iron was taken into account by using factor 0.98, i.e. the same factor that is standardly used for combustion of Solid Fuels (the oxidation factor). The major part of $CO_2$ emissions calculated in this manner is, in reality, emitted in the form of the products of combustion of blast-furnace gas occurring mainly in metallurgical plants, while a smaller part is emitted from heat treatment of pig iron during its transformation to steel.

The relevant activity data and corresponding emissions are given in Tab. 4-14.

**Tab. 4-14 Activity data and $CO_2$ emissions from iron and steel in 1990 - 2011**

| Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|
| Coke consumed in blast furnaces, *[kt]* | 4 222 | 2 959 | 3 447 | 2 582 | 2 724 | 2 857 | 2 701 | 2 846 |
| $CO_2$ from 2C1, *[Gg]* | 12 533 | 8 781 | 10 230 | 7 690 | 8 231 | 7 523 | 7 861 | 8 520 |
| | | | | | | | | |
| **Year** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
| Coke consumed in blast furnaces, *[kt]* | 2 750 | 1 941 | 2 327 | 2 175 | 2 252 | 2 459 | 2 628 | 2 260 |
| $CO_2$ from 2C1, *[Gg]* | 8 233 | 5 945 | 7 027 | 6 625 | 6 861 | 7 484 | 7 798 | 6 687 |
| | | | | | | | | |
| **Year** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | | |
| Coke consumed in blast furnaces, *[kt]* | 2 480 | 2 570 | 2 366 | 1 742 | 2 004 | 1 910 | | |
| $CO_2$ from 2C1, *[Gg]* | 7 573 | 7 757 | 7 151 | 5 298 | 5 919 | 5 623 | | |

Estimation of $CH_4$ from metal production is based on the CORINAIR methodology. Metal production emits only 2.3 – 6.0 Gg of methane.

Emissions of methane in 2011 equalled 2.7 Gg, of which 1.3 Gg corresponds to the contribution of methane emissions from coke production. 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. In contrast, the activity data used for calculation of $CO_2$ emissions, correspond to the amount of coke consumed in blast furnaces. These data were determined from the CzSO material “Energy intensity of manufacture of selected products". It should be pointed out that these two series are not completely identical (e.g. part of the coke produced is used for other purposes and imported coke can also be used in blast furnaces).

Emission estimates of precursors for the relevant subcategories have been transferred from NFR to CRF, as described in previous chapters.

### 4.4.3 Uncertainty and time consistency

The uncertainty estimates have so far been based on expert judgment (see Tab. 1-3, Tab. 1-4 and Tab 1-5 in Chapter 1.7). Their improvement is ongoing and some uncertainty estimates for Iron and steel production have recently been revised (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).

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 2011.

### 4.4.4 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.

### 4.4.5 Recalculations

No recalculations in the 2C category were employed in this submission.

### 4.4.6 Source-specific planned improvements

Application of more advanced Tier 2 methodology for Iron and steel production is planned for the next submission. At the present time, options are being explored for obtaining the relevant data for this purpose.

## 4.5 Other Production (2D)

In this sector are reported only indirect GHGs and $SO_2$ from sectors Pulp and Paper; Food and Drink.

## 4.6 Production of Halocarbons and $SF_6$ (2E)

Halocarbons and $SF_6$ are not produced in Czech Republic.

# 4.7 Consumption of Halocarbons and $SF_6$ (2F)

## 4.7.1 Source category description

Emissions of F-gases (HFCs, PFCs, $SF_6$) in the Czech Republic are at a relatively low level due to the absence of large industrial sources of F-gases emissions. As mentioned above, F-gases are not produced in the Czech Republic and 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. F-gases emissions decreased in 2011 compared to 2010 as a result of lower production in the air-conditioning, refrigeration and car industry and partially as a result of a change in technology in some industries.

1. $SF_6$ used in electrical equipment,
2. $SF_6$ used in production of sound-proof windows,
3. $SF_6$ used in special applications (laboratory),
4. HFCs, PFCs and $SF_6$ used in semiconductor manufacturing,
5. HFCs and PFCs used as refrigerants in refrigeration and air conditioning equipment,
6. HFCs used as propellants in aerosols,
7. HFCs used as blowing agents,
8. HFCs used as extinguishing agents in fixed fire-fighting systems.

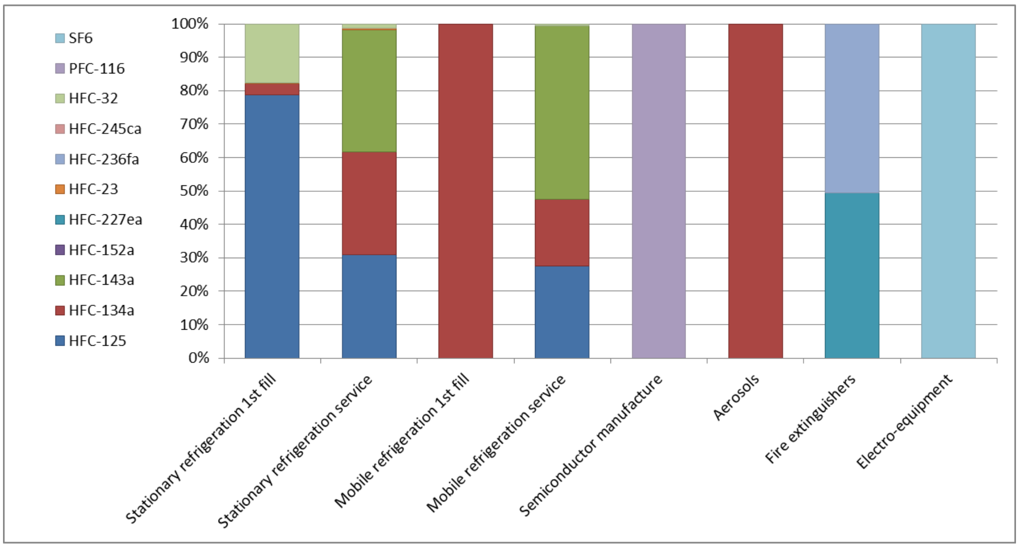



**Fig. 4-6 Share of F-gases in individual applications in 2011 as reported by individual users**

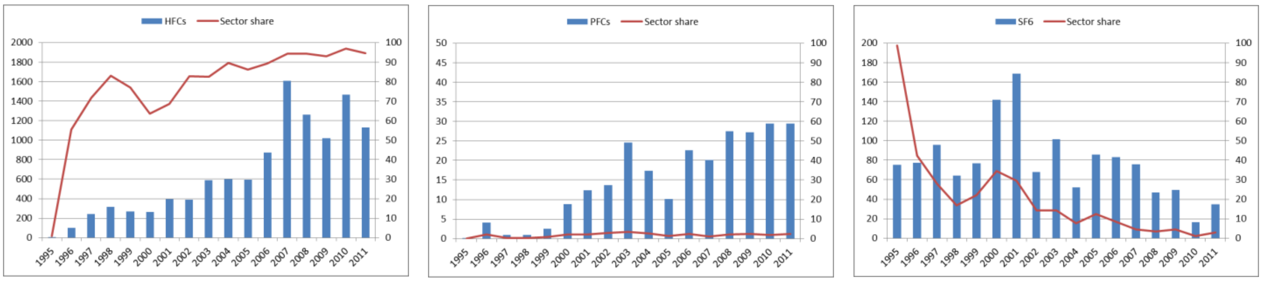



**Fig. 4-7 Emissions of HFCs, PFCs and $SF_6$ in Gg $CO_2$ eq. and their percentual share in category 2F (from left: HFCs, PFCs, $SF_6$)**

No official statistics that would allow easy disaggregated reporting and/or use of the highest tiers are currently available in the Czech Republic. Inventory of potential and actual emissions of F-gases is based on customs statistics, the national database of obligatory reporting (ISPOP) and individual verification/rectification 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.

For source consumption of F-gases, potential emissions increased from 169.38 Gg $CO_2$ eq. in 1995 to 3 575.30 Gg $CO_2$ eq. in 2010. The increase in 2010 compared to 2009 could have been explained by recovery from economic recession, but the 2011 data exhibit another slight decrease. For the source consumption of F-gases, actual emissions increased from 76.06 Gg $CO_2$ eq. in 1995 to 1 194.40 Gg $CO_2$ eq. in 2011. This significant increase could be explained as being mainly due to a substantial increase in the use of HFCs in refrigeration. The marked sharp decrease between 2007 and 2009 is due to a decrease in production as a result of the economic crisis. Detailed information about actual and potential emissions is given in Tab. 4-15 and in the CRF Tables.

**Tab. 4-15 Potential and actual emissions of HFCs, PFCs and $SF_6$ in 1995 - 2011 [Gg $CO_2$ eq.]**

| | Potential | | | | Actual | | | |
|---|---|---|---|---|---|---|---|---|
| | HFCs | PFCs | $SF_6$ | Total | HFCs | PFCs | $SF_6$ | Total |
| **1995** | 2.21 | 0.35 | 166.82 | 169.38 | 0.73 | 0.12 | 75.20 | 76.06 |
| **1996** | 134.51 | 4.22 | 183.07 | 321.80 | 101.31 | 4.11 | 77.52 | 182.94 |
| **1997** | 479.44 | 1.17 | 180.49 | 661.10 | 244.81 | 0.89 | 95.48 | 341.18 |
| **1998** | 577.87 | 1.17 | 126.02 | 705.07 | 316.56 | 0.89 | 64.19 | 381.63 |
| **1999** | 411.87 | 2.74 | 110.90 | 525.50 | 267.47 | 2.55 | 76.98 | 347.01 |
| **2000** | 674.32 | 9.45 | 206.02 | 889.79 | 262.50 | 8.81 | 141.92 | 413.23 |
| **2001** | 1 045.13 | 14.49 | 223.23 | 1 282.84 | 393.37 | 12.35 | 168.73 | 574.45 |
| **2002** | 1 092.41 | 17.91 | 211.85 | 1 322.17 | 391.29 | 13.72 | 67.72 | 472.73 |
| **2003** | 1 343.94 | 28.64 | 339.26 | 1 711.84 | 590.14 | 24.53 | 101.25 | 715.93 |
| **2004** | 1 215.00 | 20.98 | 208.00 | 1 443.98 | 600.30 | 17.33 | 51.89 | 669.51 |
| **2005** | 1 280.55 | 13.77 | 156.88 | 1 451.20 | 594.21 | 10.08 | 85.88 | 690.17 |
| **2006** | 2 573.99 | 30.33 | 161.90 | 2 766.21 | 872.35 | 22.56 | 83.07 | 977.98 |
| **2007** | 3 884.78 | 27.57 | 133.84 | 4 046.18 | 1 605.85 | 20.16 | 75.85 | 1 701.86 |
| **2008** | 3 053.38 | 38.25 | 85.32 | 3 176.95 | 1 262.45 | 27.48 | 47.04 | 1 336.98 |
| **2009** | 2 355.90 | 39.38 | 132.17 | 2 527.44 | 1 045.67 | 27.14 | 49.61 | 1 118.41 |
| **2010** | 3 854.62 | 44.25 | 16.73 | 3 915.60 | 1 503.36 | 29.43 | 16.22 | 1 549.01 |
| **2011** | 3 475.38 | 2.42 | 97.50 | 3 575.30 | 1 130.42 | 29.43 | 34.55 | 1 194.40 |

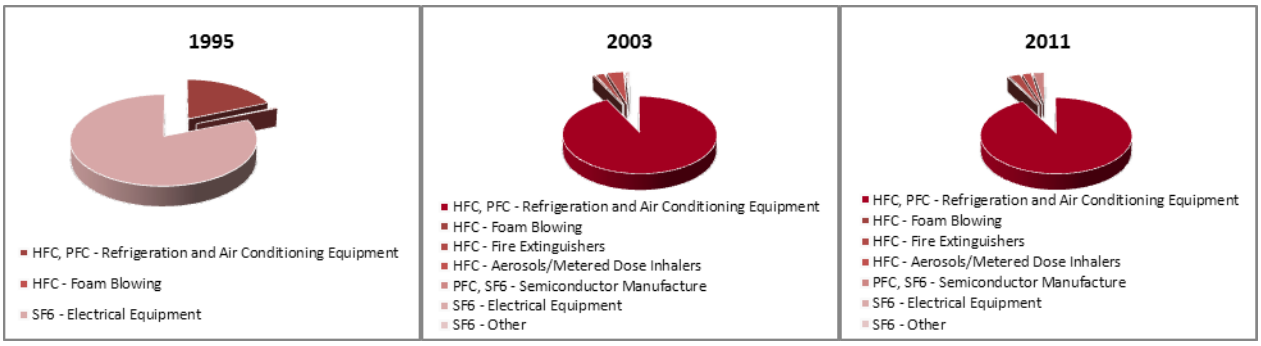



**Fig. 4-8 Share of different F-gases in subcategories in 1995, 2003 and 2011**

### 4.7.2 General methodological issues

Currently, the national F-gas inventory is based on the method of actual emissions. The method of potential emissions is used only as supporting information.

According to the Revised 1996 Guidelines (IPCC, 1997), potential emissions have been calculated from the consumption of F-gases (sum of domestic production and import minus export and environmentally sound disposal). Due to the relatively short time of use of F-gases, the disposed amount is relatively small and considered negligible for the inventory process. In 2011, a small amount of destroyed F-gases was reported, where the main volume of recovered and destroyed F-gases 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 potential methodology is the same for all categories of use of F-gases. The actual emission methodology is specified for each category.

As these substances are not produced nationally, import and export information coming from official customs authorities are of key importance. Individual F-gases do not have separate custom codes in the customs tariff list as individual chemical substances. $SF_6$ is listed as part of a cluster of non-metal halogenides and oxides, 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 potential and actual emissions. Emissions of F-gases are based on data on import and export of individual chemicals or their mixtures (as bulk), but not contents in products.

### 4.7.3 Sector-specific methodological issues

This chapter specifies the actual emission methodology used for a given sector. In the following chapters, individual sectors with similar methodology are combined. A similar approach is used in the foam blowing and sound-proof windows sectors for estimation of actual emissions, and thus the approach is described in one joint chapter. Detailed information on the data and methodology used are included in a special report prepared in 2012 by the external sectoral expert, Mr. Řeháček (Řeháček, 2012).

The most important category in the range of actual emissions is Refrigeration and Air Conditioning Equipment, which is responsible for 95.38 % of actual F-gases emissions.

#### *4.7.3.1 Refrigeration and Air Conditioning Equipment*

In the CRF Tables, emissions from this category are divided into only two sub-categories:

2F11 Domestic Refrigeration and 2F16 Mobile Air-Conditioning; emissions from other subcategories are included in these two categories because of the lack of detailed information. The methodology used in these calculations underestimates the real emissions, as information about marketed products containing F-gases is not taken into account. The underestimation for 2011 is relatively low, but will be a very important “source” in a few years, e.g. in 2025 it will correspond to additional emissions of approximately 1.5 mil t $CO_2$ eq. Measures to obtain relevant data to split the emission categories are in progress.

The main coolant media type used for the purpose of mobile air-conditioning is HFC134a 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 50/50.

In 2011 no significant change occurred in the collection and treatment policies of discarded refrigeration appliances. Companies in the market remained unchanged. Experiments have been performed in the true regeneration of disposed F-gases by only one company. They used privately constructed distilling machinery to process 1.35 t of HFC134a contaminated by mineral oil fractions. The HFC was collected and stored during previous years. Emissions from this process were 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 12-year life cycle (as reported by CzSO) in accordance with expectations. A mixture of retrieved cooling media is being incinerated is specialized facilities. In one case, the retrieved mixture of ODS is exported as a raw material for a different industrial process than air-conditioning or refrigeration. A very small amount of coolant medium (R 410) is exported for purposes of re-generation, where this amount depends on claims in the automobile market and remains at a level of in 0-3 t p.a.

Emissions from Mobile Air-Conditioning include emissions from the “First-Fill” in three Czech automobile factories and from servicing old equipment. The calculation was performed using Equation 3.44 from 2000 GPG (IPCC, 2000); recently, it has been assumed that emissions from disposal and destruction are negligible because of the relatively short time of use of F-gases in this sector. This fact is also supported by the information on disposed refrigerants (Řeháček, 2012). The contribution of this sector to total actual F-gases emissions was 24.70 % in 2011. It can be anticipated that emissions from this category will increase in the future.

Emissions from Domestic Refrigeration include emissions from servicing old equipment and emissions from production of new air-conditioning equipment since 2007. The calculation is performed using the Tier 2 top-down approach methodology (Equation 3.40 from 2000 GPG). This sector has the greatest share in the total actual emissions of F-gases, which equalled 70.67 % in 2011.

#### *4.7.3.2 Foam Blowing and Production of Sound-Proof Windows*

F-gases were used in the Czech Republic only for producing hard foam. Only HFC-143a was used regularly for foam blowing. HFC-227ea and HFC-245ca were used once in previous years for testing purposes. Use of HFC for foam blowing was not reported in 2011. Due to high costs, HFCs are being replaced by other hydrocarbons.

$SF_6$ usage for production of sound-proof windows is dropping and the amount used has been decreasing since 2003. $SF_6$ was not reported for use in the first fills of new sound-proof windows and emissions in 2011 came only from stock. $SF_6$ is being replaced by argon and its mixtures with other hydrocarbons.

Emissions from these different categories are calculated in a similar way. The default methodology and EF described in 2000 GPG (IPCC, 2000) are used for sound-proof windows, specifically Equations 3.24 and 3.35. Similar equations are used for foam blowing. The contribution of foam blowing and production of sound-proof windows to total emissions of F-gases equalled 0.23 and 0.28 %, respectively, in 2011.

#### *4.7.3.3 Fire Extinguishers*

Emissions from this category are calculated on the basis of GPG 2000 (IPCC, 2000). Calculations are based on data about production of new equipment and data about servicing of old equipment. The share of this sector in total actual F-gases emissions was 2.51 % in 2011.

It was revealed in consultations with servicing companies that first-fill leakages are very low and remain below 2 %. Operational leakages are virtually non-existent and depend solely upon activation of fire alarms. The major operator of fire brigades in the Czech Republic claims zero activation in 2011.

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 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-227, while some installations are filled with HFC-236. Due to reuse of regenerated old halon mixtures, HFCs are being introduced rather slowly.

#### *4.7.3.4 Aerosols / Metered Dose Inhalers and Solvents*

Emissions from these categories (2F4 Aerosols / Metered Dose Inhalers and 2F5 Solvents) are based on 2000 GPG (IPCC, 2000) and Equation 3.35; EF equals 50 %. A small amount of F-gases used as solvents was reported in the Czech Republic in 2011. The contribution of this sector to the total actual F-gas emissions equalled 2.09 % in 2011. F-gases as propellants for aerosols are currently being replaced by cheaper propellants, specifically dimethylether and other hydrocarbons.

#### *4.7.3.5 Semiconductor Manufacture*

Actual emissions in this category are calculated on the basis of Tier 1 methodology. In 2011, emissions in this category equalled 2.43 Gg $CO_2$, which corresponds to 0.07 % of sectoral emissions. This category is not very important and its reported emissions do not exceed the overall uncertainty in emissions in this sector.

#### *4.7.3.6 Electrical Equipment*

Emissions from this category are calculated according to 2000 GPG (IPCC, 2000), specifically Equation 3.13, which is called the Tier 3a method. Basic data about new equipment and services can be obtained from the above-mentioned questionnaires. This equipment is produced by only one company and is serviced by several companies. Emissions from this category correspond to 2.61 % of the total actual emissions of F-gases in 2011. The share of this category in the total actual emissions has decreased rapidly since 1995 due to a decrease in the use of $SF_6$ in this sector and increase in the use of HFCs in refrigeration and air-conditioning.

The users of electrical equipment maintain very eco-friendly policies, also due to the high costs of the coolant media. Operational leakage is not measured (legislation does not force operators to do so) but can be estimated based on stock change. 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. In 2011, stock change corresponded to leakage of 70 kg of $SF_6$.

$SF_6$ for use in electrical equipment is mainly imported as the part of the equipment which is filled below the operational amount. First servicing could then be considered as "first fill". Bulk imports are mostly imported for the purpose of operational stock-in-trade.

#### *4.7.3.7 Others*

This category includes the 2F9 Other / Laboratories category. 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 2011.

### 4.7.4 Uncertainty and time-series consistency

The uncertainty estimates were based on expert judgment (see Chapter 1.7 Uncertainty Analysis). Their improvement is ongoing and is planned for inclusion in the next NIR.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2011.

### 4.7.5 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 important importers and/or exporters. The methodology and calculations were performed twice independently and were compared. This comparison indicates a slight EF fault for $SF_6$ emissions.

### 4.7.6 Source-specific recalculations

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.

### 4.7.7 Source-specific planned improvements

New models taking into account the lifetimes of refrigeration and air-conditioning equipment have already been developed and implemented. Accounting for F-gases contained in products is still being developed and its inclusion is planned for the next submission.

A research on basic data mandatory to perform Tier 2 uncertainty assessment is in progress, and partial results have been published in a research project conducted in 2012 (Development of a monitoring system for Inventories and Projections of Greenhouse Gases in Czech Republic, CHMI 2012b). It is officially planned that the Tier 2 uncertainty assessment will be incorporated in the next submission.

## 4.8 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.

# 5 Solvent and Other Product Use (CRF Sector 3)

NMVOC emission shows a long-term decreasing trend. This is caused by many factors, the chief of which are primarily gradual replacement of synthetic coatings and other agents with a high content of volatile substances by water-based coatings and other preparations with low solvent contents in industry and amongst the population. In addition, BAT have been introduced in large industrial sources, especially those covered by the regime of Act No. 76/2002 Coll., on integrated prevention (IPPC). This favourable trend has been slowed down recently by increasing domestic production, especially in the automobile industry. Fig. 5-1 indicates the trend of NMVOC emissions in 2011 and the share of individual subcategories in the whole sector 3.

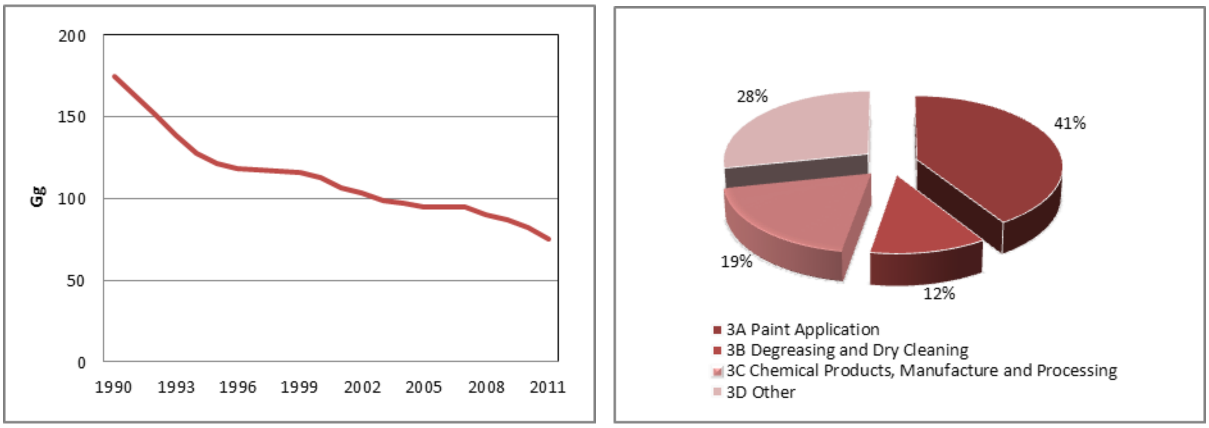



**Fig. 5-1 Trend of NMVOC emissions from Solvent and Other Product Use in 2011; share of individual subcategories in the whole sector 3 Solvent and Other Product Use**

## 5.1 Source category description

This category includes particularly emissions of NMVOC (ozone precursor) from the use of solvents, which are simultaneously considered to be a source of $CO_2$ emissions (these solvents are mostly obtained from fossil fuels), as their gradual oxidation in the atmosphere is also a factor. However, the use of solvents is not an important source of $CO_2$ emissions - in 2011, $CO_2$ emissions were calculated at the level of 0.237 Mt $CO_2$.

This category (Solvent and Other Product Use) also includes $N_2O$ emissions from the use of this substance in the food industry (aerosol cans) and in health care (anaesthesia). These not very significant emissions corresponding to 0.75 Gg $N_2O$ were derived from production in the Czech Republic (0.6 Gg $N_2O$) and from import of $N_2O$ (0.15 Gg $N_2O$), see (Markvart and Bernauer, 2010, 2011, 2012).

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.

Now the authors of the study (Markvart and Bernauer, 2012) have managed to perform studies leading to the qualified estimate that approx. 80 % of the $N_2O$ is used in medicine (anaesthesia). This estimate applies to the entire 1990 – 2011 time period.

## 5.2 Methodological issues

The IPCC methodology (IPCC, 1997) 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.

**Tab. 5-1 Conversion from SNAP into IPCC nomenclature**

| SNAP | SOLVENT AND OTHER PRODUCT USE | IPCC | |
|---|---|---|---|
| 06 01 | Paint application | 3A | Paint application |
| | Items 06.01.01 to 06.01.09 | | |
| 06 02 | Degreasing, dry cleaning and electronic | 3B | Degreasing and dry cleaning |
| | Items 06.02.01 to 06.02.04 | | |
| 06 03 | Chemical products manufacturing or processing. | 3C | Chemical products |
| | Items 06.03.01 to 06.03.14 | | |
| 06 04 | Other use of solvents + related activities | 3D | Other |
| | Items 06.04.01 to 06.04.12 | | |
| 06 05 | Use of $N_2O$ | 3D | Other |
| | Items 06.06.01 to 06.06.02 | | |

Inventory of NMVOC emissions for 2011 for this sector is based on a study prepared by SVÚOM Ltd. Prague (Geimplová, 2012). This study is elaborated annually for the UNECE / CLRTAP inventory in NFR and is also adopted for the National GHG inventory.

Solvent Use chapter is 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 used in the individual categories and subcategories vary considerably. Basic processing of data is performed in a more detailed classification than that used in the CRF Reporter. A survey of the individual groups of products and the formats of the activity data for basic processing of emission data are apparent from the following survey.

It is apparent from the Tab. 5-2 that uniform expression of the activity data cannot be employed, as this corresponds in the individual cases to consumption of coatings, degreasing agents, solvents and, in some cases, the weight of the final production, e.g. Dry Cleaning. Consequently, total NMVOC emissions are employed as activity data in the CRF Reporter.

NMVOC emissions oxidize relatively rapidly in the atmosphere, so that $CO_2$ emissions generated as a consequence of this atmospheric oxidation are also reported in CRF. The $CO_2$ emissions are calculated using a conversion factor that contains the ratio C/NMVOC = 0.855 and a recalculation ratio of C to $CO_2$ equal to 44/12. The overall conversion factor has a value of 3.14.

**Tab. 5-2 Structure for basic processing of emission data and the dimensions of activity data**

| **A Paint Application** | **EF - units** |
|---|---|
| PAINT APPLICATION - MANUFACTURE OF AUTOMOBILES | $10^3$ $m^2$ |
| PAINT APPLICATION - CAR REPAIRING | t of paint |
| PAINT APPLICATION - CONSTRUCTION AND BUILDINGS | t of paint |
| PAINT APPLICATION - DOMESTIC USE | t of paint |
| PAINT APPLICATION - COIL COATING | $10^3$ $m^2$ |
| PAINT APPLICATION - WOOD | t of paint |
| OTHER INDUSTRIAL PAINT APPLICATION | t of paint |
| OTHER NON INDUSTRIAL PAINT APPLICATION | t of paint |
| B Degreasing and Dry Cleaning | |
| METAL DEGREASING | t |
| DRY CLEANING | t |
| ELECTRONIC COMPONENTS MANUFACTURING | t |
| OTHER INDUSTRIAL CLEANING | t |
| C Chemical Products Manufacture / Processing | |
| POLYESTER PROCESSING | t |
| POLYVINYLCHLORIDE PROCESSING | t |
| POLYSTYRENE FOAM PROCESSING | t |
| RUBBER PROCESSING | t |
| PHARMACEUTICAL PRODUCTS MANUFACTURING | t |
| PAINTS MANUFACTURING | t |
| INKS MANUFACTURING | t |
| GLUES MANUFACTURING | t |
| ADHESIVE MANUFACTURING | t |
| ASPHALT BLOWING | t |
| TEXTILE FINISHING | $10^3$ $m^2$ |
| LEATHER TANNING | $10^3$ $m^2$ |
| D Other | - |

## 5.3 Uncertainties and time-series consistency

Last year, research was conducted in order to develop new uncertainty estimates. In sector 3, only uncertainties for activity data in category 3D1 Use of $N_2O$ for Anaesthesia, i.e. 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.

Time series consistency is ensured as the inventory approaches concerned are employed identically across the whole reporting period from the base year 1990 to 2011.

## 5.4 Source-specific QA/QC and verification

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 for all of Sector 3 – Solvent and Other Product Use – 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. It was found that more exact data were available to 2000, permitting assignment of consumption of the individual types of solvents and other preparations containing NMVOC to individual subcategories, from which the emissions are calculated in 4 main subcategories of *Sector 3 Solvent and Other Product Use*. As the total consumption of substances containing NMVOC in all of CR is relatively well known, from 2000 the emissions that could not be identified in the individual subcategory *3B Decreasing and Dry Cleaning* were transferred to *Category 3D Other Solvent Use*, because they were missing in the overall balance.

## 5.5 Source-specific recalculations

The errors in categories 3A – 3C in the reported data for 2010 were determined during the QC procedure. These discrepancies were corrected in this submission.

## 5.6 Source-specific planned improvements

The value of the conversion factor (3.14) is slightly higher compared to other countries. It is planned to try to obtain background information for a country-specific value. Because of funding shortage it was not possible to obtain data about carbon content in solvents used in CR.

# 6 Agriculture (CRF Sector 4)

## 6.1 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) and agricultural soils ($N_2O$ 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 are derived 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.

### 6.1.1 Key categories

For Agriculture, five of six relevant categories of sources were evaluated by analysis decribed in IPCC (2000 and 2003) as the key categories. An overview of sources, including their contribution to aggregate emissions, is given in Tab. 6-1.

**Tab. 6-1 Overview of significant categories in this sector (2011)**

| Category | | Character of category | Gas | % of total GHG* |
|---|---|---|---|---|
| 4D1 | Agricultural soils, direct emissions | KC (LA, TA, LA*, TA*) | $N_2O$ | 2.2 |
| 4A | Enteric fermentation | KC (LA, TA, LA*, TA*) | $CH_4$ | 1.5 |
| 4D3 | Agricultural soils, indirect emissions | KC (LA, TA, LA*, TA*) | $N_2O$ | 1.3 |
| 4B | Manure management | KC (LA, TA, LA*, TA*) | $N_2O$ | 0.5 |
| 4B | Manure management | KC (TA) | $CH_4$ | 0.3 |
| 4D2 | Pasture, range and paddock manure | Non-KC | $N_2O$ | 0.2 |

** 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*

### 6.1.2 Quantitative overview

Agriculture is the third largest sector in the Czech Republic with 6.4 % of total GHG emissions (incl. LULUCF) in 2011 with 8 064.84 Gg $CO_2$ eq.; 62 % of emissions is coming from Agricultural Soils, 25 % from Enteric Fermentation and 13 % from Manure Management.

The $CH_4$ emissions from agriculture present about 30 % of total national $CH_4$ emissions and the $N_2O$ emissions from agriculture present about 70 % of total national $N_2O$ emissions in 2011. During period 1990-2011 emissions from Agriculture decreased by almost 50 %. The quantitative overview and emission trends in reported period are provided in Fig.6.1 and Tab. 6-2.

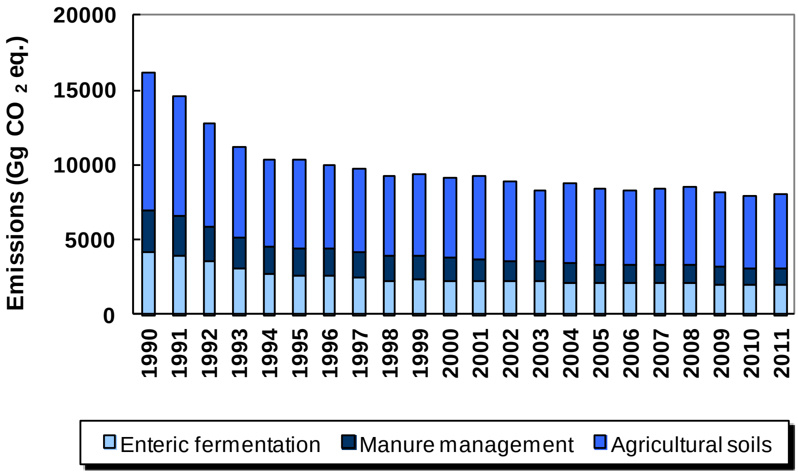



**Fig. 6-1 The emission trend in agricultural sector during reporting period 1990–2011 (in Gg $CO_2$ eq.)**

**Tab. 6-2 Emissions of Agriculture in period 1990-2011 (sorted by categories)**

| Year | Total Emissions | Enteric Fermentation *(4A)* | Manure Management *(4B)* | Agricultural Soils *(4D)* |
|---|---|---|---|---|
| | [Gg $CO_2$ eq.] | | | |
| **1990** | 16 233 | 4 219 | 2 710 | 9 304 |
| **1991** | 14 612 | 3 980 | 2 585 | 8046 |
| **1992** | 12 731 | 3 568 | 2 344 | 6 819 |
| **1993** | 11 205 | 3 088 | 2 106 | 6 011 |
| **1994** | 10 372 | 2 705 | 1 862 | 5 806 |
| **1995** | 10 332 | 2 632 | 1 742 | 5 959 |
| **1996** | 9 966 | 2 608 | 1 802 | 5 557 |
| **1997** | 9 758 | 2 436 | 1 745 | 5 578 |
| **1998** | 9 285 | 2 284 | 1 654 | 5 346 |
| **1999** | 9 350 | 2 334 | 1 659 | 5 357 |
| **2000** | 9 095 | 2 241 | 1 544 | 5 310 |
| **2001** | 9 221 | 2 257 | 1 483 | 5 481 |
| **2002** | 8 956 | 2 209 | 1 414 | 5 332 |
| **2003** | 8 315 | 2 186 | 1 351 | 4 778 |
| **2004** | 8 750 | 2 139 | 1 299 | 5 313 |
| **2005** | 8 385 | 2 094 | 1 236 | 5 054 |
| **2006** | 8 250 | 2 064 | 1 218 | 4 968 |
| **2007** | 8 403 | 2 084 | 1 212 | 5 107 |
| **2008** | 8 583 | 2 103 | 1 179 | 5 301 |
| **2009** | 8 134 | 2 047 | 1 107 | 4 980 |
| **2010** | 7 965 | 1 999 | 1 079 | 4 886 |
| **2011** | 8 065 | 2 003 | 1 043 | 5 019 |

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 (especially cattle) while the decrease in emissions derived from manure (especially swine 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.

During the in-country review in August/September 2010, the expert review team (ERT) identified the estimation of $N_2O$ emissions from Manure management of dairy cattle as a potential problem. 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 an 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. 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 the "Suckler cows" sub-category from Dairy cattle to Non-dairy cattle
2. More accurate animal population data (not rounded off to thousands) reported (cattle, swine, sheep and poultry).
3. More accurate data for individual cattle sub-categories (suckler and dairy cows, young heifers, young bulls and calves) reported (not rounded off to thousands) for the period since 2006 (since when the detailed data are available).
4. 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. Tier 2 methods implemented for the emission estimation of Manure management of dairy and non-dairy cattle.
5. Additionally, a new country-specific parameter on digestibility (DE, in %) was determined and implemented in the 2012 submission.

Given that the value of Nex for cattle was revised based on the recommendation of ERT (2011), it led to changes in $N_2O$ emissions from Animal manure applied to soils, Pasture, range and paddocks (PRP), Atmospheric deposition and N-lost through leaching and run-off. These changes apply to the entire reporting period.

The recalculation requested based on the document “Potential problems from ERT (Saturday paper)” led to increased emissions by about 14 % relative to the older approach (submission 2011). The use of updated country-specific data for cattle in calculation of emissions in the 2012 submission resulted in a decrease in emissions by about 1.2 % in 1990 and increase by about 0.6 % in 2009 compared to the 2011 submission.

Two categories were recalculated in the 2012 resubmission. Potatoes, sugarbeets, clover and alfalfa were included in the source of emissions in the Agricultural soils categories (4D1.3 a 4D1.4). The addition of new country-specific data in the calculation resulted in an increase in the total emissions from the Agriculture sector by 2.3 % in 2012. A detailed description of the recalculation is presented in the appropriate chapter (6.4 - Agricultural soils).

## 6.2 Enteric Fermentation (4A)

### 6.2.1 Source category description

This chapter describes estimation of the $CH_4$ emissions from Enteric Fermentation. In 2011, 84.1 % of agricultural $CH_4$ emissions arose from this source category (Table 6-2). This category includes emissions from cattle (dairy and non-dairy), swine, sheep, horses and goats. Buffalo, camels and llamas, and mules and asses do not occur in the Czech Republic. Enteric fermentation emissions from poultry have not been estimated, the IPCC Guidelines do not provide a default emission factor for this animal category.

### 6.2.2 Methodological issues

Emissions from enteric fermentation of domestic livestock have been calculated by using IPCC Tier 1 and Tier 2 methodologies presented in the Revised 1996 Guidelines (IPCC, 1997) and Good Practice Guidance (IPCC, 2000). Methane emissions for cattle, which are a dominant source in this category, have been calculated using the Tier 2 method, while for other livestock the Tier 1 method was used. The contribution of emissions from livestock other than cattle to the total emissions from enteric fermentation is not significant.

#### *6.2.2.1 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. according to the Revised 1996 Guidelines (IPCC, 1997) and Good Practice Guidance (IPCC, 2000) is proportional to the daily food intake and the conversion factor. It thus holds that

$$EF_i = 365 / 55.65 * \text{daily food intake}_i * Y$$

where the “daily food intake” (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 facto, which is considered to be Y = 0.06 for cattle. 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, 1990–2011), provides following categorization of cattle:

- Calves younger than 6 months[10] of age (male and female)
- Young bulls and heifers (6-12 months of age[11])
- 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 1990-2011 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, 1997 and IPCC, 2000), the “daily food intake” for each subcategory of cattle is not measured directly, but is calculated from national zoo-technical inputs, mainly weight (including the final weight of mature animals), 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. 2011) are given below, Tab. 6-3 and Tab. 6-4.

**Tab. 6-3 Weights of individual categories of cattle, 1990–2011, 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 | 540* |
| **Calves to 6 months** | 128 | 132 | 133 | 135 | 135* |

*Note: * Since 2009 the age limit for “Calves” shifted up to 8 months.*

[10] *Since 2009 the age limit for “Calves” shifted up to 8 months.*

[11] *Since 2009 the age limit for “Young bulls and heifers” shifted up to 8 -12 months.*

**Tab. 6-4 Feeding situation, 1990–2011, 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 | 22 | 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.*

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. 6-5), in which only milk from dairy cows is considered, increased to 19.53 liters/day/head in 2011, with an average fat content of 3.88 %. Milk from suckler cows is not included in the table 6.5; a relevant daily milk production of 3.5 l /day head was used for the calculation. 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", as well as the relevant cells in the CRF. 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. Based on 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 1995 and Zeman et. al., 2006; Třináctý 2009; Čermák et al., 2008). Dr. Pozdíšek (expert from the Research Institute for Cattle Breeding, Ltd., pers. communication) 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 %

Details of the calculation are given in the above-mentioned study (Kolar, Havlikova and Fott, 2004) and the results are illustrated in Tab. 6-6. 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 1990-2011 period to about one half of the former values due to the rapid decreases in the numbers of animals kept.

**Tab. 6-5 Milk production of dairy cows and fat content (1990–2011)**

| | 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 |

### 6.2.3 Enteric fermentation of other livestock

Compared to cattle, the contribution of other farm animals to the whole $CH_4$ emissions from enteric fermentation is much smaller, only about 5,5 %. Therefore, $CH_4$ emissions from enteric fermentation of other farm animals (other than cattle) are estimated by the 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 (1990-2011).

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.

**Tab. 6-6 Methane emissions from enteric fermentation, cattle (Tier 2, 1990–2011)**

| | Dairy cows | Other cattle | EF. cows | EF. other | Em. cows | Em. other | Emissions |
|---|---|---|---|---|---|---|---|
| | [thous.] | [thous.] | [kg $CH_4$ / hd] | [kg $CH_4$ / hd] | [Gg $CH_4$] | [Gg $CH_4$] | [Gg $CH_4$] |
| **1990** | 1206 | 2300 | 82.35 | 39.25 | 99.33 | 90.28 | 189.61 |
| **1991** | 1165 | 2195 | 79.01 | 39.41 | 92.08 | 86.50 | 178.58 |
| **1992** | 1006 | 1943 | 80.67 | 40.38 | 81.17 | 78.48 | 159.65 |
| **1993** | 902 | 1609 | 80.96 | 40.08 | 73.06 | 64.49 | 137.56 |
| **1994** | 796 | 1366 | 82.81 | 40.03 | 65.90 | 54.67 | 120.56 |
| **1995** | 732 | 1298 | 86.29 | 41.98 | 63.18 | 54.47 | 117.66 |
| **1996** | 713 | 1275 | 87.78 | 42.28 | 62.63 | 53.91 | 116.55 |
| **1997** | 656 | 1210 | 86.09 | 42.88 | 56.50 | 51.87 | 108.37 |
| **1998** | 598 | 1103 | 90.27 | 43.04 | 53.97 | 47.48 | 101.44 |
| **1999** | 583 | 1074 | 94.16 | 45.57 | 54.90 | 48.96 | 103.86 |
| **2000** | 548 | 1026 | 96.42 | 45.92 | 52.82 | 47.10 | 99.92 |
| **2001** | 529 | 1053 | 98.17 | 46.52 | 51.97 | 48.98 | 100.96 |
| **2002** | 496 | 1024 | 101.59 | 47.29 | 50.42 | 48.42 | 98.83 |
| **2003** | 490 | 984 | 103.98 | 47.60 | 50.99 | 46.81 | 97.80 |
| **2004** | 476 | 952 | 106.20 | 47.53 | 50.54 | 45.27 | 95.80 |
| **2005** | 438 | 960 | 108.46 | 48.31 | 47.49 | 46.36 | 93.84 |
| **2006** | 424 | 950 | 109.56 | 48.35 | 46.45 | 45.91 | 92.36 |
| **2007** | 410 | 981 | 111.07 | 48.45 | 45.58 | 47.53 | 93.11 |
| **2008** | 406 | 996 | 112.85 | 48.88 | 45.76 | 48.69 | 94.45 |
| **2009** | 400 | 964 | 113.82 | 48.77 | 45.47 | 47.00 | 92.47 |
| **2010** | 384 | 966 | 114.26 | 47.91 | 43.82 | 46.27 | 90.09 |
| **2011** | 374 | 970 | 116.55 | 48.29 | 43.57 | 46.84 | 90.41 |

### 6.2.4 Uncertainties 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. 6-1 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 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 options:

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 the 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.

Increased attention was first 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 the 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 was 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 based on expert judgement.

The uncertainty in the activity data equals 5 %.

The uncertainty in the emission factor equals 20 %.

The combined uncertainty, calculated according to IPCC GPG Tier 1 methodology, equals 20.6 %.

### 6.2.5 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in the Chapter 6.5.

### 6.2.6 Source-specific recalculations

Reallocation of the sub-category *Suckler cows* from *Dairy cattle* to *Non-dairy cattle* was performed in the 2012 submission.

Also more accurate animal population data (not off to thousands) of cattle, swine, sheep, poultry was used for the entire period and more precise data for cattle populations (cattle sub-categories) are reported (not rounded off to thousands) since 2006 where data are available.

Last but not least, the new digestibility values (DE) were employed for cattle (dairy cows, suckler cows and other cattle).

These changes in the activity data and input parameters resulted in changes in emissions for the entire reporting period.

### 6.2.7 Source-specific planned improvements

The analysis of uncertainties is currently in progress.

## 6.3 Manure Management (4B)

This chapter describes the estimation of $CH_4$ and $N_2O$ emissions from animal manure. In 2011, 15.91 % of agricultural $CH_4$ emissions (18.04 Gg $CH_4$) and 11.7 % of agricultural $N_2O$ emissions (2.14 Gg $N_2O$) were caused by this source category. Total emissions from Manure Management are 1 042.77 Gg $CO_2$ eq. in 2011.

### 6.3.1 Source category description

During period 1990-2011 emissions from Manure Management decreased by 60 %. Emissions from cattle and swine dominate the trend (see Tab. 6-7). The reduction in the cow 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 nitrogen. 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. 6-7 Manure Management emissions in the period 1990-2011**

| Year | Emissions from *Manure Management* | | | |
|---|---|---|---|---|
| | $CH_4$ emissions | | $N_2O$ emissions | |
| | [Gg $CH_4$] | [Gg $CO_2$ eq.] | [Gg $N_2O$] | [Gg $CO_2$ eq.] |
| **1990** | 47.68 | 1001.19 | 5.51 | 1708.42 |
| **1991** | 45.91 | 964.07 | 5.23 | 1621.43 |
| **1992** | 42.07 | 883.54 | 4.71 | 1460.79 |
| **1993** | 38.37 | 805.72 | 4.19 | 1300.32 |
| **1994** | 33.56 | 704.82 | 3.73 | 1157.37 |
| **1995** | 31.78 | 667.38 | 3.47 | 1074.20 |
| **1996** | 31.92 | 670.34 | 3.65 | 1131.20 |
| **1997** | 30.89 | 648.67 | 3.54 | 1096.25 |
| **1998** | 29.34 | 616.19 | 3.35 | 1038.31 |
| **1999** | 29.02 | 609.42 | 3.39 | 1049.53 |
| **2000** | 27.34 | 574.18 | 3.13 | 970.10 |
| **2001** | 26.45 | 555.36 | 2.99 | 927.67 |
| **2002** | 25.80 | 541.78 | 2.81 | 872.14 |
| **2003** | 25.00 | 524.98 | 2.67 | 826.25 |
| **2004** | 23.80 | 499.73 | 2.58 | 799.00 |
| **2005** | 22.55 | 473.62 | 2.46 | 762.87 |
| **2006** | 22.22 | 466.71 | 2.42 | 751.01 |
| **2007** | 22.11 | 464.27 | 2.41 | 748.01 |
| **2008** | 21.16 | 444.32 | 2.37 | 735.10 |
| **2009** | 19.43 | 408.07 | 2.26 | 699.20 |
| **2010** | 18.91 | 397.13 | 2.20 | 682.20 |
| **2011** | 18.04 | 378.91 | 2.14 | 663.87 |

### 6.3.2 Methodological issues

#### *6.3.2.1 Methane emissions*

$CH_4$ emissions from manure management were identified as a *key source* only by trend assessment (TA); hence these emissions for all farm animals are estimated by the Tier 1 approach. Default EFs for Western Europe were employed for similar reasons as in the previous paragraph (Tab. 6-8). Similarly as for enteric fermentation, the obsolete national approach used in the past was abandoned because of lack of comparability with other countries. Relation to the decreasing trend in animal population (especially cattle and swine, Fig. 6-2), the emissions from *Manure Management* rapidly declined during 1990-2011.

**Tab. 6-8 Table 6.8 IPCC default emission factors used to estimate $CH_4$ emissions from Manure Management**

| Livestock type | EF (kg/head/yr) |
|---|---|
| Dairy Cattle | 14 |
| Non-Dairy Cattle | 6 |
| Sheep | 0.19 |
| Goats | 0.12 |
| Horses | 1.39 |
| Swine | 3 |
| Poultry | 0.078 |

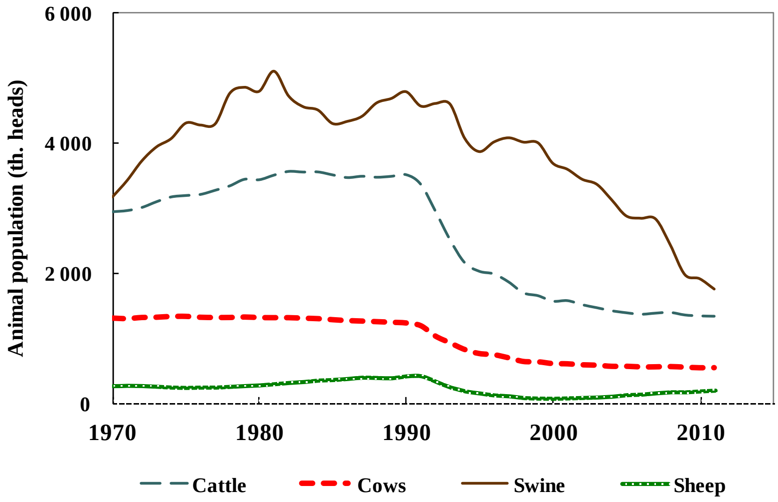



**Fig. 6 -2 Trend of individual animal population in period 1970–2011**

### *6.3.2.2 Nitrous oxide emissions*

$N_2O$ 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.

In response to the list of potential problems and further questions raised by the ERT, the Czech Republic revised the Nex values for dairy and non-dairy cattle (see Tab. 6-9) and changed the distribution ratio of manure per AWMS (see Tab. 6-10) according to the national conditions based on expert judgment (Hons and Mudřík 2004 and Kvapilík J. 2011).

The IPCC default nitrogen excretion (Nex) values and distribution of AWMS systems for other animal categories (excl. cattle) are presented in Tab. 6-11. According to GPG (IPCC, 2000), the IPCC default values for swine were taken from Tables B-3 through B-6 and the IPCC default values for all the other animal species were taken from Table 4-21. The emissions are then summed over all the manure management systems.

**Tab. 6-9 Czech national Nex (nitrogen excretion) values used to estimate $N_2O$ emissions from Manure Management**

| Year | Nitrogen excretion (Nex) | |
|---|---|---|
| | Dairy cows | Non-dairy cattle (AVG value) |
| | [kg/head/year] | |
| **1990** | 101.94 | 58.51 |
| **1991** | 99.06 | 58.66 |
| **1992** | 100.51 | 59.66 |
| **1993** | 100.85 | 59.17 |
| **1994** | 102.38 | 59.09 |
| **1995** | 105.93 | 61.27 |
| **1996** | 107.45 | 61.61 |
| **1997** | 105.75 | 62.28 |
| **1998** | 109.63 | 62.52 |
| **1999** | 114.61 | 65.43 |
| **2000** | 116.57 | 65.87 |
| **2001** | 118.26 | 66.58 |
| **2002** | 121.16 | 67.47 |
| **2003** | 123.33 | 67.90 |
| **2004** | 125.32 | 67.78 |
| **2005** | 127.15 | 69.00 |
| **2006** | 128.13 | 69.00 |
| **2007** | 129.39 | 69.00 |
| **2008** | 130.89 | 69.51 |
| **2009** | 131.71 | 69.49 |
| **2010** | 132.59 | 68.76 |
| **2011** | 133.83 | 69.17 |

**Tab. 6-10 Czech national distribution of AWMS systems for cattle categories 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 |
| **2011** | 27 | 1 | 65 | 7 |
| **Non-dairy cattle (AVG)** | **Liquid** | **Daily spread** | **Solid** | **PRP** |
| **1990** | 51 | 1 | 33 | 15 |
| **1995** | 48 | 1 | 31 | 20 |
| **2000** | 49 | 1 | 33 | 17 |
| **2005** | 52 | 1 | 27 | 20 |
| **2011** | 52 | 1 | 27 | 20 |

**Tab. 6-11 IPCC default nitrogen excretion (Nex) and distribution of AWMS systems for other animal categories (excl. cattle)**

| 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 |

#### 6.3.2.3 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 Good Practice Guidance, Table 4-22 (IPCC, 2000), see Tab. 6-12.

**Tab. 6-12 IPCC default emission factors of animal waste per different AWMS**

| AWMS | Emission Factor (EF3) (kg $N_2O$-N per kg N excreted) |
|---|---|
| **Liquid** | 0.001 |
| **Solid Storage** | 0.020 |
| **Pasture/Range/Paddock** | 0.020 |
| **Other Systems** | 0.005 |

### 6.3.3 Uncertainties 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 second of them was prepared at the level Tier 1, besides 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 option, that $CH_4$ emissions from manure management for all farm animals are estimated by the 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 Revised 1996 Guidelines (IPCC, 1997) 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). In addition, national data on the distribution of manure management practices across AWMS were collected and updated (Kvapilík J. 2011).
Uncertainty estimates based on expert judgement.

The uncertainty in the activity data equals 5 %.

The uncertainty in the emission factor for estimation of $CH_4$ emissions equals 30 %; for estimation of $N_2O$ emissions, this value equals 100 %.

The combined uncertainty for $CH_4$ emissions equals 30.4 % and that for $N_2O$ emissions equals 100.12 %.

### 6.3.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in the Chapter 6.5.

### 6.3.5 Source-specific recalculations

Based on new zoo-technical data and updated country-specific parameters and activity data the emissions from Manure management of 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 (IPCC, 2006) 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 based on 3.3 % (Poustka 2007, Ingr 2003 and Turek 2000) and protein content in feed (in dry matter) of 18 % (Zeman - Czech feed standards 12-21 %, Central Institute for Supervising and Testing in Agriculture 18 %, Karabcová pers. commun. 16-18 %).

Country-specific redistribution of manure management practices across AWMS for cattle (Tab. 6-10) was taken from Hons and Mudrik (2004) for the 1990-1999 period and updated data from Kvapilík J. (2011) 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 (feed situation of cattle categories, see Tab. 6-4).

Using the above changes, the $N_2O$ emissions from Manure management were calculated by the Tier 2 method for dairy and non-dairy cattle categories for the entire reporting period.

### 6.3.6 Source-specific planned improvements

The analysis of uncertainties is in progress.

In the next submission the attention will be paid to the using a higher–tier method to estimate $CH_4$ emissions from Manure Management as recommended by ERT.

## 6.4 Agricultural Soils (4D)

### 6.4.1 Source category description

This source category includes direct and indirect nitrous oxide emissions from agricultural soils. Both these categories (direct and indirect) of $N_2O$ soil emissions are the key sources (Tab. 6-1). 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, N-fixing crops enhance the formation of nitrous oxide emissions.

Nitrous oxide emissions from agriculture include these subcategories:

- direct emissions (emissions from synthetic fertilizers, animal manure applied to soils, crop residue and N-fixing crops)
- emissions from pasture manure (PRP)
- indirect emissions (emissions from atmospheric deposition and nitrogenous substances flushed into water courses and reservoirs – leaching)

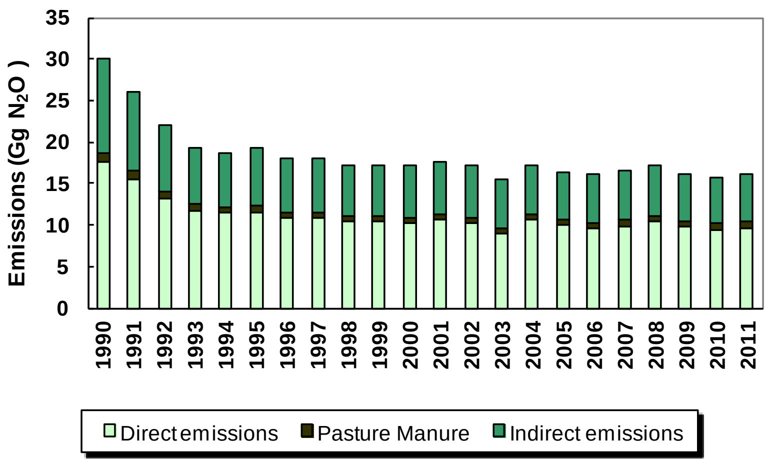



**Fig. 6-3 Nitrous oxide emissions from Agricultural soils (sub-categories)**

In 2011, 88.3 % of total $N_2O$ emissions from Agriculture originated from Agricultural Soils, while the rest originated from Manure Management (11.7 %). The trend in $N_2O$ emissions from this category is decreasing: in 2011 emissions (5 683.03 Gg $CO_2$ eq.) were 46.5 % below the base year level. Tab. 6-13 and Figure 6-3 present the $N_2O$ emissions of Agricultural soils by individual sub-category.

**Tab. 6-13 $N_2O$ emissions come from Agricultural Soils (4D category) in period 1990-2011 in Gg $N_2O$.**

| Year | Total emissions | Direct emissions | | | | Pasture Manure | Indirect emissions | |
|---|---|---|---|---|---|---|---|---|
| | | a | b | c | d | | Atmosph. deposition | Leaching |
| **1990** | 30.01 | 7.39 | 5.50 | 1.74 | 3.05 | 1.02 | 1.86 | 9.44 |
| **1991** | 25.96 | 5.26 | 5.25 | 2.29 | 2.73 | 0.99 | 1.62 | 7.82 |
| **1992** | 22.00 | 4.00 | 4.85 | 1.93 | 2.32 | 0.87 | 1.41 | 6.63 |
| **1993** | 19.39 | 3.19 | 4.38 | 1.87 | 2.31 | 0.72 | 1.23 | 5.68 |
| **1994** | 18.73 | 3.59 | 3.84 | 1.69 | 2.34 | 0.61 | 1.15 | 5.51 |
| **1995** | 19.22 | 4.05 | 3.61 | 1.60 | 2.27 | 0.80 | 1.16 | 5.71 |
| **1996** | 17.92 | 3.36 | 3.64 | 1.48 | 2.30 | 0.78 | 1.10 | 5.26 |
| **1997** | 17.99 | 3.64 | 3.51 | 1.31 | 2.37 | 0.73 | 1.10 | 5.33 |
| **1998** | 17.25 | 3.59 | 3.37 | 1.11 | 2.29 | 0.67 | 1.06 | 5.17 |
| **1999** | 17.28 | 3.54 | 3.41 | 1.06 | 2.37 | 0.67 | 1.06 | 5.17 |
| **2000** | 17.13 | 3.77 | 3.24 | 1.05 | 2.19 | 0.65 | 1.05 | 5.18 |
| **2001** | 17.68 | 3.99 | 3.17 | 1.05 | 2.48 | 0.65 | 1.05 | 5.28 |
| **2002** | 17.20 | 4.02 | 3.12 | 0.86 | 2.27 | 0.63 | 1.04 | 5.26 |
| **2003** | 15.41 | 3.39 | 3.05 | 0.67 | 1.94 | 0.62 | 0.97 | 4.78 |
| **2004** | 17.14 | 3.83 | 2.92 | 0.89 | 2.94 | 0.61 | 0.98 | 4.97 |
| **2005** | 16.30 | 3.65 | 2.80 | 0.91 | 2.59 | 0.64 | 0.95 | 4.77 |
| **2006** | 16.03 | 3.80 | 2.76 | 0.86 | 2.16 | 0.63 | 0.95 | 4.85 |
| **2007** | 16.47 | 3.95 | 2.76 | 0.79 | 2.40 | 0.65 | 0.97 | 4.95 |
| **2008** | 17.10 | 4.21 | 2.68 | 0.72 | 2.77 | 0.67 | 0.98 | 5.07 |
| **2009** | 16.06 | 3.92 | 2.49 | 0.74 | 2.61 | 0.66 | 0.91 | 4.73 |
| **2010** | 15.76 | 4.00 | 2.36 | 0.67 | 2.30 | 0.80 | 0.91 | 4.73 |
| **2011** | 16.19 | 4.22 | 2.27 | 0.64 | 2.52 | 0.82 | 0.91 | 4.82 |

*Note: a, b, c, d = individual sources of direct emissions; (a) Synthetic fertilizers, (b) Animal manure applied to soils, (c) N-fixing crops and (d) Crop residue*

### 6.4.2 Methodological issues

Although nitrous oxide emissions from agriculture are key sources, emissions are estimated and analyzed by the Tier 1 approach of the IPCC methodology (IPCC, 1997). 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 4D2. The nitrogen from manure that is spread daily is consistently included in the manure nitrogen applied to soils.

#### *6.4.2.1 Activity data*

The standard calculation of Tier 1 required the following input information based on CzSO data:

- number of heads of farm animals (dairy cows, other cattle, pigs, sheep, poultry, horses and goats),
- annual amount of nitrogen applied in the form of industrial nitrogen fertilizers - the application of agricultural fertilizers was previously intensive in this country, but decreased radically during the 1990s. The amount of nitrogen fertilizers applied in 1990 equalled over 418 kt decreased to 239 kt in 2011. This corresponds to the trend reported for use of fertilizers, which decreased a lot in early 1990s (Sálusová et al., 2006).
- annual harvests of crops, pulses, soya beans, potatoes, sugarbeets, alfalfa and clover (see Tab. 6-14).

All these data were taken from the Statistical Yearbooks of the Czech Republic (Statistical Yearbooks, 1990-2011).

Other input data consists in the mass fraction $X_{i,j}$ 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 $X_{i,1} + X_{i,2} + ... + X_{i,6} = 1$. For Tier 1, Revised 1996 Guidelines (IPCC, 1997), gives only the values of matrix X for typical means of management of animal excrement in Eastern and Western Europe. As we are aware that agricultural farming in the Czech Republic has not yet been classified according to this system, we performed the calculation for AWMS parameters presented in the IPCC methodology, Revised 1996 Guidelines (IPCC, 1997), for the case of Western Europe. Nevertheless, collection of the relevant country specific AWMS parameters is under way and perhaps it will be possible to employ such an approach sometime in the future.

**Tab. 6-14 Annual harvests of agricultural products in period 1990-2011**

| Year | Crop | Pulses | Soya | Potatoes | Sugarbeet | Alfalfa | Clover |
|---|---|---|---|---|---|---|---|
| | [in thous. tonnes] | | | | | | |
| **1990** | 8 947 | 152 | 2.2 | 1 755 | 4 026 | 1 088 | 1 344 |
| **1991** | 7 845 | 195 | 6.4 | 2 043 | 4 009 | 1 522 | 1 648 |
| **1992** | 6 565 | 203 | 3.7 | 1 969 | 3 871 | 1 279 | 1 311 |
| **1993** | 6 468 | 227 | 0.7 | 2 396 | 4 308 | 1 214 | 1 256 |
| **1994** | 6 777 | 163 | 0.7 | 1 231 | 3 240 | 1 203 | 1 069 |
| **1995** | 6 602 | 144 | 0.6 | 1 330 | 3 712 | 1 123 | 1 071 |
| **1996** | 6 644 | 136 | 0.5 | 1 800 | 4 316 | 1 037 | 982 |
| **1997** | 6 983 | 104 | 0.3 | 1 402 | 3 722 | 884 | 947 |
| **1998** | 6 669 | 133 | 0.3 | 1 520 | 3 479 | 743 | 709 |
| **1999** | 6 928 | 119 | 0.6 | 1 407 | 2 691 | 726 | 676 |
| **2000** | 6 454 | 85 | 2.3 | 1 476 | 2 809 | 755 | 698 |
| **2001** | 7 338 | 91 | 4.3 | 1 130 | 3 529 | 761 | 669 |
| **2002** | 6 771 | 65 | 6.4 | 901 | 3 832 | 662 | 504 |
| **2003** | 5 762 | 62 | 11.9 | 683 | 3 495 | 500 | 375 |
| **2004** | 8 784 | 88 | 12.9 | 862 | 3 579 | 673 | 486 |
| **2005** | 7 660 | 96 | 18.9 | 1 013 | 3 496 | 695 | 459 |
| **2006** | 6 386 | 88 | 17.8 | 692 | 3 138 | 668 | 434 |
| **2007** | 7 153 | 65 | 13.2 | 821 | 2 890 | 610 | 432 |
| **2008** | 8 370 | 48 | 9.4 | 770 | 2 885 | 584 | 386 |
| **2009** | 7 832 | 62 | 13.6 | 753 | 3 038 | 587 | 377 |
| **2010** | 6 878 | 58 | 16.1 | 665 | 3 065 | 527 | 338 |
| **2011** | 8 285 | 64 | 17.9 | 805 | 3 899 | 476 | 338 |

### *6.4.2.2 Emission factors and other parameters*

IPCC default emission factors have been used for calculating $N_2O$ emissions from agricultural soils. The emission factors for calculation of direct $N_2O$ emissions from the agriculture soil category, direct emissions from atmospheric deposition and leaching were used according to Tab. 6-15.

The default fraction values were used to estimate emissions (Tab. 6-16). The fraction of livestock N excreted and deposited onto soil during grazing ($Frac_{GRAZ}$) varied from 0.085 in 1990 to 0.153 in 2011.

**Tab. 6-15 IPCC default parameters/fractions used for emission estimation**

| Parameters/Fractions | Default values |
|---|---|
| $Frac_{GASM}$ | 0.20 |
| $Frac_{NCR0}$ | 0.015 |
| $Frac_{NCRBF}$ | 0.03 |
| $Frac_{R}$ | 0.45 |
| $Frac_{BURN}$ | 0.00 |

**Tab. 6-16 Emission factors (EFs) for the calculation of Agricultural Soils**

| | Emissions (sources) | Emission Factors |
|---|---|---|
| **Direct emissions** | Synthetic fertilizer | EF1=0.0125 kg $N_2O$-N/kg N |
| | Animal Waste | |
| | N-fixing crops | |
| | Crop residue | |
| **Pasture, range & paddock manure** | Grazing animals | EF3=0.02 kg $N_2O$-N/kg N |
| **Indirect emissions** | Atmospheric Deposition | EF4=0.01 kg $N_2O$-per kg emitted $NH_3$ and $NO_X$ |
| | Nitrogen Leaching | EF5=0.025 kg $N_2O$ - per kg of leaching N |

Based on the ERT recommendation (2012 resubmission), some other sources of emissions were included in the Crop residue sub-category (potatoes and sugarbeets) and N-fixing crops (alfalfa and clover). The emissions originating in these sources are estimated using the country-specific parameters.

### *Category 4D1.3 – N-fixing crops (alfalfa and clover)*

IPCC GPG (IPCC, 2000) was applied and available information on production of crops (alfalfa and clover) and national values were used to estimate $N_2O$ emissions. The information on production comes from the Czech Statistical Office (CzSO). The country-specific data for the fraction of nitrogen (FracNCRBF) and the fraction of dry matter content (FracDM) in aboveground biomass of forage crops were employed in the emission inventory. The fraction of dry matter and fraction of nitrogen were determined on the basis of the materials (results of research projects) obtained from the Faculty of Agronomy, South Bohemia University (Jeteloviny - internal/study material, www.zf.jcu.cz) (see Tab. 6-17).

**Tab. 6-17 National parameters used to estimate direct $N_2O$ emissions from clover and alfalfa**

| | $Frac_{DM}$ | $Frac_{NCRBF}$ |
|---|---|---|
| **Clover** | 0.15 | 0.19 |
| **Alfalfa** | 0.18 | 0.21 |

### *Category 4D1.4 – Crop Residue (potatoes and sugarbeets)*

$N_2O$ Direct Soil Emissions from Crop Residue (potatoes and sugarbeets) were estimated applying IPCC GPG (IPCC, 2000) and using available information on production of these crops. The information about crop production was obtained from the Czech Statistical Office (CzSO). The default $N_2O$ EFs and default values for other relevant parameters were used in accordance with the IPCC GPG methodology.

Equation 4.29 (Tier 1b, GPG IPCC 2000, page 4.59) was used to estimate these emissions. The calculation was based on 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 sugarbeets (Table 4-16, IPCC 2000, page 4.58) and default fraction of crop residue removed from the field as crop (Table 4-17, Revised 1996 Guidelines, Reference Manual, page 4.85). The country-specific data for the dry matter fraction was used. The value of FracDM for potatoes is based on the study of Cabajova, MU LF Brno (2009) and corresponds to other available sources. The value of FracDM for sugarbeets is based on the study of Blaha, CZU Prague (1986) and corresponds to other available sources. Both national parameters correspond to the interval of IPCC default values (see Tab. 6-18). The fraction of crop residue that is burned on the field equals zero.

**Tab. 6-18 National parameters used to estimate direct $N_2O$ emissions from potatoes and sugarbeets**

| | Res/Crop | $Frac_{DM}$ | $Frac_{NCRO}$ |
|---|---|---|---|
| **Potatoes** | 0.40 | 0.30 | 0.011 |
| **Sugarbeet** | 0.20 | 0.12 | 0.004 |

Using the above changes, the $N_2O$ direct emissions from Agricultural soils were calculated by the *Tier 2* method for the entire reporting period.

### 6.4.3 Uncertainties and time-series consistency

In relation to the consistency of the emission series for $N_2O$ (agricultural soils), it should be mentioned that emission estimates have been calculated in a consistent manner since 1996 according to the default methodology of Revised 1996 Guidelines (IPCC, 1997). 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.

The quantitative overview and emission trends during period 1990-2011 are shown in Tab. 6-2. The trend in $N_2O$ emissions from agricultural soils is summarized in Tab. 6-13. During 1990-2011 the total emissions from agricultural soils decreased by 47 % (rapidly during period 1990-1995, about 40 %), direct emissions decreased by 40 % and indirect emissions by 50 %. More than 60 % 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.

Given that the value of Nex for cattle was revised based on the recommendation of ERT (2011), it led to changes in $N_2O$ emissions from i) animal manure applied to soils (4D1b), ii) PRP (4D2), iii) atmospheric deposition (4D3.1) and iv) N lost through leaching and run-off (4D3.2). 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 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 ERT noted that this is not in line with the Revised 1996 Guidelines, and thus it was requested that these emission categories 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 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
2. 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 category 4D.1 (Direct emissions from agricultural soils) after recalculation by approx. 6 % in 2011, leading to an increase in total $N_2O$ emissions by about 3 % in 2011.

Uncertainty estimates based on expert judgement.

The uncertainty in the activity data for estimation of direct and indirect emissions from agricultural soils equals 20 %; for Pasture, Range and Paddock Manure (PRP) this value equals 10 %.

The uncertainty in the emission factor for estimation of direct and indirect emissions from agricultural soils equals 50 %; for estimation of emissions from PRP Manure this value equals 100 %.

The combined uncertainty for the direct and indirect emissions from agricultural soils equals 53.85 %; for $N_2O$ emissions from PRP Manure this value equals 100.5 %.

### 6.4.4 Source-specific QA/QC and verification

A detailed description of source-specific QA/QC and inventory verification of agriculture is presented in the Chapter 6.5.

### 6.4.5 Source-specific recalculations

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, it led to changes in $N_2O$ emissions from:

1. animal manure applied to soils (4D.1b)
2. pasture, range and paddocks (4D.2)
3. atmospheric deposition (4D.3.1)
4. nitrogen lost through leaching and run-off (4D.3.2)

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 (categories 4D1.3 and 4D1.4) were recalculated and reported in the 2012 resubmission. This led to changes in $N_2O$ emissions from:

1. N-fixing crops (4D.1.3)
2. Crop residues (4D.1.4)

### 6.4.6 Source-specific planned improvements

The analysis of uncertainties is in progress.

## 6.5 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 the AGROBIO are other institutes contributing information used in the sector of Agriculture. Slovak agricultural experts (SHMI) also participate in debates on inventory improvements.

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 to comply

- The inclusion of all activity data for animal categories, selected harvests (crops, pulses, soya beans), amount of synthetic fertilizers (agricultural statistics)
- The consistency of time-series activity data and emission factors (agricultural statistics)
- The annual 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 (specifically concerned with 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 CRF Tables are sent to the NIS coordinator for final time-series checking and 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 (4A, 4B and 4D). 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.

# 7 Land Use, Land-Use Change and Forestry (CRF Sector 5)

## 7.1 Overview

The emission inventory of the 5 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 is 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 Parties to UNFCCC. The application of GPG for LULUCF in the national emission inventory entails manifold specific requirements on the inventory of the sector, which have been implemented gradually. The current inventory of the LULUCF sector represents an advanced phase of this implementation. It employs a refined system of land use identification at the level of the individual cadastral units, which was also utilized for determination of land-use changes. This inventory submission contains additional improvements to some degree reflecting the suggestions following from the latest reviews of the LULUCF emission inventory. Where feasible, the methodological elements from 2006 Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) for the Agriculture, Forestry and Other Land Use (AFOLU) were also used. Although the Czech LULUCF inventory is still expected to undergo further development and consolidation, it already represents a solid system for providing information on GHG emissions and removals in the LULUCF sector, as well as for providing the 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 six major LULUCF land-use categories, namely 5A Forest Land, 5B Cropland, 5C Grassland, 5D Wetlands, 5E Settlements and 5F Other Land, which were linked to the Czech cadastral classification of lands. The emissions and/or removals of greenhouse-gases are reported for all mandatory categories. The current submission covers the whole reporting period from the base year of 1990 to 2011 (Fig. 7-1).

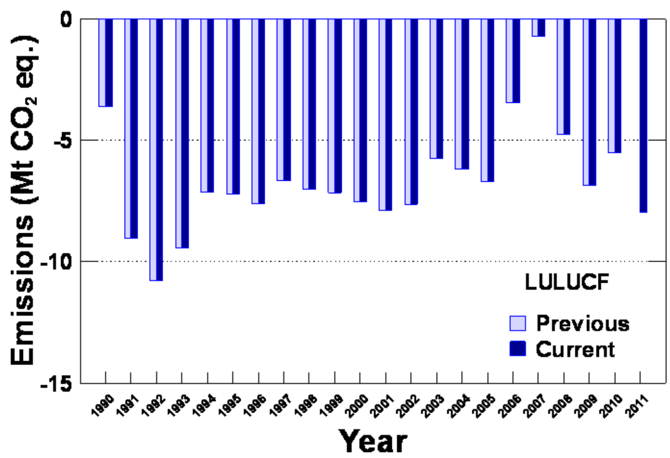



**Fig. 7-1 Current and previously reported assessment of emissions for the LULUCF sector. The values are negative, hence representing net removals of green-house gases**

### 7.1.1 Estimated emissions

Tab. 7-1 provides a summary of the LULUCF GHG estimates for the base year 1990 and the most recently reported year 2011. In 2011, the net GHG flux for the LULUCF sector, estimated as the sum of emissions and removals, equalled -7.959 Mt $CO_2$ 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 2011, the removals realized within the LULUCF sector decrease the GHG emissions generated in other sectors by 5.7 %. Correspondingly, for the base year of 1990, the total emissions and removals in the LULUCF sector equalled -3.618 Mt $CO_2$ eq. In relation to the emissions generated in all other sectors, the inclusion of the LULUCF estimate reduces the total emissions by 1.85 % for the base year of 1990. It is important to note that the emissions within the LULUCF sector exhibit high inter-annual variability (Fig. 7-1) and the values shown in Tab. 7-1 should not be interpreted as trends. The entire data series can be found in the corresponding CRF Tables.

**Tab. 7-1 GHG estimates in Sector 5 (LULUCF) and its categories in 1990 (base year) and 2011**

| Sector/category | Emissions 1990 Gg $CO_2$ eq. | Emissions 2011 Gg $CO_2$ eq. |
|---|---|---|
| **5 Total LULUCF** | -3 618 | -7 959 |
| **5A Forest Land** | -4 947 | -7 903 |
| **5A1 Forest Land remaining Forest Land** | -4 667 | -7 574 |
| **5A2 Land converted to Forest Land** | -280 | -329 |
| **5B Cropland** | 1 337 | 154 |
| **5B1 Cropland remaining Cropland** | 1089 | 61 |
| **5B2 Land converted to Cropland** | 247 | 93 |
| **5C Grassland** | -128 | -329 |
| **5C1 Grassland remaining Grassland** | 59 | 2 |
| **5C2 Land converted to Grassland** | -187 | -331 |
| **5D Wetlands** | 23 | 32 |
| **5D1 Wetlands remaining Wetlands** | (0) | (0) |
| **5D2 Land converted to Wetlands** | 23 | 32 |
| **5E Settlements** | 86 | 87 |
| **5E1 Settlements remaining Settlements** | (0) | (0) |
| **5E2 Land converted to Settlements** | 86 | 87 |
| **5F Other Land** | (0) | (0) |
| **5G Other** | 12 | 0 |

*Note: Emissions of non-$CO_2$ gases ($CH_4$ and $N_2O$) are also included.*

### 7.1.2 Key categories

**Tab. 7-2 Key categories of the LULUCF sector (2011)**

| Category | Character of category | Gas | % of total GHG |
|---|---|---|---|
| **5A1 Forest Land remaining Forest Land** | KC (LA, TA) | $CO_2$ | -6.09 |
| **5B1 Cropland remaining Cropland** | KC (TA) | $CO_2$ | 0.05 |

*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. 7-1, two of them were identified as key categories according to the IPCC Good Practice (Good Practice Guidance, IPCC 2000, Good Practice Guidance for LULUCF, IPCC 2003). Of these LULUCF categories, the largest effect on the overall emission inventory in the country is attributed to 5A1 Forest Land remaining Forest Land. With a contribution of -6.1 %, it is the only LULUCF category identified by the level assessment for the year 2011 (Tab. 7-2). It was also identified as a key category by the trend assessment. The emissions of this category are determined by the changes in biomass carbon stock. Additionally, one LULUCF category was identified by the trend assessment, namely 5B1 Cropland remaining Cropland (Tab. 7-2). In 5B1, the trend analysis basically reflected the effect of liming on emissions from agricultural soils, which decreased rapidly in early 1990s compared to the following years.

## 7.2 General methodological issues

### 7.2.1 Methodology for representing land-use areas

The reporting format requires the estimation of GHG emissions into the atmosphere by sources and sinks for six land-use categories, namely 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 outlines 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 GPG for LULUCF. The adopted land-use representation and land-use change identification system was built gradually since the 2007 NIR submission. It was radically improved in the 2008 NIR submission and further refined in 2009 inventory submission.

Initially, the identification of land-use categories was based on two key data sources. Information on areas of the individual land-use categories was obtained from the Czech Office for Surveying, Mapping and Cadastre (COSMC; www.cuzk.cz). It provided annually updated cadastral information, published as aggregated data in the statistical yearbooks. The second data source utilized previously was the Land Cover Database of the Pan-European CORINE project (reference years 1990 and 2000), administered by the Czech Ministry of the Environment. The combination of COSMC cadastral data and CORINE land-use change trends permitted estimation of land-use changes. Although this method was endorsed by the 2007 in-country review, the aggregated land-use information did not provide sufficient spatial details and the CORINE-derived trends remained uncertain for several reasons.

Since the 2008 NIR submission, land-use representation and the land-use change identification system have been based exclusively on the annually updated COSMC data, elaborated at the level of about 13 thousands individual cadastral units. This system was built 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 (GPG for LULUCF), permitting accounting for all land-use transitions in the annual time step.

#### *7.2.1.1 Source data compilation*

The methodology requirements and principles associated with the approaches recommended by the GPG for LULUCF (IPCC, 2003) imply that, for the reported period of 1990 to 2011, the required land use should be available for the period starting from 1969. Information on land use was obtained from the

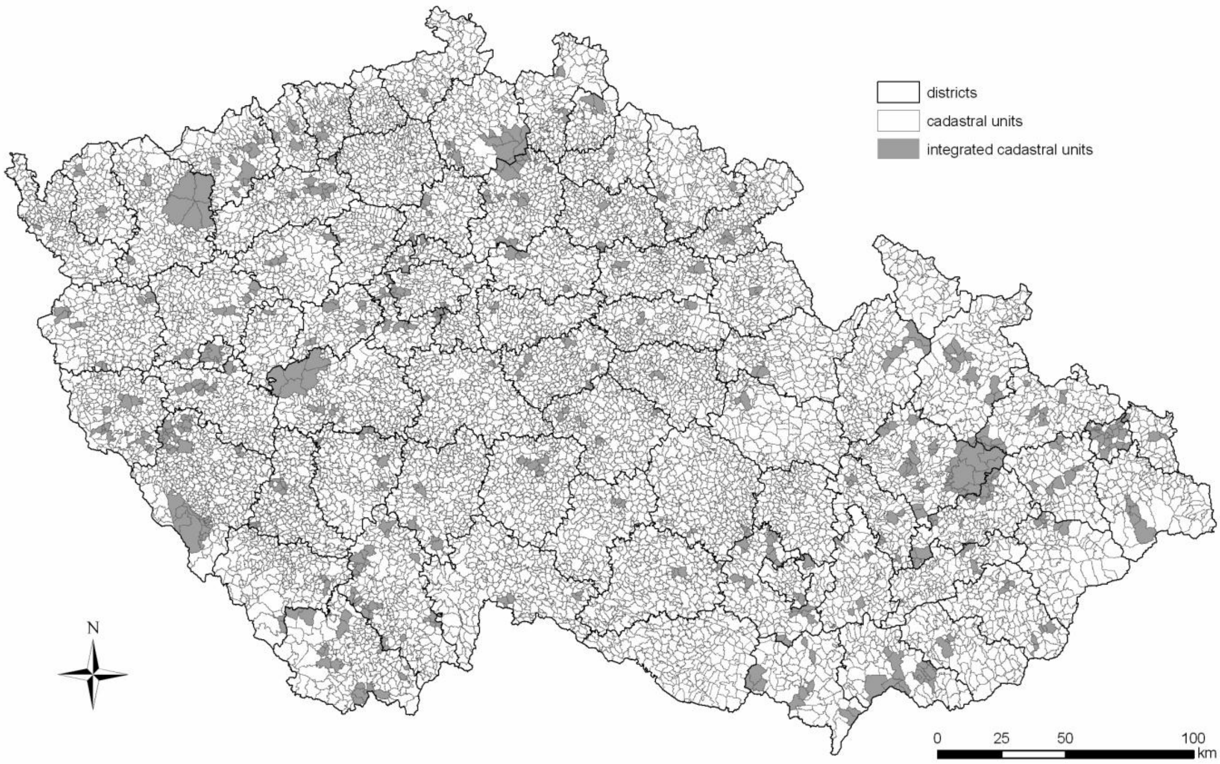
Czech Office for Surveying, Mapping and Cadastre (COSMC), which administers the database of "Aggregate areas of cadastral land categories" (AACLC). The AACLC data were compiled at the level of the individual cadastral units (1992-2011) and individual districts (1969-2011). There are over 13 000 cadastral units, the number of which varied due to separation or division for various administrative reasons. In the period of 1992 to 2011, the total number of cadastral units varied between 13 027 and 13 079.

To identify the administrative separation and division of cadastral units, these were crosschecked by comparing the areas in subsequent years using a threshold of one hectare difference. Neighbouring cadastral units mutually changing their areas in subsequent years were integrated. Until the reported year of 2006, this concerned a total of 706 former and/or current units that were integrated into 235 newly labelled units. This resulted in a total of 12 624 cadastral units, for which the annual land-use change was specifically estimated (see below). The land use system was further refined for reporting years since 2007. Thereon, the eventual integration of cadastral units is performed on an annual basis and hence concerns only those cadastral units where some land was exchanged between two subsequent years. For 2011, there were 46 integrated cadastral units, which affected a total of 114 individual cadastral units. This further increased the spatial resolution of the system, as the land use change identification could be analysed for 12 990 individual units in 2011 as compared to 12 624 units for the years until 2006 (Fig. 7-2).

To obtain information on land-use and land-use change prior 1993, a complementary data set from COSMC at the level of 76 district units was prepared. It actually covered the period since 1969. It was required for application of the IPCC default transition time period of 20 years for carbon stock change in soils. The overlapping time period of 1993 to 2006 was utilized to correct the land-use change assessment based on the coarser, i.e., district data (see below for details). The spatial coverage of cadastral and district units is also shown in Fig. 7-2.

#### *7.2.1.2 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 by 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). Additionally, the land register included information on land use for every land parcel. Different AACLC land categories may have identical use. Both land categories and land use in 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 GPG for LULUCF (IPCC, 2003). The specific definition content can be found in the respective Chapters 7.3 to 7.8 devoted to each of the major land-use categories.



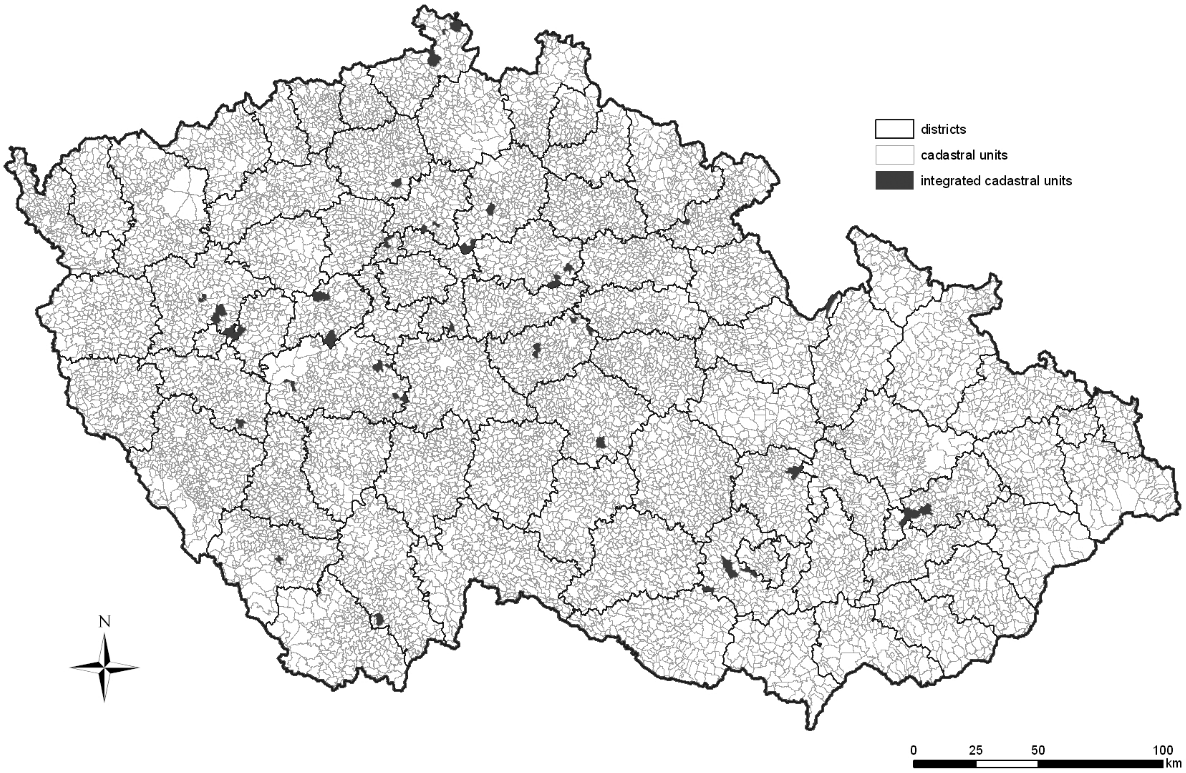




**Fig. 7-2 Cadastral units (grey lines), integrated cadastral units (shading) and district borders (black lines) as used until year 2006 (top) and the currently refined situation for year 2011 (bottom)**

### 7.2.1.3 Land-use change identification

The critical issue of any LULUCF emission inventory is the determination of land-use change. This inventory identifies and quantifies land-use change by balancing the six major land-use areas for each of the individual or integrated cadastral units (12 990 units in year 2011) on an annual basis using the subsequent years of the available period. The approach is exemplified in Fig. 7-3. In the example of the cadastral unit of Jablunkov (ID 656305), it can be observed that, during 2006, three land-use categories lost their land, while one exhibited an increase. This identifies three types of land-use conversion with specific areas corresponding to the proportion of the loss of all the contributing categories. Similarly, if the converted land were to be attributed to two or more land-use categories, it would be accordingly distributed in proportion to the increase in their specific areas. Since this task is computation-intensive, involving tens of thousands of matrix manipulations, it is handled by a specific software application developed for this purpose using the MS-Access file format. All identified land-use transfers are summarized by each type of land-use change on an annual basis to be further used for calculation of the associated emissions.

| YEAR | ID_CU (Name) | Cropland | Forestland | Grassland | Otherland | Settlements | Wetlands | ALL |
|---|---|---|---|---|---|---|---|---|
| 2005 | 656305 (Jablunkov) | 2880337 | 1737355 | 3480215 | 302322 | 1649308 | 336775 | 10386312 |
| 2006 | 656305 (Jablunkov) | 2806120 | 1737355 | 3473992 | 302322 | 1729860 | 336666 | 10386315 |
| **Difference** | | -74217 | 0 | -6223 | 0 | 80552 | -109 | 3 |
| | | | | | | | | |
| | Increment | | | | | 100% | | 80552 |
| | Loss | 92.1% | | 7.7% | | | 0% | -80549 |
| | **Estimation** | 74220 | | 6223 | | | 109 | |
| | | | | | | | | |
| | **Conversion type** | **Area (m2)** | | | | | | |
| | Cropland_Settlements | 74220 | | | | | | |
| | Grassland_Settlements | 6223 | | | | | | |
| | Wetlands_Settlements | *109* | | | | | | |

**Fig. 7-3 Example of land-used change identification for year 2006 and cadastral unit 656306 (Jablunkov); all spatial units are in $m^2$**

### 7.2.1.4 Complementing time series

The above described calculation of land-use change could only be performed for the years 1993 to 2011, because the data on land-use for the individual cadastral units has only been available since 1992. For the years preceding 1993, i.e., for land-use change attributed to the years 1970 to 1992, an identical approach as described above was used, but with aggregated cadastral input data at the level on the individual districts. The effect of an increased scale and data aggregation always results in a lower area of identified land-use change. This is probably due to within-domain compensation of area losses and increments. To compensate this effect for the 1970 to 1992 data series, a correction was applied to the estimates, based on district data input. The correction was based on a linear regression function between R (the ratio of identified land conversions at the level of the districts and individual cadastral units) and the logarithmically transformed areas from the data at the district level. The corrections were derived at the level of the major land-use categories, using the annual data from the period of 1993 to 2006, for which the land-use conversions could be estimated independently at both spatial levels, i.e., districts and individual cadastral units. More details, including the statistics and estimated parameters of the regression equation, are given in Cienciala and Apltauer (2007). The correction procedure was the final step in land-use database operations required to provide a consistent data-series on annual land-use conversions for the 1970 to 2011 period.

### 7.2.2 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 2011 period are shown in Fig. 7-4. The largest quantitative change is associated with the Cropland and Grassland land-use categories.

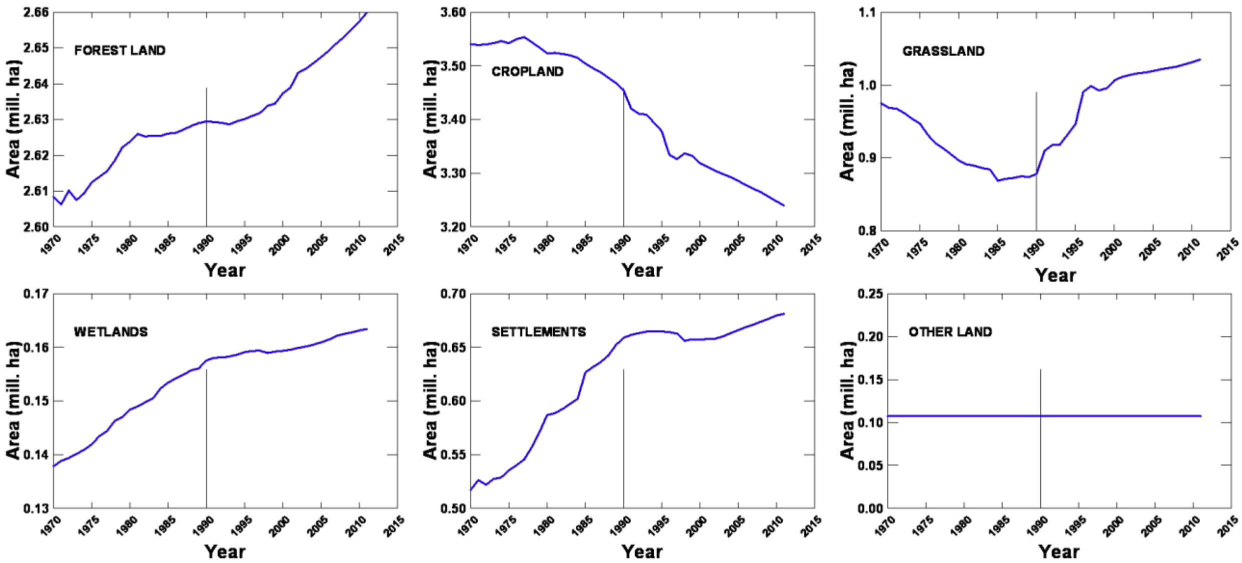



**Fig. 7-4 Trends in areas of the six major land-use categories in the Czech Republic between 1970 and 2011 (based on information from the Czech Office for Surveying, Mapping and Cadastre)**

An insight into the net trends shown in Fig. 7-4 is provided by analysis of land-use changes as described in Section 7.1.2. Tab. 7-3 Land-use matrices describing initial and final areas of particular land-use categories and the identified annual land-use conversions among these categories for years 1990 to 2011 shows a product of that analysis, namely the areas of land-use change among the major land-use categories over the 1990 to 2011 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 accounts for the progressing 20-year transition period that began in 1970. This is a Tier 1 assumption of GPG for LULUCF for estimation of changes in soil carbon stock. This also implies that the areas relevant to the biomass pool are not the same as those for the soil pools; this is important for interpretation of the emission factors estimated from the land-use change areas accumulated over 20-year periods. Secondly, for Forest Land, the available input information at a detailed (cadastral, district) level did not permit separation of the fraction of permanently unstocked Forest Land devoted to use other than growing forests. This small fraction of Forest Land was separated ex-post after estimating land-use changes and summing over the whole country, when it was assigned to Grassland.

**Tab. 7-3 Land-use matrices describing initial and final areas of particular land-use categories and the identified annual land-use conversions among these categories for years 1990 to 2011**

| **Year 1990** | | **Initial (1989)** | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1990)** | Forest Land | **2 628.2** | 0.5 | 0.7 | 0.0 | 0.0 | 0.0 | 2 629.5 |
| | Grassland | 0.1 | **867.3** | 10.8 | 0.0 | 0.0 | 0.0 | 878.2 |
| | Cropland | 0.1 | 1.2 | **3 453.4** | 0.1 | 0.2 | 0.0 | 3 455.0 |
| | Wetland | 0.0 | 0.4 | 0.4 | **155.9** | 0.8 | 0.0 | 157.5 |
| | Settlements | 0.3 | 3.7 | 3.7 | 0.1 | **651.2** | 0.0 | 658.9 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 628.7 | 873.1 | 3 469.0 | 156.1 | 652.2 | 107.2 | **7 886.4** |

| **Year 1991** | | **Initial (1990)** | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1991)** | Forest Land | **2 628.8** | 0.1 | 0.4 | 0.0 | 0.0 | 0.0 | 2 629.3 |
| | Grassland | 0.4 | **876.4** | 32.6 | 0.0 | 0.3 | 0.0 | 909.8 |
| | Cropland | 0.3 | 0.5 | **3 419.4** | 0.0 | 0.2 | 0.0 | 3 420.4 |
| | Wetland | 0.1 | 0.1 | 0.6 | **157.4** | 0.0 | 0.0 | 158.1 |
| | Settlements | 0.2 | 0.3 | 3.4 | 0.0 | **657.7** | 0.0 | 661.6 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 629.6 | 877.4 | 3 456.4 | 157.4 | 658.2 | 107.2 | **7 886.4** |

| **Year 1992** | | **Initial (1991)** | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1992)** | Forest Land | **2 628.7** | 0.1 | 0.2 | 0.0 | 0.0 | 0.0 | 2 629.1 |
| | Grassland | 0.2 | **907.3** | 10.2 | 0.1 | 0.0 | 0.0 | 917.9 |
| | Cropland | 0.1 | 0.7 | **3 409.9** | 0.0 | 0.2 | 0.0 | 3 410.9 |
| | Wetland | 0.0 | 0.1 | 0.2 | **157.8** | 0.0 | 0.0 | 158.1 |
| | Settlements | 0.3 | 0.4 | 2.0 | 0.1 | **660.5** | 0.0 | 663.3 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 629.5 | 908.6 | 3 422.4 | 158.0 | 660.7 | 107.2 | **7 886.4** |

| **Year 1993** | | **Initial (1992)** | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1993)** | Forest Land | **2 628.2** | 0.1 | 0.1 | 0.0 | 0.2 | 0.0 | 2 628.6 |
| | Grassland | 0.1 | **916.6** | 1.6 | 0.0 | 0.3 | 0.0 | 918.6 |
| | Cropland | 0.2 | 0.6 | **3 407.9** | 0.0 | 0.4 | 0.0 | 3 409.1 |
| | Wetland | 0.0 | 0.1 | 0.0 | **157.9** | 0.3 | 0.0 | 158.3 |
| | Settlements | 0.5 | 0.4 | 1.2 | 0.1 | **662.3** | 0.0 | 664.6 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 629.1 | 917.8 | 3 410.9 | 158.1 | 663.4 | 107.2 | **7 886.4** |

| Year 1994 | | Initial (1993) | | | | | | Area (kha) |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1994)** | Forest Land | **2 628.1** | 0.2 | 0.2 | 0.1 | 0.9 | 0.0 | 2 629.5 |
| | Grassland | 0.1 | **917.2** | 14.8 | 0.0 | 0.4 | 0.0 | 932.5 |
| | Cropland | 0.1 | 0.7 | **3 392.7** | 0.0 | 0.4 | 0.0 | 3 394.0 |
| | Wetland | 0.0 | 0.1 | 0.0 | **158.1** | 0.4 | 0.0 | 158.6 |
| | Settlements | 0.4 | 0.4 | 1.3 | 0.1 | **662.6** | 0.0 | 664.8 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 628.7 | 918.6 | 3 409.1 | 158.4 | 664.7 | 107.2 | **7 886.7** |

| Year 1995 | | Initial (1994) | | | | | | Area (kha) |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1995)** | Forest Land | **2 629.0** | 0.4 | 0.3 | 0.0 | 0.5 | 0.0 | 2 630.1 |
| | Grassland | 0.1 | **930.9** | 15.4 | 0.0 | 0.5 | 0.0 | 946.9 |
| | Cropland | 0.2 | 0.8 | **3 376.9** | 0.1 | 0.6 | 0.0 | 3 378.5 |
| | Wetland | 0.0 | 0.1 | 0.1 | **158.4** | 0.4 | 0.0 | 159.1 |
| | Settlements | 0.3 | 0.4 | 1.2 | 0.1 | **662.8** | 0.0 | 664.8 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 629.5 | 932.5 | 3 393.9 | 158.6 | 664.8 | 107.2 | **7 886.6** |

| Year 1996 | | Initial (1995) | | | | | | Area (kha) |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1996)** | Forest Land | **2 629.2** | 0.4 | 0.9 | 0.0 | 0.5 | 0.0 | 2 631.0 |
| | Grassland | 0.3 | **943.7** | 45.4 | 0.1 | 1.3 | 0.0 | 990.9 |
| | Cropland | 0.2 | 2.2 | **3 330.8** | 0.1 | 0.8 | 0.0 | 3 334.0 |
| | Wetland | 0.0 | 0.1 | 0.1 | **158.8** | 0.3 | 0.0 | 159.3 |
| | Settlements | 0.4 | 0.5 | 1.4 | 0.1 | **661.8** | 0.0 | 664.2 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 630.1 | 946.9 | 3 378.6 | 159.1 | 664.7 | 107.2 | **7 886.7** |

| Year 1997 | | Initial (1996) | | | | | | Area (kha) |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1997)** | Forest Land | **2 630.1** | 0.4 | 0.3 | 0.0 | 0.9 | 0.0 | 2 631.8 |
| | Grassland | 0.2 | **987.2** | 10.2 | 0.1 | 1.1 | 0.0 | 998.8 |
| | Cropland | 0.2 | 2.6 | **3 322.2** | 0.1 | 1.3 | 0.0 | 3 326.4 |
| | Wetland | 0.0 | 0.1 | 0.1 | **159.0** | 0.2 | 0.0 | 159.4 |
| | Settlements | 0.4 | 0.6 | 1.1 | 0.1 | **660.8** | 0.0 | 662.9 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 630.9 | 990.9 | 3 334.0 | 159.3 | 664.3 | 107.2 | **7 886.6** |

| Year 1998 | | Initial (1997) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1998)** | Forest Land | **2 630.3** | 0.7 | 0.5 | 0.1 | 2.3 | 0.0 | 2 633.8 |
| | Grassland | 0.4 | **983.6** | 5.8 | 0.3 | 2.8 | 0.0 | 992.9 |
| | Cropland | 0.4 | 13.4 | **3 318.3** | 0.4 | 4.5 | 0.0 | 3 337.0 |
| | Wetland | 0.1 | 0.2 | 0.1 | **158.2** | 0.4 | 0.0 | 159.0 |
| | Settlements | 0.5 | 0.9 | 1.5 | 0.3 | **652.9** | 0.0 | 656.1 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 631.7 | 998.8 | 3 326.2 | 159.3 | 662.8 | 107.2 | **7 886.0** |

| Year 1999 | | Initial (1998) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (1999)** | Forest Land | **2 632.9** | 0.5 | 0.3 | 0.0 | 0.7 | 0.0 | 2 634.5 |
| | Grassland | 0.1 | **991.1** | 4.1 | 0.0 | 0.4 | 0.0 | 995.7 |
| | Cropland | 0.1 | 0.9 | **3 330.6** | 0.0 | 0.6 | 0.0 | 3 332.2 |
| | Wetland | 0.1 | 0.1 | 0.2 | **158.7** | 0.1 | 0.0 | 159.2 |
| | Settlements | 0.6 | 0.6 | 1.9 | 0.1 | **654.4** | 0.0 | 657.5 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 633.8 | 993.1 | 3 337.1 | 159.0 | 656.2 | 107.2 | **7 886.4** |

| Year 2000 | | Initial (1999) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2000)** | Forest Land | **2 633.8** | 0.5 | 0.5 | 0.1 | 2.4 | 0.0 | 2 637.3 |
| | Grassland | 0.1 | **992.9** | 13.1 | 0.1 | 0.4 | 0.0 | 1 006.6 |
| | Cropland | 0.1 | 1.7 | **3 316.6** | 0.1 | 0.3 | 0.0 | 3 318.8 |
| | Wetland | 0.1 | 0.1 | 0.2 | **158.9** | 0.1 | 0.0 | 159.3 |
| | Settlements | 0.4 | 0.5 | 1.9 | 0.1 | **654.3** | 0.0 | 657.2 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 634.5 | 995.8 | 3 332.2 | 159.3 | 657.5 | 107.2 | **7 886.5** |

| Year 2001 | | Initial (2000) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2001)** | Forest Land | **2 636.8** | 0.5 | 0.4 | 0.0 | 1.1 | 0.0 | 2 638.9 |
| | Grassland | 0.1 | **1 004.8** | 6.0 | 0.0 | 0.5 | 0.0 | 1 011.4 |
| | Cropland | 0.1 | 0.8 | **3 310.3** | 0.0 | 0.3 | 0.0 | 3 311.6 |
| | Wetland | 0.0 | 0.1 | 0.1 | **159.2** | 0.1 | 0.0 | 159.6 |
| | Settlements | 0.3 | 0.4 | 1.9 | 0.1 | **655.1** | 0.0 | 657.8 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 637.3 | 1 006.6 | 3 318.7 | 159.4 | 657.2 | 107.2 | **7 886.5** |

| Year 2002 | | Initial (2001) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2002)** | Forest Land | **2 638.4** | 0.9 | 1.1 | 0.0 | 2.5 | 0.0 | 2 643.1 |
| | Grassland | 0.1 | **1 009.3** | 3.7 | 0.0 | 0.9 | 0.0 | 1 014.0 |
| | Cropland | 0.0 | 0.3 | **3 303.9** | 0.1 | 0.1 | 0.0 | 3 304.5 |
| | Wetland | 0.1 | 0.1 | 0.2 | **159.4** | 0.2 | 0.0 | 159.9 |
| | Settlements | 0.3 | 0.8 | 2.6 | 0.1 | **654.3** | 0.0 | 658.1 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 638.9 | 1 011.4 | 3 311.6 | 159.6 | 658.0 | 107.2 | **7 886.8** |

| Year 2003 | | Initial (2002) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2003)** | Forest Land | **2 642.1** | 0.6 | 0.7 | 0.0 | 0.7 | 0.0 | 2 644.2 |
| | Grassland | 0.1 | **1 011.2** | 4.6 | 0.0 | 0.3 | 0.0 | 1 016.3 |
| | Cropland | 0.1 | 1.5 | **3 296.9** | 0.0 | 0.1 | 0.0 | 3 298.6 |
| | Wetland | 0.0 | 0.1 | 0.2 | **159.7** | 0.1 | 0.0 | 160.1 |
| | Settlements | 0.5 | 0.6 | 2.1 | 0.1 | **656.9** | 0.0 | 660.2 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 642.9 | 1 014.0 | 3 304.5 | 159.9 | 658.1 | 107.2 | **7 886.7** |

| Year 2004 | | Initial (2003) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2004)** | Forest Land | **2 643.5** | 0.8 | 0.8 | 0.0 | 0.6 | 0.0 | 2 645.7 |
| | Grassland | 0.1 | **1 013.8** | 3.1 | 0.0 | 0.4 | 0.0 | 1 017.4 |
| | Cropland | 0.1 | 0.7 | **3 291.9** | 0.0 | 0.2 | 0.0 | 3 292.8 |
| | Wetland | 0.0 | 0.2 | 0.2 | **159.9** | 0.1 | 0.0 | 160.5 |
| | Settlements | 0.5 | 0.9 | 2.7 | 0.1 | **658.9** | 0.0 | 663.1 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 644.2 | 1 016.4 | 3 298.7 | 160.1 | 660.2 | 107.2 | **7 886.8** |

| Year 2005 | | Initial (2004) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2005)** | Forest Land | **2 645.1** | 0.9 | 0.9 | 0.0 | 0.6 | 0.0 | 2 647.4 |
| | Grassland | 0.1 | **1 015.1** | 4.0 | 0.0 | 0.3 | 0.0 | 1 019.5 |
| | Cropland | 0.1 | 0.4 | **3 284.9** | 0.0 | 0.2 | 0.0 | 3 285.7 |
| | Wetland | 0.0 | 0.2 | 0.2 | **160.4** | 0.1 | 0.0 | 160.9 |
| | Settlements | 0.4 | 0.8 | 2.7 | 0.1 | **661.9** | 0.0 | 666.0 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 645.7 | 1 017.4 | 3 292.8 | 160.5 | 663.1 | 107.2 | **7 886.7** |

| Year 2006 | | Initial (2005) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2006)** | Forest Land | **2 647.0** | 0.7 | 1.0 | 0.0 | 0.4 | 0.0 | 2 649.1 |
| | Grassland | 0.1 | **1 017.6** | 4.0 | 0.0 | 0.2 | 0.0 | 1 021.9 |
| | Cropland | 0.1 | 0.4 | **3 277.5** | 0.0 | 0.2 | 0.0 | 3 278.2 |
| | Wetland | 0.0 | 0.2 | 0.3 | **160.7** | 0.2 | 0.0 | 161.4 |
| | Settlements | 0.3 | 0.7 | 2.8 | 0.1 | **664.9** | 0.0 | 668.8 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 647.4 | 1 019.5 | 3 285.6 | 160.9 | 665.9 | 107.2 | **7 886.7** |

| Year 2007 | | Initial (2006) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2007)** | Forest Land | **2 648.8** | 0.6 | 0.9 | 0.0 | 0.9 | 0.0 | 2 651.2 |
| | Grassland | 0.1 | **1 019.9** | 3.5 | 0.0 | 0.2 | 0.0 | 1 023.7 |
| | Cropland | 0.0 | 0.5 | **3 270.4** | 0.0 | 0.2 | 0.0 | 3 271.2 |
| | Wetland | 0.0 | 0.2 | 0.3 | **161.2** | 0.4 | 0.0 | 162.1 |
| | Settlements | 0.3 | 0.7 | 3.0 | 0.1 | **667.1** | 0.0 | 671.2 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 649.1 | 1 021.9 | 3 278.1 | 161.4 | 668.8 | 107.2 | **7 886.7** |

| Year 2008 | | Initial (2007) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2008)** | Forest Land | **2 650.8** | 0.5 | 0.8 | 0.1 | 0.9 | 0.0 | 2 653.0 |
| | Grassland | 0.0 | **1 021.8** | 3.3 | 0.0 | 0.1 | 0.0 | 1 025.4 |
| | Cropland | 0.1 | 0.4 | **3 263.6** | 0.0 | 0.2 | 0.0 | 3 264.4 |
| | Wetland | 0.0 | 0.2 | 0.3 | **161.9** | 0.1 | 0.0 | 162.5 |
| | Settlements | 0.3 | 0.7 | 3.1 | 0.1 | **669.8** | 0.0 | 674.0 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 651.2 | 1 023.6 | 3 271.1 | 162.1 | 671.2 | 107.2 | **7 886.5** |

| Year 2009 | | Initial (2008) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2009)** | Forest Land | **2 652.6** | 0.7 | 0.8 | 0.1 | 1.1 | 0.0 | 2 655.2 |
| | Grassland | 0.1 | **1 023.3** | 4.7 | 0.0 | 0.3 | 0.0 | 1 028.4 |
| | Cropland | 0.0 | 0.5 | **3 255.4** | 0.0 | 0.2 | 0.0 | 3 256.2 |
| | Wetland | 0.0 | 0.2 | 0.3 | **162.9** | 0.1 | 0.0 | 162.8 |
| | Settlements | 0.3 | 0.8 | 3.2 | 0.2 | **672.2** | 0.0 | 676.6 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 653.0 | 1 025.4 | 3 264.3 | 162.5 | 674.0 | 107.2 | **7 886.5** |

| Year 2010 | | Initial (2009) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2010)** | Forest Land | **2 654.6** | 0.6 | 1.1 | 0.1 | 0.9 | 0.0 | 2 657.4 |
| | Grassland | 0.1 | **1 026.1** | 4.8 | 0.0 | 0.5 | 0.0 | 1 031.5 |
| | Cropland | 0.1 | 0.6 | **3 246.7** | 0.0 | 0.2 | 0.0 | 3 247.6 |
| | Wetland | 0.1 | 0.2 | 0.4 | **162.3** | 0.2 | 0.0 | 163.1 |
| | Settlements | 0.3 | 1.0 | 3.2 | 0.3 | **674.7** | 0.0 | 679.6 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 655.2 | 1 028.5 | 3 256.2 | 162.8 | 676.6 | 107.2 | **7 886.5** |

| Year 2011 | | Initial (2010) | | | | | | *Area (kha)* |
|---|---|---|---|---|---|---|---|---|
| | **Category** | Forest Land | Grassland | Cropland | Wetlands | Settlements | Other Land | |
| **Final (2011)** | Forest Land | **2 656.9** | 0.6 | 0.8 | 0.1 | 1.4 | 0.0 | 2 659.8 |
| | Grassland | 0.1 | **1 029.6** | 4.8 | 0.0 | 0.5 | 0.0 | 1 035.0 |
| | Cropland | 0.1 | 0.6 | **3 238.7** | 0.1 | 0.5 | 0.0 | 3 239.9 |
| | Wetland | 0.1 | 0.2 | 0.3 | **162.8** | 0.1 | 0.0 | 163.1 |
| | Settlements | 0.2 | 0.7 | 3.1 | 0.2 | **677.1** | 0.0 | 681.3 |
| | Other Land | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **107.2** | 107.2 |
| | *Area (kha)* | 2 657.3 | 1 031.6 | 3 247.7 | 163.1 | 679.6 | 107.2 | **7 886.5** |

### 7.2.3 Methodologies to estimate emissions

The estimation of emissions and removals of $CO_2$ and non-$CO_2$ gases for the sector was performed according to Chapter 3 of GPG for LULUCF (IPCC, 2003). Additionally, the 2006 Guidelines for National Greenhouse Gas Inventories – Agriculture, Forestry and Other Land Use (IPCC, 2006) were consulted whenever appropriate. The following text describes the inventory for the individual land-use categories, noting vital information on the category within the conditions of the Czech Republic, the methodology employed, uncertainty and time consistency, QA/QC and verification, recalculations and source-specific planned improvements.

## 7.3 Forest Land (5A)

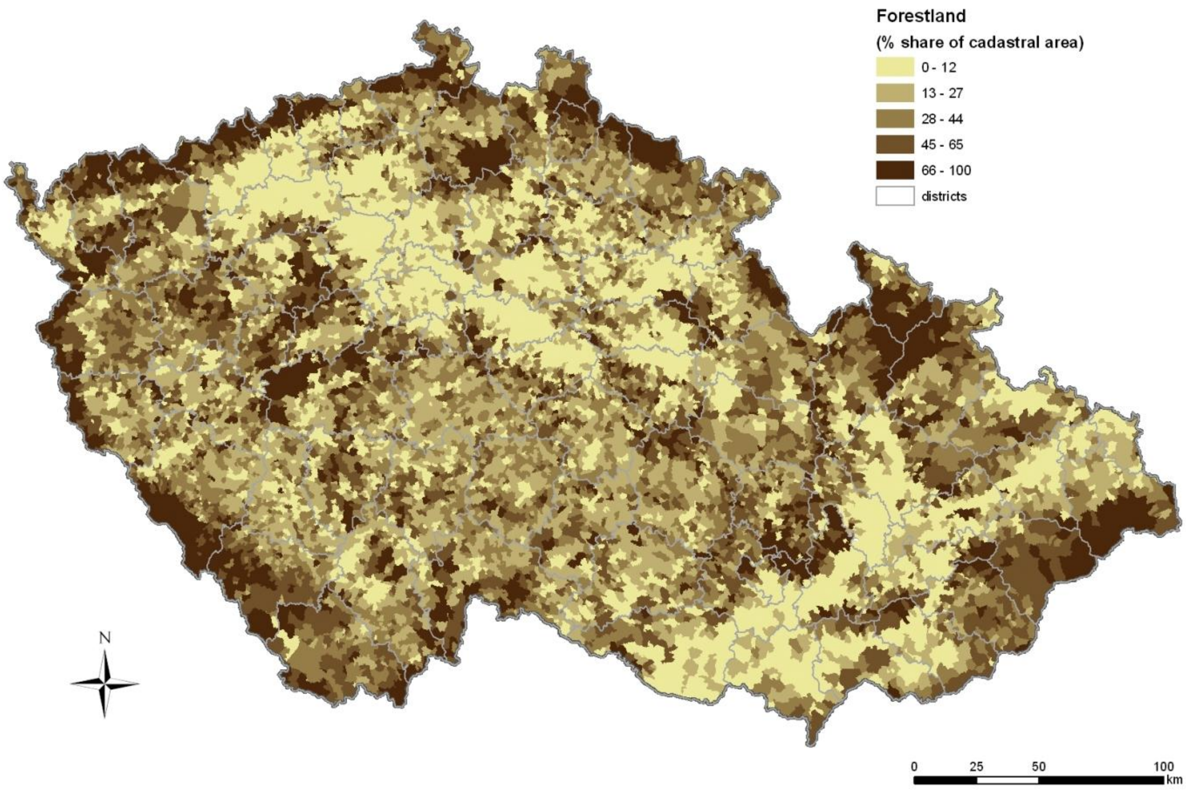



**Fig. 7-5 Forest Land in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2011)**

### 7.3.1 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 (GPG Chapter 3, IPCC 2003). With respect to the definition thresholds of the Marrakesh Accords, Forest Land 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[12]. This definition of forests excludes the areas of permanently unstocked cadastral forest land, such as forest roads, forest nurseries and land under power transmission lines. The permanently unstocked area of cadastral forest land has predominantly the attributes of Grassland, and therefore it was ascribed to that category. Hence, Forest Land in this emission inventory corresponds to the national definition of timberland (Czech Forestry Act 84/1996). In 2011, the stocked forest area (timberland) qualifying under the category of Forest Land in this emission inventory equalled 2 607 thousand ha, representing 98 % of the cadastral forest land in the Czech Republic. The permanently unstocked area represents 2 % of the forest land according to cadastral data and it was linked by this proportion to the area of Forest Land for the whole time series since 1969.

Forests (cadastral forest land) currently occupy 33.8 % of the area of the country (MA, 2012). The tree species composition is dominated by conifers, which represent 73.6 % of the timberland area. The four

[12] *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*

most important tree species in this country are spruce, pine, beech and oak, which account for 51.7, 16.7, 7.5 and 7.0 % of the timberland area, respectively (MA, 2012). Broadleaved tree species have been favored in new afforestation since 1990. The proportion of broadleaved tree species increased from 21 % in 1990 to over 25 % in 2011. 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 683 mil. $m^3$ (under bark) in 2011 (MA, 2012).

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. 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 consists in the 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)[13]. The second NFI cycle is currently in operation, scheduled for years 2011 to 2015. The most recent statistical information on forests at a county level gives the Czech landscape inventory (CzechTerra; www.czechterra.cz), a project funded by the Ministry of Environment (Černý 2009, SP/2d1/93/07)[14]. This emission inventory is dominantly based on the FMP data, which have also been used for all the international reporting on forests of the Czech Republic to date. Whenever feasible, the information from other inventory programs mentioned above and/or other sources was also utilized.

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 in Fig. 7-6 that the average growing stock has increased steadily for all tree species groups since 1990 in this country. In addition to the four major categories by predominant tree species, clear-cut areas are also distinguished, forming another, specific sub-category of Forest Land as reported in this submission. A clear-cut area is defined as a temporarily unstocked area 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 2011, clear-cut areas represented 1.1 % of Forest Land.

[13] *The first cycle of the statistical (sample based, tree level) forest inventory was performed during 2001-2004 by the Forest Management Institute (FMI), Brandýs n. Labem. These data indicate significantly higher growing stock volumes (328 $m^3$/ha under bark, excluding standing dead trees) than those reported so far for this country on the basis of data from forest management plans. This was mainly prescribed to methodological differences between the stand-wise inventory used for forest management planning and the tree-level, sample based statistical forest inventory (e.g., Černý, et al., 2006; FMI, 2007). However, only one inventory cycle of sample based inventory it is not readily usable for detecting carbon stock change in forests.*

[14] *The results of the CzechTerra national landscape inventory project show a mean growing stock volume of 305 $m^3$/ha under bark (IFER, 2010), i.e., significantly lower than the estimates of FMI (2007).*

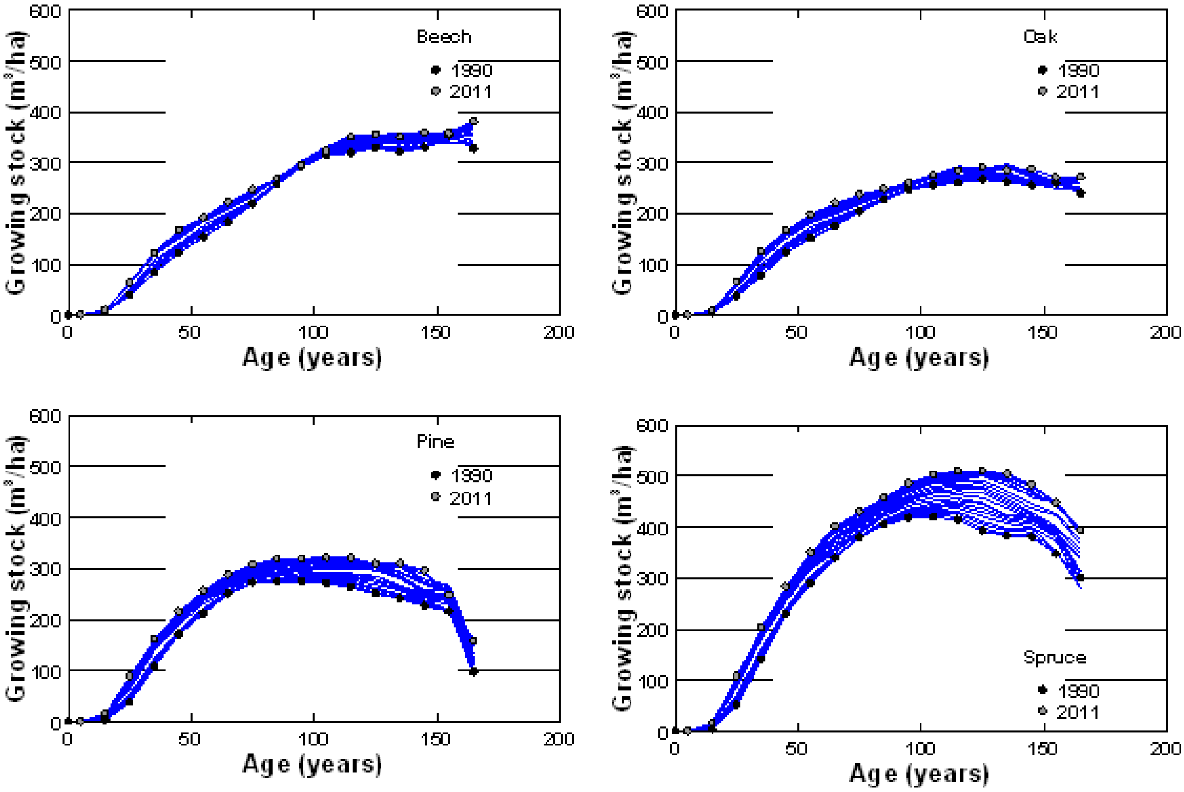



**Fig. 7-6 Activity data – mean growing stock volume against stand age for the four major groups of species during 1990 to 2011; each line corresponds to an individual inventory year. The symbols identify only the situation in 1990 and 2011**

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 encompasses commercial harvest and fuel wood, and included 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 15.4 mil. $m^3$ (under bark) in 2011, down from the all-time high 18.5 mil. $m^3$ harvested in 2007 (all data refer to underbark volumes, MA 2012). Additionally in the emission inventory, harvest loss of 5 and 15 % is applied to final and salvage logging volumes, respectively (see Section 7.3.2 below). The salvage logging operations concern primarily stands of coniferous species, which are commonly hit by windstorms, snow and bark-beetle calamities in this country. Therefore, the totally applicable harvest loss in the emission inventory is higher than the official statistics and in part related to share of salvage logging that is annually reported (e.g., MA 2012). Hence, in 2011, the applicable volume of harvest loss reached 16.5 mill. $m^3$, down from the maximum 20.9 mill. $m^3$ of wood volume that corresponds to the total harvest loss in 2007. The applicable harvest loss for the entire reporting period since 1990 to 2011 is shown in Fig. 7-7.

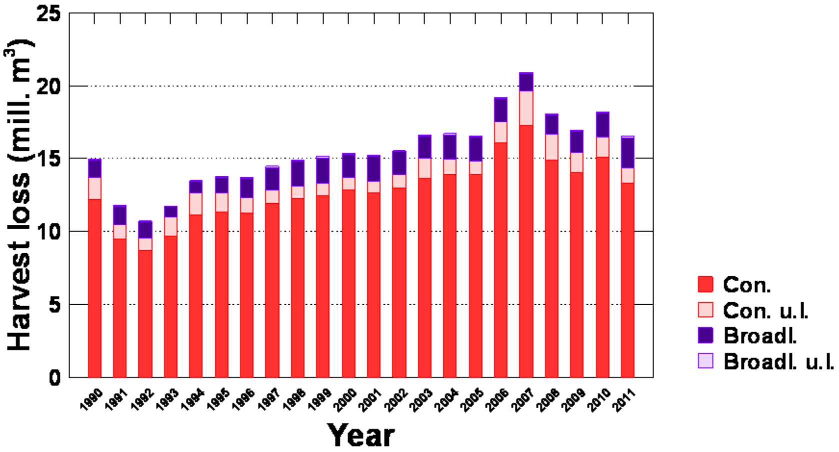



**Fig. 7-7 The applicable harvest loss for coniferous (Con.) and broadleaved (Broadl.) tree species includes the reported quantities from the official statistics and the estimated unreported harvest loss for coniferous (Con. u.l.) and broadleaved (Broadl. u.l.) tree species, all shown for the reported period 1990 to 2011**

### 7.3.2 Methodological issues

Category *5A 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 *5A1 Forest Land remaining Forest Land*, and *5A2 Land converted to Forest Land*. The following text describes the major methodological aspects related to emission inventories of both forest sub-categories.

The methods of area identification described in Section 7.1.2 distinguish the areas of forest with no land-use change over the 20 years prior the reporting year. These lands are included in subcategory *5A1 Forest Land remaining Forest Land*. The other part represents subcategory *5A2 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., *5A1* and *5A2* 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. 7-3 above.

#### *7.3.2.1 Forest Land remaining Forest Land*

Carbon stock change in category *5A1 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[15] according to eq. 3.3.2 of GPG 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. 3.2.4 and 3.2.5 of GPG 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 by FMI (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

[15] *Alternative approaches of the stock-change method (Eq. 3.2.3; IPCC 2003) were also analyzed (Cienciala et al. 2006a) for this category. However, for several reasons the default method was finally adopted, which is discussed in the cited study.*

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 apply only the latest source across the entire reporting period. This was to comply with the GPG for LULUCF requirements of consistent time series. No change, apart from entering the increment of latest reported year, was made to the increment in the inventory submissions thereafter (Fig. 7-8).

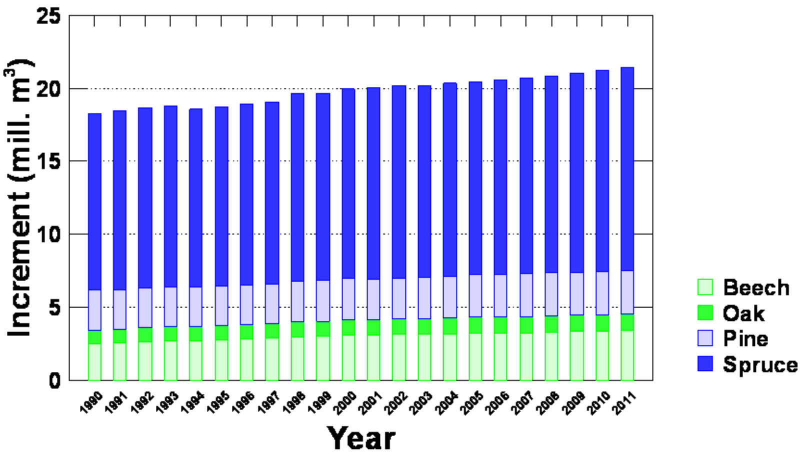



**Fig. 7-8 Current annual increment ($I_V$; m$^3$ underbark) by the individual tree species groups as used in the reporting period 1990 to 2011**

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:

$$\Delta C_G = \sum_j (A_j * G_{Total_j} * CF_j) \tag{1}$$

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:

$$G_{Total} = \sum \{ I_V * BCEF_i * (1 + R) \} \tag{2}$$

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. 7-4 lists the factors used in the calculation of the biomass carbon stock increment.

**Tab. 7-4 Input data and factors used in carbon stock increment calculation (1990 and 2011 shown) for beech, oak, pine and spruce species groups, respectively**

| Variable or conversion factor | Unit | Year 1990 | Year 2011 |
|---|---|---|---|
| **Area of forest land remaining forest land (*A*)** | kha | 372; 152; 455; 1504 | 471; 178; 429; 1 456 |
| **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 | 0.50 | 0.50 |
| **Root/shoot ratio (*R*)** | - | 0.20 | 0.20 |
| **Volume increment ($I_v$)** | m$^3$ha$^{-1}$ | 6.55; 5.96; 5.84; 7.89 | 7.21; 6.17; 6.85; 9.43 |

In Tab. 7-4, $A$ represents only the areas of *5A1 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. 7-4 are weighted means considering the actual volumes of the individual age classes for each of the major tree species. Besides the allometric equations noted above, the source dendrometrical material used for derivation of the country-specific $BCEF_i$ values were the data of the landscape inventory program CzechTerra (Černý, 2009). Its first cycle was completed in 2009 and these dendrometrical data hence represent the most current information on the Czech Forests available in the country. The tree level data together with the information of age was used to assess the median $BCEF_i$ values for each age class and major tree species. $CF$ of 0.50 is a generally accepted default constant, which is also recommended by IPCC (2003). $R$ 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. 2) in the category *5A1 Forest Land remaining Forest Land* basically follows eq.s. 3.2.6, 3.2.7 and 3.2.8 (IPCC, 2003). It uses the annual amount of total harvest removals ($H$) reported by the CzSO for individual tree species in the country. $H$ covers thinning and final cut, as well as the amount of fuel wood, which is reported as an assortment under the conditions of Czech Forestry. To include a potentially unaccounted-for loss associated with $H$, the factor $F_{HL}$ was applied to $H$; it was calculated from annual harvest data and the share of salvage logging, assuming 5 % loss under planned forest harvest operations and 15 % for accidental/salvage harvest applicable for coniferous species. Hence, the harvest volumes entering the actual emission calculation ($H$ in eq. 3 below) include the correction by the above described factor, $F_{HL}$. The calculation of the carbon drain ($L$; loss of carbon) otherwise also follows eq. 2.12 (AFOLU 2006) as

$$L_{wood-removals} = H * BCEF_h * (1+R) * CF \qquad (3)$$

where $BCEF_h$ represents a 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. 7-4. The specific values of input variables and conversion factors used to calculate $L$ are listed in Tab. 7-5.

**Tab. 7-5 Specific input data and factors used in calculation of carbon drain (1990 and 2011 shown) for beech, oak, pine and spruce species groups, respectively**

| Variable or conversion factor | Unit | Year 1990 | Year 2011 |
|---|---|---|---|
| **Harvest volume ($H$, incl. $F_{HL}$)** | mill. $m^3$ | 0.89; 0.33; 1.50; 12.2 | 1.69; 0.46; 2.05; 12.3 |
| **Biomass expansion factor ($BCEF_h$)** | Mg $m^{-3}$ | 0.69; 0.81; 0.52; 0.59 | 0.69; 0.81; 0.52; 0.57 |

The impact of disturbances (Eq. 2.14, AFOLU, 2006) has not been explicitly estimated. To the present time, the disturbance in Czech forests since 1990 has not reached proportions above the buffering capacity of Czech forestry management practices. Consequently, any salvage felling is flexibly allocated to the desired amount of planned wood removals, and is thereby accounted for in the reported harvest volumes.

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, 2003). This concerns both mineral and organic soils. The organic soils occur only in the areas of the Spruce sub-category on *5A1 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 other the sub-categories by the predominant species of Beech, Oak and Pine.

Emissions in category *5A1 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. 3.2.19 and the emission ratios in Table 3A.1.15 (Tier 1, IPCC, 2003). Under the conditions in this country, part of the biomass residues is burnt in connection with final cut. There is no official estimate of the biomass fraction burnt in forests of the country. The expert judgment employed in this inventory revision considers that 15 % of the biomass residues including bark is burnt. This is less than assumed in the previous emission inventory reports, which corresponds with the trend in current forest management practices in the country. The biomass fraction burnt 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 burnt (dry matter) was estimated as 585 Gg in 1990 and 303 Gg in 2011.

The emissions of greenhouse gases due to wildfires were estimated on the basis of known areas burnt annually by forest fires and the average biomass stock in forests according to eq. 3.2.9 (IPCC, 2003). This equation used a default factor of biomass left to decay after burning (0.45; Table 3A.1.12). The associated amounts of non-$CO_2$ gases ($CH_4$, CO, $N_2O$ and $NO_X$) were estimated according to eq. 3.2.19. The amount of biomass (dry matter) burned in wildfires was estimated as 10.2 Gg in 1990 and 24.9 Gg in 2011. The most extreme year of the reporting period was 1997, when about 228 Gg of biomass was burned due to wildfires. 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.

#### *7.3.2.2 Land converted to Forest Land*

The methods employed to estimate emissions in the *5A2 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.

For estimation of the net carbon stock change in living biomass on Land converted to Forest Land by the Tier 1 method (IPCC, 2003), 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 7.1.2) 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 the year 2007 and forward, increment is derived for individual tree species using the ratio of increment for individual tree species to the total stand increment estimated from the period 2000 to 2006.

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 2011 was 3.19 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 increment in terms of aboveground biomass is facilitated by the age and species dependent $BCEF_i$ values as described in Section 7.3.2.1 above. The estimated species-specific values of $BCEF_i$ applicable for young trees until 20 years 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 is implicitly accounted for within the category Forest Land remaining Forest Land.

The net changes of carbon stock in dead organic matter were assumed to be insignificant (zero), in accordance with the assumptions of the Tier 1 method (IPCC, 2003).

The net change of carbon stock in mineral soils was estimated using the country-specific Tier 2/Tier 3 method. It was based on the vector map of topsoil organic carbon content (Macků et al., 2007; Šefrna and Janderková 2007; see Fig. 7-9). 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=12 990 in 2011), 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 *5A Forest Land, 5B Cropland* and *5C Grassland*. The estimated quantities of carbon stock change at the level of the individual spatial units entered 20-year accumulation matrices distributing carbon into fractions over 20 years (Tier 1, IPCC 2003). These quantities, together with the accumulated areas under the specific conversion categories, were used for estimation of emissions and removals of $CO_2$.

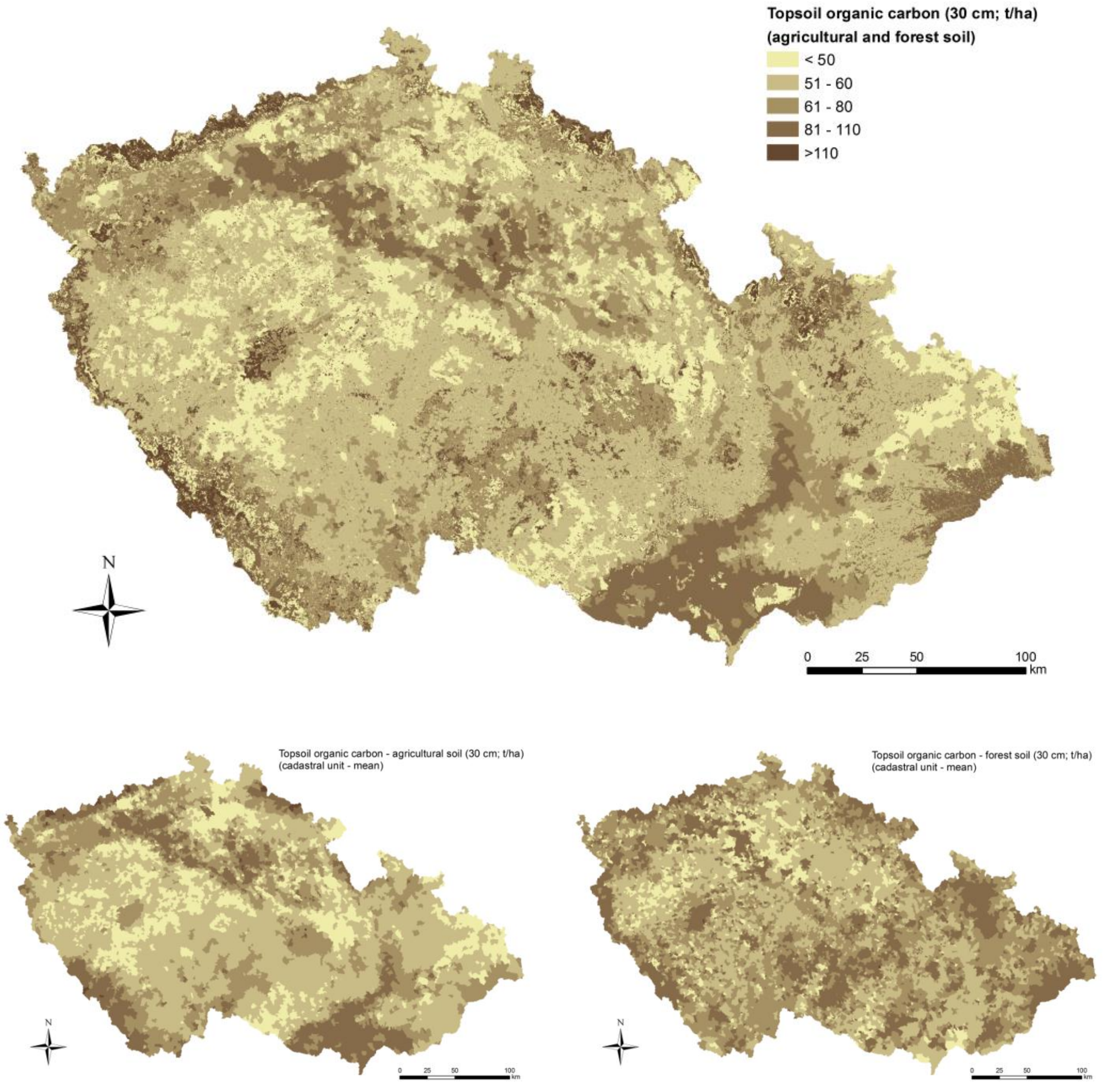



**Fig. 7-9 Top - topsoil (30 cm) organic carbon content map adapted from Macků et al. (2007), Šefrna and Janderková (2007); bottom –topsoil carbon content for agricultural (left) and forest (right) soils estimated as cadastral unit means from the source maps. The unit (t/ha) and unit categories are identical for all maps**

The net changes of 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 besides the drained ones (IPCC, 2003).

Non-$CO_2$ emissions from burning are not estimated for category *5A2 Land converted to Forest Land*, as there is no such practice in this country. The same applies to the $N_2O$ emissions from nitrogen fertilization, which is not employed in this country.

### 7.3.3 Uncertainties and time consistency

The methods used in this inventory were consistently employed across the whole reporting period from the base year of 1990 to 2011.

The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003), employing the following equations:

$$U_{Total} = \sqrt{U_1^2 + U_1^2 + ... + U_n^2} \quad (4)$$

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. 5.2.1, IPCC 2003).

For the quantities that are combined by addition or subtraction, we used the following equation to estimate the uncertainty:

$$U_E = \frac{\sqrt{(U_1 * E_1)^2 + (U_2 * E_2)^2 + .... + (U_n * E_n)^2}}{|E_1 + E_2 + .... + E_n|} \quad (5)$$

where $U_E$ is the percentage uncertainty of the sum, $U_i$ is the percentage uncertainty associated with source/sink *i*, and $E_i$ is the emission/removal estimate for source/sink *i* (Eq. 5.2.2, IPCC 2003).

It should be noted, however, that eq. 5 as exemplified in GPG for LULUCF, is not well applicable for the LULUCF sector. Summing negative (removals) and positive (emission) members ($E_i$) in denominator of equation 5 may easily produce unrealistically high uncertainties and theoretically lead to a 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 to individual uncertainty components prior the resulting product of equation 5.

In this inventory report, we followed the recommendations of the recent reviews and revised the uncertainty values and calculation. The currently adopted uncertainty values are listed below and/or under the corresponding subchapters of other land use categories. Apart the IPCC (2006), the source information for adjusted uncertainty values was the recently conducted statistical landscape inventory of the Czech Republic CzechTerra (Černý et al., 2009). 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 (3 %), 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 %.

Secondly, we revised the approach of uncertainty combination for individual sub-categories of tree species differently in this submission. Specifically, we calculate 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 preserve the recommended logics of combining uncertainties on the level of entire land use category or on the level of 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 source and sink categories to be combined. This approach together with the revised emission estimates significantly reduced the overall uncertainty estimates on the level of major land use categories and entire LULUCF sector as compared to previously reported values.

For 2011, the uncertainty estimates for the categories *5A1 Forest Land remaining Forest Land* and *5A2 Land converted to Forest Land* using the above revised approach reached 15.6 and 38.8 %, respectively. Correspondingly, the uncertainty for the entire category *5A Forest Land* reached 15.1 %.

### 7.3.4 Category-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, provides a table of personal responsibilities a timetable of sector-specific QA/QC procedures. This plan consolidates the quality assurance procedures and facilitates an 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 (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 5.5.1 of GPG for LULUCF (IPCC, 2003).

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.

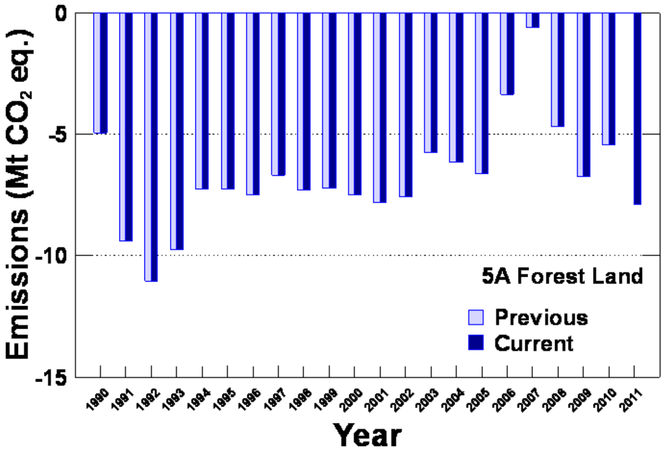



**Fig. 7-10 Current and previously reported assessment of emissions for category 5A Forest Land. The values are negative, hence representing net removals of green-house gases**

### 7.3.5 Category-specific recalculations

Since the last submission, no emission recalculation has been performed in the category of Forest Land. Therefore, the current and previous estimates are identical for the jointly reported years (Fig. 7-10).

### 7.3.6 Category-specific planned improvements

The current report applicable for Forest Land includes improvements regarding uncertainty estimation following the suggestions of the recent inventory reviews. Other recommendations such as reporting emissions/removals by sub-categories of major tree species groups, revised categorization of land-use and an improved land-use determination system were already implemented before. Nonetheless, the category will require additional efforts to further consolidate the estimates. This includes a further improvement of the uncertainty assessment (exploring the Monte-Carlo approaches) and further formalization and enhancement of QA/QC procedures. Over a longer term, utilization of the stock change method in as explored in Cienciala et al. (2006a) will be considered.

Emissions from lime application on forest land remain being reported under the category *5G Other* due to the current technical limitations of the CRF Reporting software. The addition of emissions from lime application on forest land makes the reporting under Convention compatible with that of KP LULUCF activities where emissions from lime applications are also reported for the activities related to forest land.

## 7.4 Cropland (5B)

### 7.4.1 Source category description

In the Czech Republic, Cropland is predominantly represented by arable land (93 % of the category), while the remaining area includes hop-fields, vineyards, gardens and orchards. These categories correspond to five of the six real estate categories on 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. 7-4). While, in 1990, Cropland represented approx. 44 % of the total area of the country, this share decreased to nearly 41 % in 2011. It can be expected that this trend will continue. The conversion of arable land to grassland is also actively promoted by state subsidies. In addition, there is a growing demand for land for infrastructure and settlements. The current estimate of probable excess lands qualifying for conversion to other land-use in the near future is about 600 000 ha. Conversion to grassland concerns mainly the lands of less productive regions of alpine and sub-alpine regions.

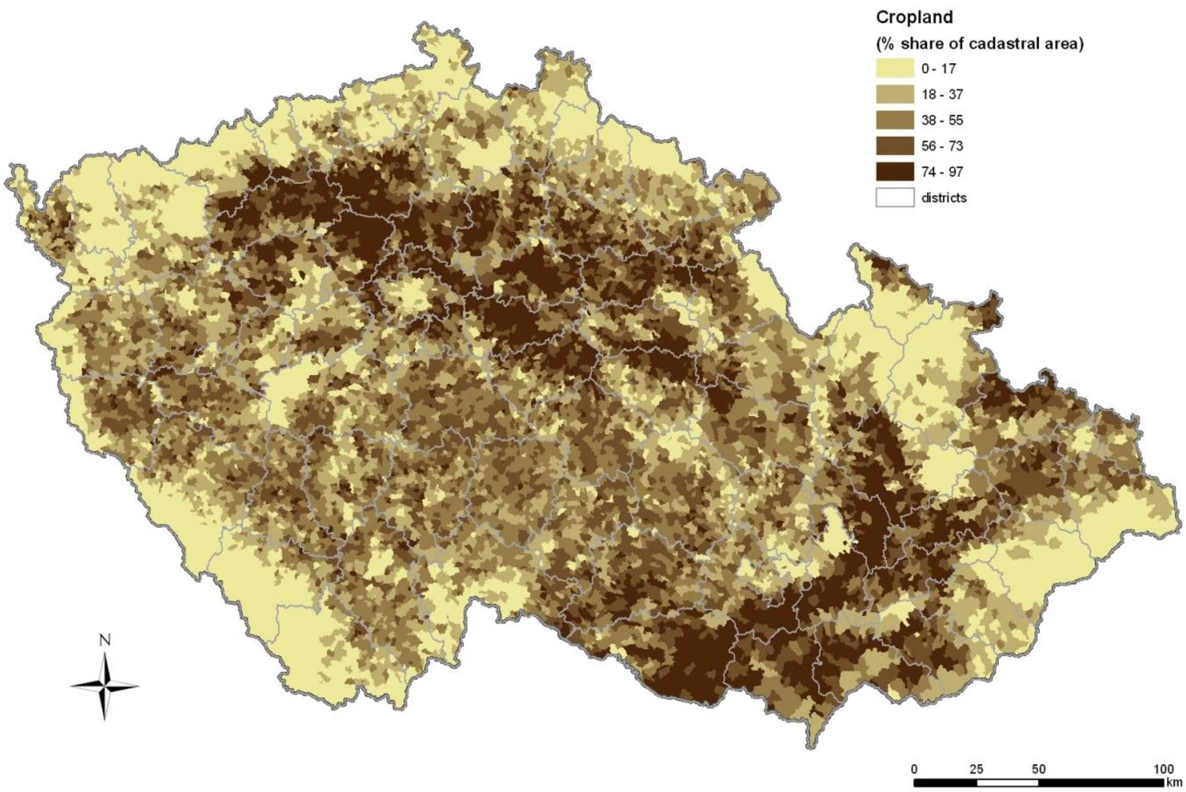



**Fig. 7-11 Cropland in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2011)**

### 7.4.2 Methodological issues

The emission inventory of Cropland concerns sub-categories *5B1 Cropland remaining Cropland* and *5B2 Land converted to Cropland*. The emission inventory of Cropland considers changes in living biomass and soil. In addition, $CO_2$ emissions resulting from application of agricultural limestone and $N_2O$ emissions associated with soil disturbance during land-use conversion to cropland are quantified for this category.

#### *7.4.2.1 Cropland remaining Cropland*

For category *5B1 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, we applied a default factor for the biomass accumulation rate (2.1 t C/ha/year, Table 3.3.2, IPCC 2003) and estimated changes in the areas concerned.

The carbon stock changes in soil in the category Cropland remaining Cropland are 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. While organic soils practically do not occur on Cropland, emissions were estimated for mineral soils. Based on the average carbon content on Cropland estimated from the detailed soil carbon maps (Fig. 7-9), we applied the default relative stock change factors for land use ($F_{LU}$; 1.0), management ($F_{MG}$; 1.08) and input of organic matter ($F_I$; 1.0), respectively (Table 5.5; IPCC 2006). These differentiate management activities on individual Cropland subcategories, in our case arable land, hop fields and the sub-categories containing perennial woody crops. The average soil carbon on typical arable cropland, estimated as the area-weighted average from individual cadastral units, was 59 t/ha, while it was estimated as 63.7 t/ha for soils with woody vegetation, such as in orchards. The changes in soil carbon stock, associated with the annually changing proportion of land areas of cropland sub-categories, result in emissions/removals. These are calculated after redistribution of the estimated carbon stock change over a 20-year rolling period.

The Cropland category also includes emissions due to liming, which were estimated from the reported limestone use and application area. Liming by either limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$) is used to improve soil for crop growth by increasing the availability of nutrients and decreasing acidity. However, the reactions associated with limestone application also lead to evolution of $CO_2$, which must be quantified. Of the reported total limestone use in agriculture, 95 % was ascribed to Cropland (the reminder to Grassland), based on expert judgment (V. Klement, Central Institute for Supervising and Testing in Agriculture – personal communication, 2005). The quantification followed the Tier 1 method of GPG for LULUCF (Eq. 3.3.6 IPCC 2003), with an emission factor of 0.12 t C/t $CaCO_3$. 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. t, but decreased to less than 200 000 t annually during the most recent years (see the corresponding CRF Tables). This dramatic decrease makes the entire category of *5B1 Cropland remaining Cropland* a key category identified by trend, although its quantitative contribution to national emissions in recent years is marginal and reached only 0.05 % in 2011. 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 (Salusová et. al., 2006).

Non-$CO_2$ greenhouse gas emissions from burning do not occur in category *5A2 Land converted to Forest Land*, as there is no such practice in this country.

#### *7.4.2.2 Land converted to Cropland*

Category *5B2 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 land-use identification system was also able to detect some land conversion in the opposite direction, i.e., to Cropland.

The estimation of carbon stock changes in biomass in the category *5B2 Land converted to Cropland* was based on quantifying the difference between the carbon stock before and after the conversion, including the estimate of one year of cropland growth (5 t C/ha; Table. 3.3.8, IPCC 2003), 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 the *5A Forest Land* category in Section 7.2.2.1 above. For biomass carbon stock on Grassland prior the conversion, the default factors of 6.8 t/ha for above-ground and below-ground biomass were used (Table 6.4, IPCC, 2006). A biomass content of 0 t/ha was assumed after land conversion to *5B Cropland*.

The estimation of net carbon stock change in dead organic matter concerns the land use conversion from Forest Land. In this case, the input information on standing and lying deadwood was obtained from the recently (2008 to 2009) conducted field campaign of the Czech landscape inventory CzechTerra (Cerny, 2009; www.czechterra.cz). It provides data on the mean standing deadwood biomass (2.17 t/ha) and volume of lying deadwood (7.5 $m^3$/ha) classified in four categories according to decomposition degree. 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.

The estimation of the carbon stock change in soils for the category *5B2 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 is described in detail in Section 7.2.2.2 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 eq.s. 3.3.14 and 3.3.15 (IPCC, 2003). Accordingly, $N_2O$ was quantified on the basis of the detected changes in mineral soils employing a default emission factor of 0.0125 kg $N_2O$-N/kg N, and C:N ratio of 15.

Other non-$CO_2$ emissions may be related to those from burning. However, this is not common practice in this country and no other non-$CO_2$ emissions besides the above described are reported in the LULUCF sector.

### 7.4.3 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 2007, which applies also for the land use category of Cropland. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and described in Section 7.3.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by UNFCCC (2005) and IPCC (2003, 2006). These were partly revised for this submission as reported above in section 7.3.3. The following uncertainty values were used: land use areas 3 %, 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 %, amount of lime 10 %, emission factor for liming 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).

For 2011, using the revised uncertainty values, the total estimated uncertainty for category *5B1 Cropland remaining Cropland* was 12.5 %. The corresponding uncertainty for category *5B2 Land converted to Cropland* was 38 %. The overall uncertainty for category *5B Cropland* was estimated to be 23 %.

### 7.4.4 Category-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 GPG for LULUCF. 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 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

### 7.4.5 Category-specific recalculations

No recalculation has been performed in the category of Cropland since the last submission. Therefore, the current and previous estimates are identical for the jointly reported years (Fig. 7-12).

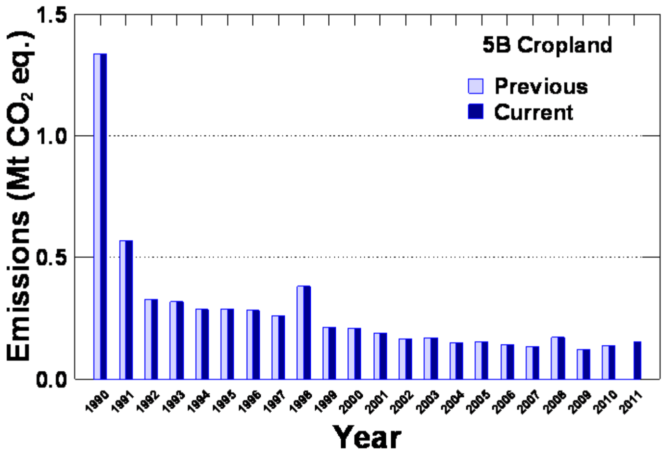



**Fig. 7-12 Current and previously reported assessment of emissions for category 5B Cropland**

### 7.4.6 Category-specific planned improvements

Similarly as for other categories, additional efforts will be exerted to further consolidate the current estimates for Cropland. Specific attention will be paid to a likely overall formalization and enhancement of the QA/QC procedures. Also, a more detailed stratification of Cropland area to allow a more specific application of appropriate factors used in emission estimation will be explored as also suggested by the latest in-country review.

## 7.5 Grassland (5C)

### 7.5.1 Source category description

Through its spatial share of close to 14 % in 2011, the category of Grassland ranks third among land-use categories in the Czech Republic. Its area has been growing since 1990, specifically in early 1990s (Fig. 7-4). 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 production role and for preserving biodiversity in the landscape. According to the national agricultural programs, the representation of Grassland should further increase to about 18 % of the area of the country. The dominant share 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 about 17 % (in 2011) since 1990.

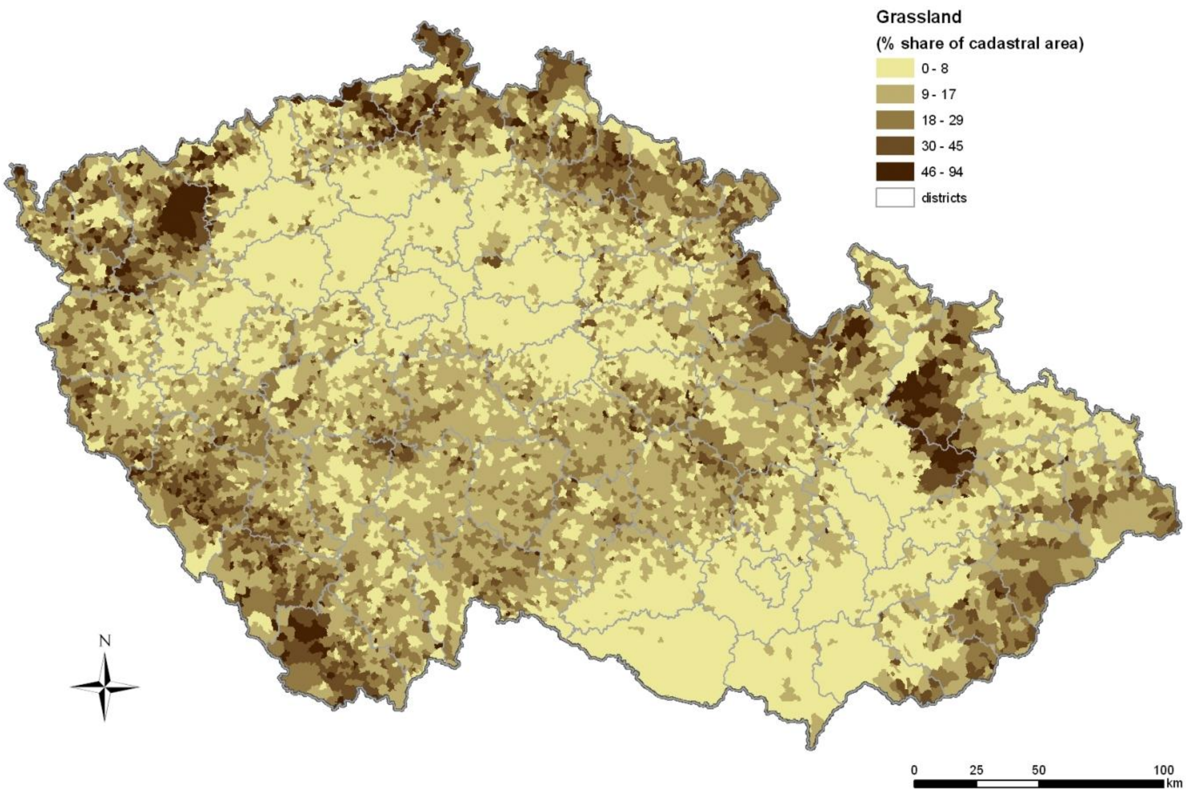



**Fig. 7-13 Grassland in the Czech Republic – distribution calculated as a spatial share of the category within individual cadastral units (as of 2011)**

### 7.5.2 Methodological issues

The emission inventory of *5C Grassland* concerns sub-categories *5C1 Grassland remaining Grassland* and *5C2 Land converted to Grassland*. Similarly to *5B Cropland*, the emission inventory of *5C Grassland* considers changes in living biomass and soil. In addition, the effect of application of agricultural limestone is quantified for this category.

#### *7.5.2.1 Grassland remaining Grassland*

For category *5C1 Grassland remaining Grassland*, the assumption of no change in carbon stock held in living biomass was employed, in accordance with the Tier 1 approach of IPCC (2003). 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.

The emissions estimates from changes in soil carbon stock were estimated for category *5C1*. These changes are due to an effect of different management regimes and the changing proportion of the concerned subcategories of *5C1*. The changes also concern permanently unstocked cadastral Forest Land, which has the attributes of Grassland and is treated accordingly in the emission estimates (see Section 7.3.1). Other land belonging to the category of Grassland is considered as typically managed grassland. The reference soil carbon stock for this category is estimated as area-weighted mean for all the individual cadastral units. The analogous mean carbon content for the category of unmanaged grassland is determined using the corresponding factors (Table 5.5; IPCC 2006). These included the stock change factor for land use ($F_{LU}$; 1.0), stock change factor for the management regime ($F_{MG}$; 0.95) and stock change factor for input of organic matter ($F_I$; 1.0). The estimated area-weighted average soil carbon stock for classically managed grassland was equal to 69 t C/ha, while that for unmanaged grassland was 65.5 t/ha. This is estimated for the whole reporting period and the soil carbon stock change was derived from the difference between the consecutive years. The changes in soil carbon stock associated with the annually changing proportion of land areas of cropland sub-categories result in emissions/removals. These are calculated after redistribution of the estimated carbon stock change over a 20-year rolling period.

Other explicitly quantified effect on soil carbon that results in $CO_2$ emissions is that of limestone application. This was quantified as described in Section 7.3.2.1 for *5B Cropland*. The applicable amount of limestone was set at 5 % of the reported limestone use on agricultural lands, based on expert judgment (V. Klement, Central Institute for Supervising and Testing in Agriculture – personal communication, 2005).

Non-$CO_2$ gases on category *5C1 Grassland remaining Grassland* do not concern the LULUCF sector in the Czech Republic.

#### 7.5.2.2 Land converted to Grassland

For category *5C2 Land converted to Grassland*, the estimation concerns carbon stock changes in living biomass and soils.

For living biomass, the calculation used eq. 3.4.13 (IPCC, 2003) with the assumed carbon content before the conversion of *5B Cropland* set at 5 t C/ha (Table 3.4.8; IPCC 2003) and that of Forest Land calculated from the mean growing stock volumes as described in Section 7.3.2.2 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 6.8 t C/ha (Table 3.4.9; IPCC 2003).

For dead organic matter, emissions are reported due to changes in deadwood that concern the category *5C21 Forest Land converted to Grassland.* Apart from the actual areas concerned, the emission estimation is identical as described in Section 7.4.2.2 above.

The estimation of carbon stock change in soils for category *5C2 Land converted to Grassland* in the Czech Republic concerns the changes in mineral soils. The soil carbon stock changes following the conversion from *5A Forest Land* and *5B Cropland* were quantified by the country-specific Tier 2/Tier 3 approach described in detail in Section 7.2.2.2 above.

### 7.5.3 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 2011. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and described in Section 7.3.3. The uncertainty estimation utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). As reported above in chapter 7.3.3, uncertainty estimation was revised for this submission, which applies also to this land use category. The following uncertainty values were used: converted land use areas 3 %, 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 %, 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 %, amount of lime 10 %, emission factor for liming 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 2011, the total estimated uncertainty for category *5C1 Grassland remaining Grassland* reached 9.4 %. The corresponding uncertainty for category *5C2 Land converted to Grassland* reached 18.6 %. The overall combined uncertainty for category *5C Grassland* reached 18.7 %.

### 7.5.4 Category-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 GPG for LULUCF. 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 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

### 7.5.5 Category-specific recalculations

No recalculation has been performed in the category of Grassland since the last submission. Therefore, the current and previous estimates are identical for the jointly reported years (Fig. 7-14).

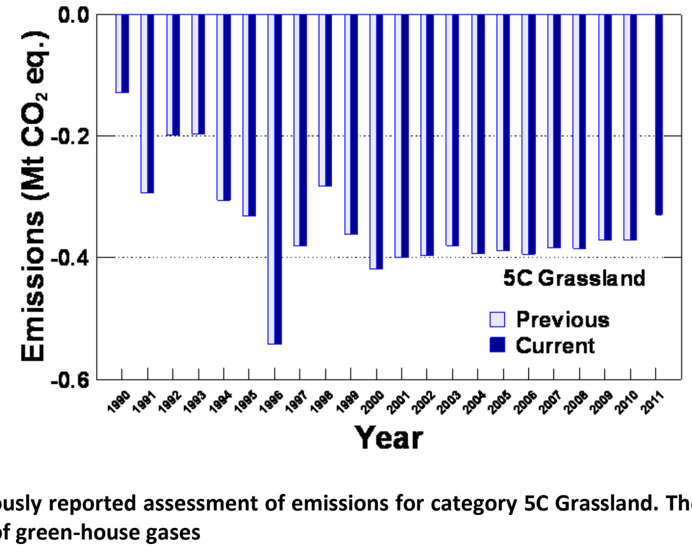



**Fig. 7-14 Current and previously reported assessment of emissions for category 5C Grassland. The values are negative, hence representing net removals of green-house gases**

### 7.5.6 Category-specific planned improvements

Further efforts to consolidate the emission estimates are expected for the category of Grassland. Specific attention will be paid to a likely overall formalization and enhancement of the QA/QC procedures. Also, a more detailed stratification of Grassland area to allow a more specific application of factors used in emission estimation will be explored.

## 7.6 Wetlands (5D)

### 7.6.1 Source category description

Category *5D 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 wetlands identified as Ramsar[16] 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 5D emission category.

The area of *5D Wetlands* currently covers 2.1 % of the total territory. It has been growing steadily since 1990 (Fig. 7-4) with even a stronger trend since 1970. It can be expected that this trend would continue and that the area of Wetlands would increase further. This is mainly due to programs aimed at increasing the water retention capacity of the landscape[17].

[16] *Convention on Wetlands, Ramsar, Iran, 1971*

[17] *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)*

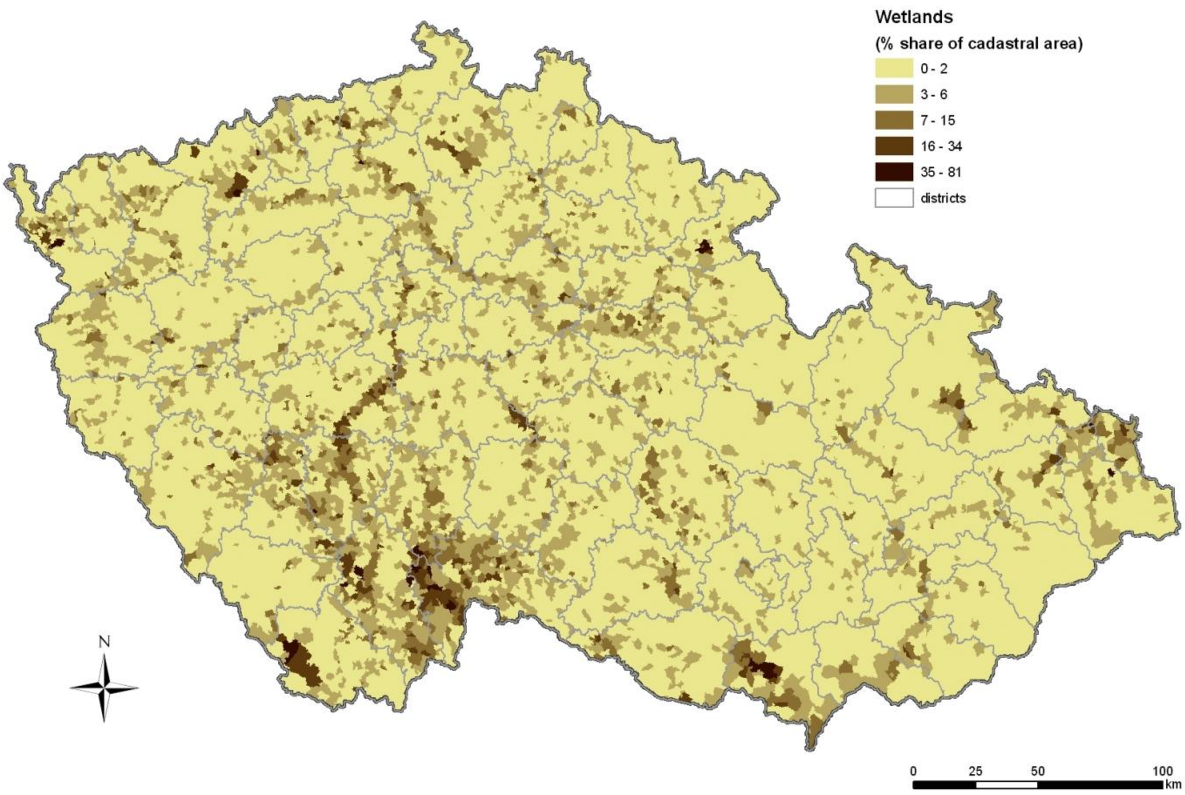



**Fig. 7-15 Wetlands – distribution calculated as a spatial share of the category within individual cadastral units (as of 2011)**

### 7.6.2 Methodological issues

The emission inventory of sub-category *5D1 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 *5D1 Wetlands remaining Wetlands* were not explicitly estimated and they can safely be considered negligible.

Sub-category *5D2 Land converted to Wetlands* encompass conversion from *5A Forest Land*, 5B *Cropland* and *5C Grassland*. This is 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 in the case of conversion from Forest land, also deadwood. The emissions were generally estimated using the Tier 1 approach and eq. 3.5.6 of GPG 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 *5A Forest Land*, 5B *Cropland* and *5C Grassland* categories was estimated and/or assumed identically as described above in Sections 7.3.2.2 and 7.4.2.2. The latter section also describes the estimation of emissions related to deadwood component, which was applied identically in this land use category.

### 7.6.3 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 2011. Similarly as for the other land-use categories, the uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and described in Section 7.3.3. It utilized primarily the default uncertainty values as recommended by IPCC (2003, 2006). As reported above in chapter 7.3.3, uncertainty estimation was revised for this submission, which applies also to this land use category. The following uncertainty values were used: converted land use areas 3 %, 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 *5D2 Land converted to Wetlands*, the uncertainty is estimated for this category. For 2011, the estimated uncertainty for category *5D2* was 74 %.

### 7.6.4 Category-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 GPG for LULUCF. 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 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

### 7.6.5 Category-specific recalculations

No recalculation has been performed in the category of Wetlands since the last submission. Therefore, the current and previous estimates are identical for the jointly reported years (Fig. 7-16).

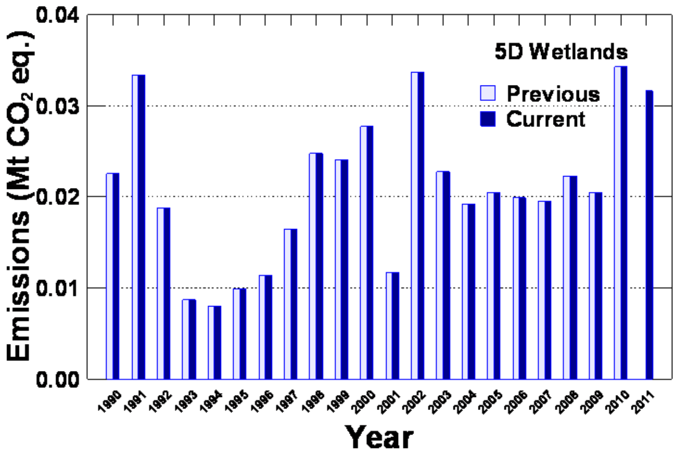



**Fig. 7-16 Current and previously reported assessment of emissions for the category 5D Wetlands**

### 7.6.6 Category-specific planned improvements

For the category of *5D Wetlands*, attention will be paid to a further consolidation of the uncertainty assessment and to overall formalization and enhancement of the QA/QC procedures.

## 7.7 Settlements (5E)

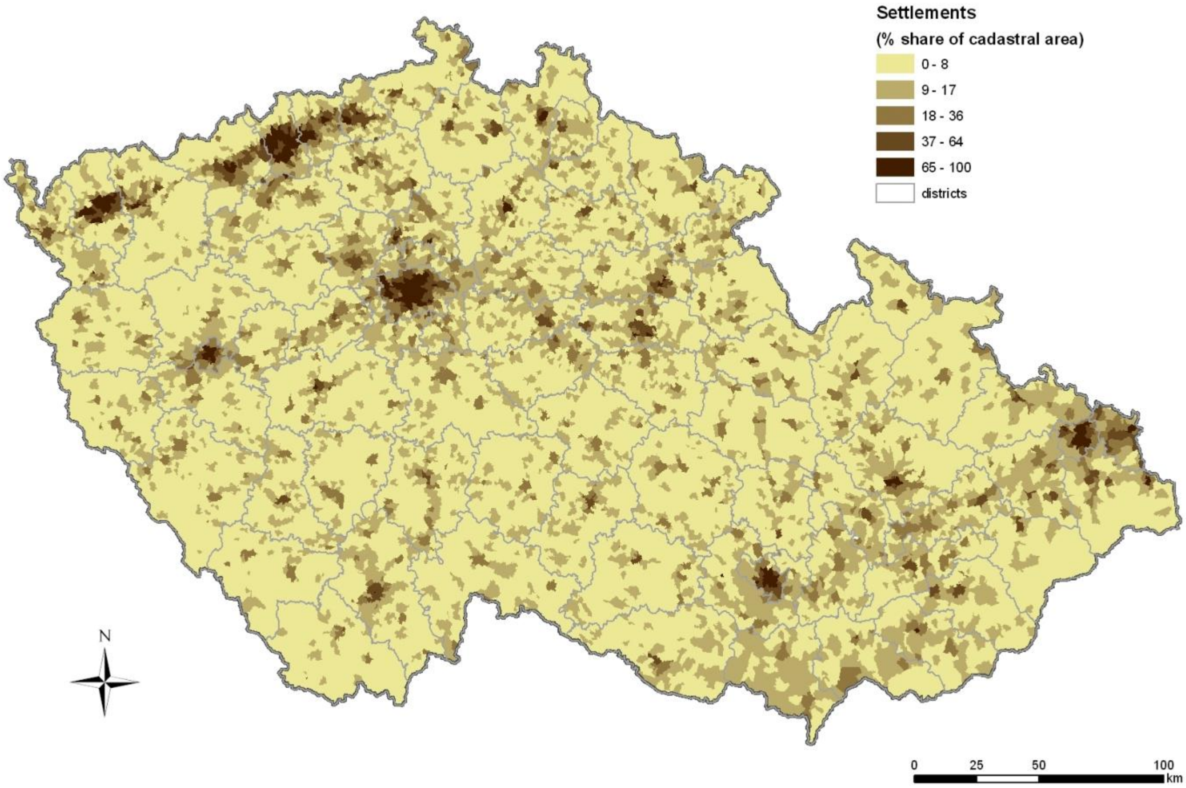



**Fig. 7-17 Settlements – distribution calculated as a spatial share of the category within individual cadastral units (as of 2011)**

### 7.7.1 Source category description

Category *5E Settlements* is defined by IPCC (2003) as all developed land, including transportation infrastructure and human settlements. For this emission inventory, the area definition under category *5E Settlements* was revised to better match the IPCC (2003) default definition. The category currently includes two categories of the database “Aggregate areas of cadastral land categories” (AACLC), 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 *5F Other Land*. Hence, the Settlements category also includes all land used for infrastructure, as well as that of industrial zones and city parks, previously included in category *5F Other Land*.

The category of Settlements as defined above currently represents about 8.6 % of the area of the country. The area of this category has increased since 1990 and especially during the most recent years (see Fig. 7-4).

### 7.7.2 Methodological issues

The emission inventory for this category concerns primarily *5E2 Land converted to Settlements*. As for category *5E1 Settlements remaining Settlements*, emissions of $CO_2$ were considered insignificant as no change in biomass, dead organic matter and soil carbon pools is assumed (Tier 1, IPCC 2006). Emissions quantified in this inventory concern the category *5E2 Forest Land converted to Settlements*. The emissions result mainly from the biomass carbon stock change, which was quantified using eq. 3.6.1 (IPCC, 2003). The carbon stock prior conversion was estimated as described in Section 7.3.2.2. All biomass is assumed to be lost during the conversion, according to the Tier 1 assumption of GPG for LULUCF. Additional contribution to emissions is from deadwood component. It was estimated identically as described in Section 7.4.2.2 above, using the actual areas of the land use change concerned.

### 7.7.3 Uncertainties and time series consistency

The methods used in this inventory for *5E Settlements* were consistently employed across the whole reporting period from the base year of 1990 to 2011. The uncertainty estimation was guided by the Tier 1 methods outlined in GPG for LULUCF (IPCC, 2003) and described in Section 7.3.3. It utilized primarily the default uncertainty values as recommended by IPCC (2003, 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 %, which was derived from the work of Lehtonen et al. (2007).

The emission estimate concerns only category *5E2 Land converted to Settlements*; therefore, the uncertainty is estimated only for this category. For 2011, the estimated uncertainty for the category *5E2* was 102 %.

### 7.7.4 Category-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 GPG for LULUCF. 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 7.3.4 above, following the application of the QA/QC plan applicable for the LULUCF sector.

### 7.7.5 Category-specific recalculations

Similarly as for the other categories, no recalculation has been performed in the category of Settlements since the last submission. Therefore, the current and previous estimates are identical for the jointly reported years (Fig. 7-18).

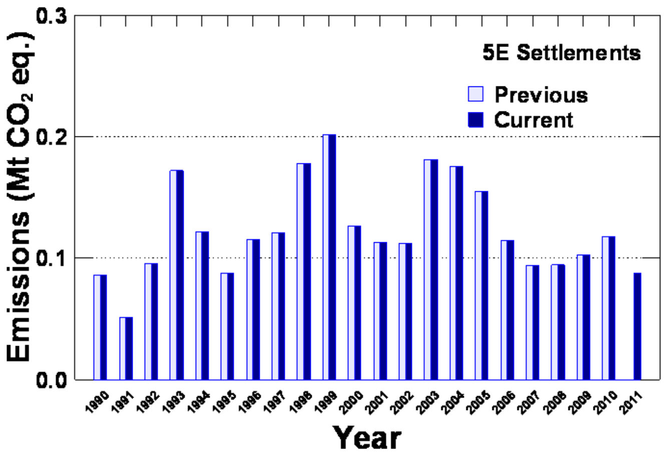



**Fig. 7-18 Current and previously reported assessment of emissions for the category 5E Settlements**

### 7.7.6 Category-specific planned improvements

Further efforts to consolidate the emission estimates are expected for the category of Settlements. This will include an assessment of how the data from the recently conducted statistical landscape inventory CzechTerra (Cerny, 2009) could be utilized. Attention will also be paid to further improvement of the uncertainty assessment and overall formalization and enhancement of the QA/QC procedures.

## 7.8 Other Land (5F)

### 7.8.1 Source category description

Since NIR 2008 submission, the category *5F Other Land* represents unmanaged (unmanageable) land areas, matching the IPCC (2003) default definition. These areas were assessed from the database of “Aggregate areas of cadastral land categories” (AACLC), collected and administered by COSMC. It is a part the AACLC category “other lands” with the specific land use category “unproductive land”, assessed from the 2006 land census of COSMC. This category represents 1.0 % of the territory of the country and it is considered to be constant, not involving any land-use conversions.

### 7.8.2 Methodological issues

Change in carbon stocks and non-$CO_2$ emissions are not considered for *5F1 Other Land remaining Other Land* (IPCC, 2003). Since no land-use conversion involving “other land” is assumed by this inventory, no emissions were considered in the entire category *5F Other Land*.

### 7.8.3 Uncertainties and time series consistency

The uncertainty estimates are not reported here. Time series consistency is ensured as the inventory approaches and/or assumptions are applied identically across the whole reporting period from the base year 1990 to 2011.

### 7.8.4 Category-specific QA/QC and verification

The activity data are based on land-use information from the national sources and the estimation approaches follow the recommendations of GPG for LULUCF.

The QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, limited to those relevant for this specific land-use category.

### 7.8.5 Category-specific recalculations

No recalculations concern category *5F Other Land*.

### 7.8.6 Category-specific planned improvements

There are no short-term plans concerning this category.

## 7.9 Other (5G)

### 7.9.1 Source category description

Since the 2012 submission, the category *5G Other* is reported. Unlike other land use categories, *5G Other* has no area representation and therefore it is not reported in land use matrices (Tab. 7-3). It was introduced to facilitate reporting of emissions from lime application on Forest land. This is due to the current technical restrictions of the CRF Reporter software, which does not permit adding emissions from lime application under the category of *5A Forest Land* where these emissions should actually be attributed to.

### 7.9.2 Methodological issues

For the emissions from lime application, the methodology described in Section 3.3.1.2.1 of GPG for LULUCF (IPCC, 2003) was used. The activity data in terms of forest area and amount of limestone applied were taken from the national reports on Czech forestry (Green report, MA 2012). In 2011, the amount of lime applied to forest soils equalled 29 t and concerned an area of 26 ha.

### 7.9.3 Uncertainties and time series consistency

The uncertainty estimates are not specifically reported here. Time series consistency is ensured as the inventory approaches and/or assumptions are applied identically across the whole reporting period from the base year 1990 to 2011.

### 7.9.4 Category-specific QA/QC and verification

The activity data are based on land-use information from the national sources and the estimation approaches follow the recommendations of GPG for LULUCF.

The QA/QC elements were adopted in the same manner as described in Section 7.3.4 above, limited to those relevant for this specific emission category.

### 7.9.5 Category-specific recalculations

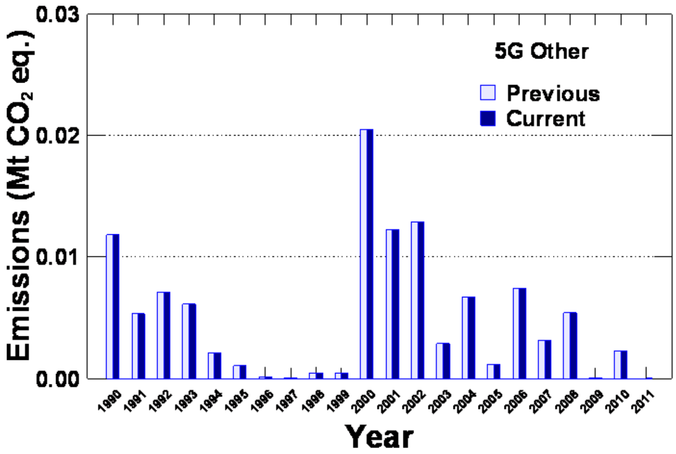



**Fig. 7-19 Currently reported assessment of emissions for the category 5G Other, represented solely by emissions from lime application on Forest land. Not applicable (NA) for the previous submission**

No recalculations are applicable for the category *5G Other* and the emission quantities reported in the previous and current inventory report are identical (Fig. 7-19).

### 7.9.6 Category-specific planned improvements

The UNFCCC Secretariat will be further consulted to allow reporting of the emissions from lime application on forest land under the category *5A Forest Land*, where it logically belongs. Once this will be made possible in the CRF Reporter, the category *5G Other* will not be used for this purposes.

## 7.10 Acknowledgement

The authors would like to thank Vladimír Henžlík, formerly at the Forest Management Institute in Brandýs n. Labem, for some of the activity data and his expert advice. Thanks are also due to Jan Hána, Patrik Pacourek and Miroslav Zeman, Forest Management Institute in Brandýs n. Labem, for compiling the required increment data concerning forests. Some of the analyses required for this inventory were performed within the project CzechCarbo (VaV/640/18/03), while some of the critical data were obtained from the project CzechTerra (SP/2d1/93/07), both funded by the Czech Ministry of the Environment.

# 8 Waste (CRF sector 6)

## 8.1 Overview of sector

The waste sector consists of several categories. The main source category of this sector is 6A Methane emissions from solid waste disposal sites. In 2011, this category emitted 131 Gg of methane (2744 Gg of $CO_2$ eq.). The second source category is 6B emissions from waste-water, which is calculated as the sum of four subcategories – emissions of methane from industrial waste-water treatment, domestic waste-water treatment, on-site treatment and emissions of nitrous oxide from waste-water. These subcategories summed up in 2011 emitted 24.6 Gg of methane and 0.66 Gg of $N_2O$. The last source category in this sector is incineration of wastes, which was recalculated last year and split between two sectors. Waste used as a fuel for energy purposes was calculated and reported in category 1A1a other fuels. Industrial and hazardous waste remained in category 6 C and produced a total of 191 Gg of fossil $CO_2$ eq.This inventory year sector 6 produced 3656 Gg of $CO_2$ eq. in total.

**Tab. 8-1 Overview of significant categories in this sector (2011)**

| Category | Character of category | Gas | % of total GHG* |
|---|---|---|---|
| 6A Solid Waste Disposal on Land | KC (LA, TA, LA*, TA*) | $CH_4$ | 2.1 |
| 6B Waste Water Handling | non-KC | $CH_4$ | 0.4 |
| 6C Waste Incineration (without MSW) | non-KC | $CO_2$ | 0.1 |
| 6B Waste Water Handling | non-KC | $N_2O$ | 0.1 |

** 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*

Right from the start, CHMI co-operated in compilation of the emission inventory for this sector with professional workplaces, in particular with the Institute for Environmental Science of the Faculty of Sciences at Charles University in Prague (PřFUK) (Havránek, 2001), the University of Chemical Technology (VŠCHT) (Zábranská, 2004) and the Institute for Research and Use of Fuels in Prague Běchovice (ÚVVP) (Straka, 2001). In the framework of this cooperation, all the emission inventories in this category were recalculated for the entire time series from the reference year of 1990 to the present. At the present time, this sector is managed by the Charles University Environmental Center (CUEC).

## 8.2 Solid Waste Disposal on Land (6A)

### 8.2.1 Source category description

Treatment and disposal of municipal, industrial and other solid waste produces significant amounts of methane ($CH_4$). 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 category produces 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). Only $CH_4$ is addressed in this report.

Category was recalculated last year. Based on suggestions in the in-country review, we gathered country-specific waste composition data. Using the default carbon content suggested in the Good Practice Guidelines (IPCC, 2000), we derived the country-specific DOC for particular waste streams.

### 8.2.2 Methodological issues

***Waste disposal to SWDS***

Key activity data for methane quantification from 6.A is the amount of waste disposed in landfills. Annual disposal is shown Tab. 8-2. Data for annual disposal are from mixed sources because correct application of the FOD model requires data from 1950 to the present day. These data are not available in the country and therefore assumptions about the past must have been used. These assumptions are described in the working paper published in this issue (Havránek, 2007) but the method can be simply described as intrapolation and extrapolation between points in time; we correlated waste production with social product (predecesor of current GDP) as a test method. The higher of the two estimates was used in the quantification.

Data used for present dates are based on information system of waste management (ISOH) managed by CENIA – Czech Environmental Information Agency. The system contains bottom up data from about 60 000 respondents and reporting obligation to this system is based on national legislation. In the year 2011 we experienced for a first time in modern history slight decline in waste deposited in to landfills. Unfortunatelly we think that this decline is only temporary and it is closely connected to increase of waste incinerated for energy purposes in 1A1a due to reconstruction of incinerator in Brno.

**Tab. 8-2 MSW disposal in SWDS in the Czech Republic [Gg], 1990-2011**

| 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 | | |
| **1992** | 2484 | **1999** | 2632 | **2006** | 3221 | | |
| **1993** | 2543 | **2000** | 2803 | **2007** | 3314 | | |
| **1994** | 2561 | **2001** | 2826 | **2008** | 3424 | | |
| **1995** | 2621 | **2002** | 2920 | **2009** | 3406 | | |
| **1996** | 2683 | **2003** | 2952 | **2010** | 3185 | | |

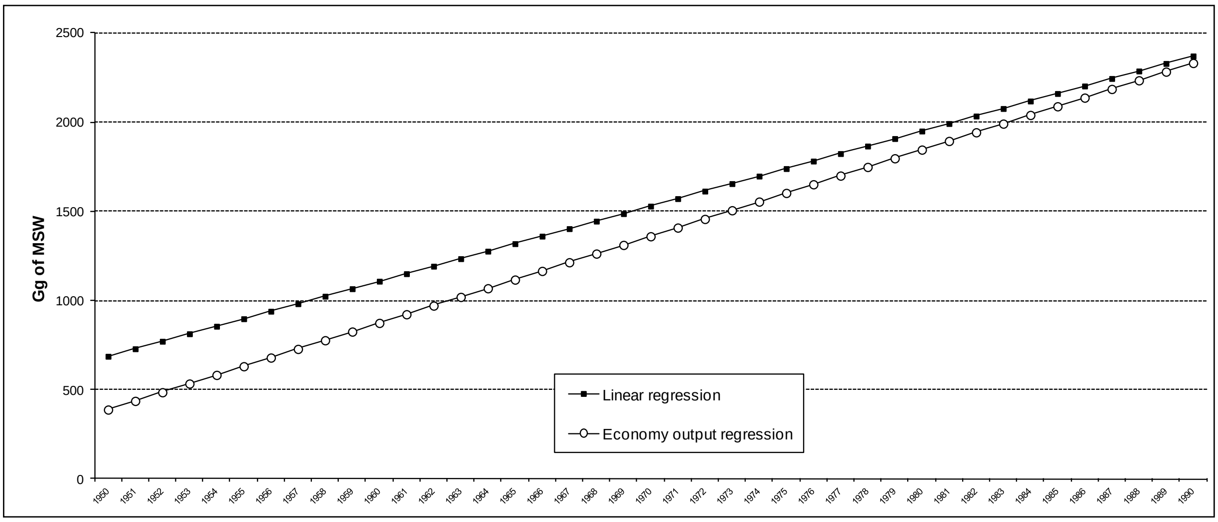



**Fig. 8-1MSW disposal in SWDS in the Czech Republic, 1950-1990**

The method used for estimation of methane emissions from this source category is the *Tier 2* FOD approach (first-order decay model). The first-order decay (FOD) model assumes gradual decomposition of waste disposed in landfills. We calculated GHG emissions 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*

Waste composition is crucial for emission estimations. We made several attempts to obtain country-specific data about waste composition (Tab. 8-3). Greyed data (1990-1995)  are based on the IPCC default values for Eastern Europe, blackened data (1996-2000 and 2002-2004) are based on intrapolation between data points. Data in the white rows (2001 and 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 we use latest available data and trying to encourage continuation of waste composition monitoring.

As can be noted table does not include all possible waste streams that might be deposited in to landfill. What is missing is sludge. Reality is that projects that we use to derive waste composition did not noted any sludge to be part of the waste mixture. However we are aware that research covered limited number of landfill and because the practice of sludge deposition is not wide spreaded they did not encountered its deposition. Therefore we do not calculate sludge in to waste mixture even when there probably is some. Doing so we don’t underestimate emissions because mass deposited to landfills already include sludge (data are bottom up data from landfills) and average DOC by 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. We used 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). The average DOC for particular waste streams is also based on the IPCC default values for particular categories of waste. The average DOC for a particular year is in the last column of the table.

**Tab. 8-3 MSW composition for the Czech Republic used in the quantification (fractions of total, 1990-2011)**

| | Paper | Food | Textil | Wood and straw | DOC |
|---|---|---|---|---|---|
| **k-*rate*** | 0.06 | 0.185 | 0.06 | 0.03 | |
| **DOC** | 0.4 | 0.15 | 0.24 | 0.43 | |
| | **Share of particular waste streams** | | | | |
| **1990** | 0.22 | 0.30 | 0.05 | 0.08 | 0.176 |
| **1991** | 0.22 | 0.30 | 0.05 | 0.08 | 0.176 |
| **1992** | 0.22 | 0.30 | 0.05 | 0.08 | 0.176 |
| **1993** | 0.22 | 0.30 | 0.05 | 0.08 | 0.176 |
| **1994** | 0.22 | 0.30 | 0.05 | 0.08 | 0.176 |
| **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** | 0.16 | 0.35 | 0.08 | 0.13 | 0.193 |
| **2010** | 0.16 | 0.35 | 0.08 | 0.13 | 0.193 |
| **2011** | 0.16 | 0.35 | 0.08 | 0.13 | 0.193 |

### *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 larger MCF values. 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. 8-4.

**Tab. 8-4 Methane correction values (IPCC, 1997)**

| | MCF |
|---|---|
| Unmanaged, shallow | 0.4 |
| Unmanaged, deep | 0.8 |
| Managed | 1.0 |
| Managed, semi-aerobic | 0.5 |
| Uncategorised | 0.6 |

**Tab. 8-5 MCF values employed, 1950-2011**

| | MCF |
|---|---|
| 1950 – 1959 | 0.6 |
| 1960 – 1969 | 0.6 |
| 1970 – 1979 | 0.8 |
| 1980 – 1989 | 0.9 |
| 1990 – 2011 | 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 how intensive the oxidation of methane is. 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 mentions a non-zero oxidation factor, but these figures seem to be site-specific (and really high) and therefore cannot be used as representative for the whole country. However, the methodology (IPCC, 2000) 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 methanogenesion) do not start immediately. The assumption employed in the IPCC model is that the reaction starts on the first of January in the year after deposition, which 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. In this work, we revised these values based on new evidence (MIT, 2005). MIT receives annual reports from landfills capturing their LFG; SWDS report the net calorific value of their captured LFG. We used this value for comparison with the gross calorific value of pure methane, yielding a value of approx. 0.55, which well within the IPCC range and was used in the quantification.

***Recovered methane***

On SWDS in the country, methane is sometimes collected by an LFG collection system and incinerated for energy purposes. Based on Good Practice Guidelines (IPCC, 2000), this methane is converted to $CO_2$ and, having biogenic origin, it is not considered to constitute an emission of GHG. Recovered methane (R) is substituted in the equation in Appendix 1. There is no default value for R, so we used country estimates based on various sources. The Ministry of Industry and Trade conducts an annual survey of all SWDS. All the energy data about LFG is collected. An attempt is made to update old estimates as much as possible. Since the start of the survey in 2005, it has been possible to provide estimates for time series from 2003 to 2011. The estimates in Straka, 2001 were used for the 1990-1996 period. Linear intrapolation of recovered methane was used for the period between 2003 and 1996. In 2011 there were 61 facilities in the country recovering LFG which is two more than in previous year.

Total emissions of methane are based on the equation from the IPCC $CH_4$ model. Detailed time series from 1950 with breakdown into individual waste components are given in the paper by Havranek 2007, together with the other model outputs gives the trends in emissions of methane from SWDS following recalculation.

**Tab. 8-6 Emissions of methane from SWDS [Gg], Czech Republic, 1990-2011**

| | $CH_4$ 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 | 26.1 | 14.5 | 131.7 |

### 8.2.3 Uncertainties and time-series consistency

This sector was extensively recalculated in 2012 reporting period. We changed waste composition to be consistent with the country estimates and we have changed recovered methane estimates to be consistent with the latest data collection work on LFG. Havranek, 2007 contains a sensitivity analysis for several key factors and assumption used in the previous recalculation when we moved from Tier 1 to Tier 2. This year there were no changes compared to 2012 report.

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 1950-2011 and therefore it cannot be quantified by simple analysis.

### 8.2.4 Source-specific QA/QC and verification

During the year 2012 we updated and adopted QA/QC plan for the sector. 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 insinght in to it.

### 8.2.5 Source-specific recalculations

No recalculations were performed in this submission.

### 8.2.6 Source-specific planned improvements

No sectoral improvement has been performed.

## 8.3 Waste-water Handling (6B)

### 8.3.1 Source category description

This category has CRF code 6B and consists of four separately calculated sub-categories – emissions of methane from *6B1 Industrial Waste-water*, *6B2 Domestic and Commercial Waste-water* and *6B3 Other (Treatment on site)* and emissions of nitrous oxide from *6B2 Domestic and Commercial Waste-water*.

### 8.3.2 Methodological issues

The basic factor for determining methane emissions from waste-water handling is the content of organic pollution in the water. The content of organic pollution in municipal waste-water and sludge is given as $BOD_5$ (the biochemical oxygen demand). BOD is a group method of determination of organic substances and expresses the amount of oxygen consumed in the biochemical oxidation, and is thus a measure of biologically degradable substances. In contrast, COD (chemical oxygen demand) is the amount of oxygen required for chemical oxidation and includes both biologically degradable and biologically non-degradable substances. COD is used according to the Revised 1996 Guidelines (IPCC, 1997) for calculation of methane emissions from industrial waste-water and is always larger than BOD.

The current IPCC methodology employs BOD for evaluation of municipal waste-waters and sludge and COD for industrial waste-waters. The new method is also extended to include determination of emissions from sludge that are primarily the products of various methods of treatment of waste-waters and, under anaerobic conditions, may contribute to methane production and methane emissions. The amount of nitrous oxide emitted from waste-waters is a function of protein consumption in the population rather than BOD or COD.

#### *8.3.2.1 Industrial waste-water (6B1)*

The main activity data for estimation of methane emissions from this subcategory is determination of the amount of degradable pollution in industrial waste-water. In this inventory we use specific production of pollution - the amount of pollution per production unit - kg COD / kg product and then we multiply it by the production, or the value obtained from the overall amounts of industrial waste-water and from a qualified estimate of their concentrations (in kg COD/$m^3$). We use the procedure from the Revised 1996 Guidelines (IPCC, 1997) and Good Practice Guidance (IPCC, 2000). The necessary activity data were taken from the material of CZSO (*Czech Statistical Office - Statistical Yearbook*) and the other parameters required for the calculation were taken from the Good Practice Guidance (IPCC, 2000). On the basis of information on the total amount of industrial waste-water equal to 159 mil.$m^3$ (actually only 156 mil.$m^3$ were treated) we are able to correct our overestimation of possible waste-water generation of industry (36 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, in accordance with Revised 1996 Guidelines (IPCC, 1997), it was estimated that the amount of sludge equals 10 % of the total pollution in industrial water (25 % was assumed in the Meat & Poultry, Paper and Pulp and in Vegetables, Fruits & Juices category). These estimates are based on Dohanyos and Zábranská (2000); Zábranská (2004), see Tab. 8-7.

**Tab. 8-7 Estimation of COD generated by individual sub-categories 2011**

| | 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** | 21 | 11.0 | 24.00 | 0.10 | 562 | 5 062 |
| **Dairy Products** | 1 229 | 2.7 | 7.00 | 0.10 | 2 323 | 20 911 |
| **Malt & Beer** | 3 281 | 2.9 | 6.30 | 0.10 | 5 994 | 53 950 |
| **Meat & Poultry** | 347 | 4.1 | 13.00 | 0.25 | 4 625 | 13 875 |
| **Organic Chemicals** | 153 | 3.0 | 67.00 | 0.10 | 3 075 | 27 678 |
| **Pet. ref./Petrochemicals[18]** | 0 | 1.0 | 0.60 | 0.10 | 0 | 0 |
| **Plastics and Resins** | 552 | 3.7 | 0.60 | 0.10 | 123 | 1 104 |
| **Pulp & Paper** | 824 | 9.0 | 162.00 | 0.25 | 300 579 | 901 738 |
| **Soap and Detergents** | 29 | 0.9 | 3.00 | 0.10 | 7 | 67 |
| **Starch production** | 81 | 10.0 | 9.00 | 0.10 | 733 | 6 598 |
| **Sugar Refining** | 570 | 3.2 | 9.00 | 0.10 | 1 642 | 14 774 |
| **Textiles(natural)** | 34 | 0.9 | 172.00 | 0.10 | 531 | 4 778 |
| **Vegetable Oils** | 123 | 0.9 | 3.10 | 0.10 | 32 | 292 |
| **Vegetables, Fruits & Juices** | 111 | 5.0 | 20.00 | 0.25 | 2 776 | 8 327 |
| **Wine & Vinegar** | 60 | 1.5 | 23.00 | 0.10 | 208 | 1 873 |
| ***Unidentified waste-water*** | -35 789 | 3.0 | 1.00 | 0.10 | -10 737 | -96 633 |
| **Total** | | | | | 312 475 | 964 394 |

**Tab. 8-8 Parameters for $CH_4$ emissions calculation from industrial waste-water 1990-2011**

| | MCF | 1990 | 1993 | 1996 | 1999 | 2002 | 2005 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Non-treated** | 0.05 | 29 % | 18 % | 13 % | 5 % | 7 % | 3 % | 2% | 1% | 1% |
| **Aerobic treatment of water** | 0.06 | 67 % | 73 % | 70 % | 70 % | 65 % | 68 % | 69% | 70% | 69% |
| **Anaerobic treatment of water** | 0.70 | 4 % | 8 % | 17 % | 25 % | 28 % | 29 % | 30% | 29% | 30% |
| **Aerobic treatment of sludge** | 0.10 | 40 % | 40 % | 40 % | 40 % | 30 % | 27 % | 27% | 27% | 27% |
| **Anaerobic treatment of sludge** | 0.30 | 60 % | 60 % | 60 % | 60 % | 70 % | 73 % | 73% | 73% | 73% |

In accordance with Good Practice Guidance (IPCC, 2000), the maximum theoretical methane production $B_0$ was considered to equal 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 waste-water 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 waste-water and sludge because of the energy advantages of this means of treating waste-water. Tab. 8-7 describes this trend. The conversion factor for anaerobic treatment is 0.06 and, for aerobic treatment, 0.7.

In contrast to a quite stable ratio for waste-water treatment technologies (6B2), ratio used for sludge keeps shifting in favor of anaerobic treatment. This is mostly due its economic efficiency. The 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 6B2, 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 and waste-water 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 biological $CO_2$). Experts at the

[18] *Due to changes in the statistical data, we are no longer able to identify Pet. ref./Petrochemicals*

*University of Chemical Technology* recommended the conversion factors and other parameters given in this part, see (Dohanyos and Zábranská, 2000; Zábranská, 2004).

**Tab. 8-9 Emissions of $CH_4$ (Gg) from 6B1, 1990-2011, Czech Republic**

| | 1990 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$CH_4$ 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 |
| **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 |
| **Total $CH_4$ emissions** | 24.5 | 13.3 | 10.9 | 12.9 | 12.3 | 12.2 | 12.1 | 12.7 | 12.3 | 12.1 | 11.8 | 12.3 | 12.2 |

### *8.3.2.2 Municipal and commercial waste-water treatment (6B2) and treatment on site (6B3)*

The basic activity data (and their sources) for determining emissions from these subcategories are as follows:

- the number of inhabitants (source Czech Statistical Office);
- the organic pollution produced per inhabitant (source IPCC default value);
- the conditions under which the waste-water is treated. (source Czech Statistical Office, with some specific national factors);
- the amount of proteins in the diet of the population (source FAO).

Calculations for conditions in this country are based on pollution production per inhabitant of 18.25 kg BOD p.a. (IPCC, 1997), of which approx. 33% is present in the form of insoluble substances, i.e. is separated as sludge. This factor was slightly changed in 2003 mainly due to increasing water savings in water use (aprox. 10-20%). The total amount of organic pollution is same, but the density is higher than for the period before 2003. From 2003 onwards, we assume that 40% of the BOD is separated as sludge. (Zábranská, 2004).

Other data entering the calculation also include the number of inhabitants connected to the sewers and the percent of treated waste-water collected in the sewers. gives the amounts for the time series. According to Good Practice Guidance (IPCC, 2000), the maximum theoretical methane production B0 equals 0.25 kg $CH_4$/kg COD, corresponding to 0.6 kg $CH_4$/kg BOD. This data is used to determine the emission factors for municipal waste-water and sludge. In determining the emission factor for sludge, it is necessary to evaluate the technology used to treat the particular sludge and to assign a conversion factor to it - MCF - Methane Conversion Factor - giving the part of the organic material that will be transformed as methane (the remainder to $CO_2$). The literature (Dohanyos and Zábranská, 2000; Zábranská, 2004) contains a survey of the nationally specific factors for the ratio of aerobic and anaerobic technologies for 1990-2004. There is also a certain fraction of sewage that does not enter the sewer system and is treated on site. For this situation, the IPCC methodology (IPCC, 1997; IPCC, 2000) recommends that separation into waste-water and sludge not be carried out (this corresponds to latrines, septic tanks, cesspools, etc.). The residual waste-water in the Czech Republic which does not enter the sewer system is considered to be treated on site. All methane generated in anaerobic processes for sludge is considered to be removed (recovered for energy purposes or flared). The remaining methane is considered to be emitted. This assumption is based on Czech national standards (to certain degree similar to ISO standards) CSN 385502, CSN 105190 and CSN 756415. On the basis of these standards, every waste-water treatment facility is obliged to maintain safety and abate gas emission. Leakage might occur only during accidents, but the amount of methane emitted is assumed to be insignificant (the estimate based on expert judgment is less than 1% of the total amount) (Zábranská, 2004).

In the estimation of methane emissions from waste-water and sludge, it is necessary to determine the total amount of organic substances contained in them and to determine (estimate) the emission factors for the individual means of waste-water treatment. For this purpose, professional cooperation was undertaken with the *University of Chemical Technology* and a study was carried out (Havránek, 2001), supplementing an earlier study (Dohányos and Zábranská, 2002) and related to a new study (Zábranská, 2004).

**Tab. 8-10 Population connection to sewers and share of treated water, 1990-2011, 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 | **2001** | 10 224 | 74.9 | 95.5 |
| **1991** | 10 308 | 72.3 | 69.6 | **2002** | 10 201 | 77.4 | 92.6 |
| **1992** | 10 317 | 72.7 | 78.7 | **2003** | 10 202 | 77.7 | 94.5 |
| **1993** | 10 330 | 72.8 | 78.9 | **2004** | 10 207 | 77.9 | 94.9 |
| **1994** | 10 336 | 73.0 | 82.2 | **2005** | 10 234 | 79.1 | 94.6 |
| **1995** | 10 330 | 73.2 | 89.5 | **2006** | 10 267 | 80.0 | 94.2 |
| **1996** | 10 315 | 73.3 | 90.3 | **2007** | 10 323 | 80.8 | 95.8 |
| **1997** | 10 303 | 73.5 | 90.9 | **2008** | 10 486 | 81.1 | 95.3 |
| **1998** | 10 294 | 74.4 | 91.3 | **2009** | 10 492 | 81.3 | 95.2 |
| **1999** | 10 282 | 74.6 | 95.0 | **2010** | 10 517 | 81.9 | 96.2 |
| **2000** | 10 272 | 74.8 | 94.8 | **2011** | 10 496 | 82.6 | 96.8 |

**Tab. 8-11 Methane conversion factors (MCF) and share of individual technology types [%], 1990-2011**

| | MCF | 1990 | 1993 | 1996 | 1999 | 2002 | 2005 | 2008 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|
| **On-site treatment**[19] | 0.15 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Discharged into rivers** | 0.05 | 27 | 21 | 10 | 5 | 7 | 5 | 5 | 4 | 3 |
| **Aerobic water** | 0.05 | 48 | 54 | 65 | 70 | 68 | 72 | 73 | 73 | 74 |
| **Anaerobic water** | 0.50 | 25 | 25 | 25 | 25 | 25 | 23 | 23 | 23 | 23 |
| **Aerobic sludge** | 0.10 | 45 | 40 | 35 | 30 | 20 | 15 | 15 | 15 | 15 |
| **Anaerobic sludge** | 0.50 | 55 | 60 | 65 | 70 | 80 | 85 | 85 | 85 | 85 |

The method of quantification is described in the Good Practice Guidelines (IPCC, 2000) as a Tier 1 approach and we follow it in this subcategory without any modification. The amount of methane emitted from 6B2 is given by the equation:

$$\textbf{Total Gg } \mathbf{CH_4} \textbf{ p.a.} = \textbf{Gg } \mathbf{CH_{4\,(tos)}} + \textbf{Gg } \mathbf{CH_{4\,(wwt)}} + \textbf{Gg } \mathbf{CH_{4\,(sld)}} - \mathbf{R}$$

Where tos is the part of the waste-water treated on site, wwt is the part treated as waste-water and sld is the part treated as sludge. R is the recovered methane (flared or used as gas fuel). Each part (tos, wwt, sld) is calculated as the share of this part in the organic pollution (according to Tab. 8-1 and share of individual technology types [%], 1990-2011), multiplied by an emission factor.

[19] *Amount of organic pollution associated with this technology is the average pollution per capita multiplied by the number of people not connected to sewers (Tab. 8-10)*

Particular MCFs are calculated as a weighted average – thus, the wwt emission factor is, in fact, the maximum methane capacity multiplied by the weighted average of MCF for aerobic, anaerobic and river discharge treatment options. The results for 2009 are presented in Tab. 8-12.

**Tab. 8-12 Emissions of $CH_4$ and $N_2O$ [Gg] from 6B2 and 6B3, 1990-2011, Czech Republic**

| | 1990 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2009 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **$CH_4$ production** | 22.3 | 23.9 | 24.9 | 25.1 | 27.0 | 27.0 | 27.3 | 27.5 | 27.7 | 28.3 | 28.5 |
| **Oxidized $CH_4$** | 7.4 | 9.7 | 11.1 | 11.4 | 14.8 | 14.8 | 15.1 | 15.3 | 15.5 | 15.9 | 16.1 |
| **Total $CH_4$ emissions** | 14.9 | 14.3 | 13.9 | 13.8 | 12.3 | 12.3 | 12.2 | 12.2 | 12.2 | 12.4 | 12.3 |
| **Total $N_2O$ emissions** | 0.52 | 0.65 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 0.65 | 0.65 | 0.66 | 0.66 |

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. The $N_2O$ emissions according to the Revised 1996 Guidelines (IPCC, 1997) would then equal:

$$\mathbf{N_2O\ emissions = 10\,517\,000 \times 25 \times 0.16 \times 0.01 \times 44 / 28 / 1\,000\,000 = 0.66\ Gg}$$

The values of 0.16 kg N/kg protein and 0.01 kg $N_2O$-N/kg N correspond to the mass fraction and standard recommended emission factor. The amount of proteins consumed in the Czech Republic is derived from the nutrition statistics of FAO (Faostat, 2005).

### 8.3.3 Uncertainties and time-series consistency

This particular category is methodologically consistent and is quantified each year using same method. Data sources for methane activity data are the same and therefore we can assume activity data consistency in time as well. Very few country-specific factors are used (mainly the fraction of each treatment technology in the country) and most of activity data are based on the statistics of the central statistical office.

Consistency of time series can be disturbed by a discontinuous change in the technology share, which is based on particular studies in time and as happened in the case of industrial water through a change in the activity data from the survey results, where the statistical office may deny access to data that are the subject of business secrets.

Consistency of $N_2O$ quantification is disturbed by a change in of activity data source in 2000 (global nutrition values were replaced by country-specific protein consumption) which led to a slight increase in this subcategory. It is planned to smooth the trend and recalculate this according to new data, but this is of low priority at the moment due to the overall insignificance of this sub-category.

The uncertainty in most of the factors (default IPCC values) is determined according to Good Practice Guidelines (IPCC, 2000). 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 last year expert team reviewed waste sector and suggested and developed new uncertainty ranges. They all can be found in uncertainty chapter in 6C Waste incineration.

### 8.3.4 Source-specific QA/QC and verification

During the year 2012 we updated and adopted QA/QC plan for the sector. 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.

### 8.3.5 Source-specific recalculations

No recalculation performed in this submission.

### 8.3.6 Source-specific planned improvements

We plan to review industry wastewater source category. Reason is that due to extensive use of biogas Ministry of Industry and Trade started to gather data about water treatment and gas production. In the light of this data we will review this category and we might eventually recalculate it according to the new findings.

## 8.4 Waste incineration (6C)

### 8.4.1 Overview

This category contains emissions from waste incineration in the Czech Republic. Types of waste incinerated include industrial waste, hazardous waste and clinical waste. 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 times, 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.

This year, the whole category was changed as part of the incinerated MSW was shifted to the energy chapter. MSW in the country is used as fuel, so the logic behind this switch is in accordance with the suggestions of the Good Practice Guidelines (IPCC, 2000). At the present, this category consists of emissions from incineration of hazardous and industrial waste (clinical waste CW and sludge is part of hazardous waste) – H/IW.

### 8.4.2 Source category description

There are also 76 other facilities incinerating or co-incinerating industrial and hazardous waste with a total capacity 600 Gg of waste. Most of this capacity is not used. Some of the incinerators have energy recovery but how much of the incinerated waste is used for energy purposes is still under review. Once we will be able to identify and split the total H/IW used for energy/non-energy purposes, we will move the particular part of this category to the energy sector.

### 8.4.3 Methodological issues

In line with the Revised 1996 Guidelines (IPCC, 1997), only $CO_2$ emissions resulting from oxidation, during incineration and from open burning of carbon in waste of fossil origin (e.g., plastics, rubber, liquid solvents, and waste oil) are considered in the net emissions and should be included in the national $CO_2$ emissions estimate. Additionally, incinerator plants produce small amounts of methane and nitrous oxide. All these emissions are reported in category 6C2. This year we also estimated biogenic emissions from H/IW and these are reported under 6C1.

Estimation of $CO_2$ emissions from H/IW incineration is based on the Tier 1 approach (IPCC, 2000). It is assumed that 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. As no country-specific data were available for the necessary parameters, the calculation default data was taken from the Good Practice Guidance (IPCC, 2000), see Tab. 8-13. To save place in the table, the results are split into biogenic and non-biogenic parts of the waste only for important gases – $CO_2$. Methane and nitrous oxide are listed together in this table although they are reported in the UNFCCC reporter separately from the biogenic and fossil parts of the waste.

The activity data are based on the statistical surveys performed by ISOH – waste management information system on operated by MoE/CENIA and the missing data (system does not contain data before 2002) was obtained by taking data from MIT. An MIT questionnaire is sent to all the facilities incinerating waste and alternative fuels. There is a certain simplification because the questionnaires do not allow assessment of the exact nature of the waste (i.e. composition, calorific value) and use simplified grouping of waste as MSW and waste that is hazardous, industrial (HW/IW). Also part of this waste stream is incinerated clinical waste and sludge. Czech legislation does not discern explicitly between types of wastes because clinical waste, industrial waste and sludge is all hazardous from point of management. We avoid underestimation by using hazardous waste emission factors for whole HW/IW/CW/Sludge mixture that is incinerated in HW/IW facilities as HW emission factors are far bigger than sludge and CW.

**Tab. 8-13 H/IW incineration in 1990 – 2011 with used parameters and results**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **H/IW incinerated (Gg )** | 14.1 | 16.9 | 19.8 | 27.1 | 38.4 | 43.1 | 43.3 | 45.4 | 45.6 | 46.6 | 38.4 |
| **Amount of carbon fraction** | 0.5 | | | | | | | | | | |
| **Fosil carbon fraction** | 0.9 | | | | | | | | | | |
| **Combust efficiency fraction** | 0.995 | | | | | | | | | | |
| **C-$CO_2$ ratio** | 3.7 | | | | | | | | | | |
| **Emission factor Gg $CH_4$/Gg** | 5.6E-07 | | | | | | | | | | |
| **Emission factor Gg $N_2O$/Gg** | 1.0E-04 | | | | | | | | | | |
| **Total $CO_2$ (Gg $CO_2$) Fossil** | 23.1 | 27.7 | 32.5 | 44.4 | 63.0 | 70.7 | 71.1 | 74.5 | 74.8 | 76.5 | 63.0 |
| **Total $CO_2$ (Gg $CO_2$) Bio.** | 2.6 | 3.1 | 3.6 | 4.9 | 7.0 | 7.9 | 7.9 | 8.3 | 8.3 | 8.5 | 7.0 |
| **Total $CH_4$ (Gg $CH_4$)** | 7.9E-06 | 9.5E-06 | 1.1E-05 | 1.5E-05 | 2.1E-05 | 2.4E-05 | 2.4E-05 | 2.5E-05 | 2.6E-05 | 2.6E-05 | 2.2E-05 |
| **Total $N_2O$ (Gg $N_2O$)** | 1.4E-03 | 1.7E-03 | 2.0E-03 | 2.7E-03 | 3.8E-03 | 4.3E-03 | 4.3E-03 | 4.5E-03 | 4.6E-03 | 4.7E-03 | 3.8E-03 |
| | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** |
| **H/IW incinerated (Gg )** | 52.5 | 75.6 | 117.0 | 109.9 | 106.7 | 116.1 | 122.9 | 146.6 | 121.2 | 109.4 | 114.1 |
| **Amount of carbon fraction** | 0.5 | | | | | | | | | | |
| **Fosil carbon fraction** | 0.9 | | | | | | | | | | |
| **Combust efficiency fraction** | 0.995 | | | | | | | | | | |
| **C-$CO_2$ ratio** | 3.7 | | | | | | | | | | |
| **Emission factor Gg $CH_4$/Gg** | 5.6E-07 | | | | | | | | | | |
| **Emission factor Gg $N_2O$/Gg** | 1.0E-04 | | | | | | | | | | |
| **Total $CO_2$ (Gg $CO_2$) Fossil** | 86.1 | 124.0 | 192.1 | 180.5 | 175.2 | 190.7 | 201.8 | 240.7 | 198.9 | 179.7 | 187.4 |
| **Total $CO_2$ (Gg $CO_2$) Bio.** | 9.6 | 13.8 | 21.3 | 20.1 | 19.5 | 21.2 | 22.4 | 26.7 | 22.1 | 20.0 | 20.8 |
| **Total $CH_4$ (Gg $CH_4$)** | 2.9E-05 | 4.2E-05 | 6.6E-05 | 6.2E-05 | 6.0E-05 | 6.5E-05 | 6.9E-05 | 8.2E-05 | 6.8E-05 | 6.1E-05 | 6.4E-05 |
| **Total $N_2O$ (Gg $N_2O$)** | 5.2E-03 | 7.6E-03 | 1.2E-02 | 1.1E-02 | 1.1E-02 | 1.2E-02 | 1.2E-02 | 1.5E-02 | 1.2E-02 | 1.1E-02 | 1.1E-02 |

The suggested default emission factors for hazardous waste incineration were 100 kg of $N_2O$ per Gg of incinerated HW and 0.56 kg of methane per Gg of incinerated HW. Recently we also estimated biogenic emissions of $CO_2$ from this category. The approach is based on the default factor for fossil carbon, as we assume that the rest of the carbon in the material is non-fossil.

### 8.4.4 Uncertainties and time-series consistency

Uncertainty in waste sector is a wicked problem. Activity data required by methodology is most of time derived from other data. These additional step(s) are increasing uncertainty of real activity data. Moreover data providers do not produce any relevant statistics that would help us determine standard deviation or other useful data characteristic. Main data provider is statistical office. A Czech Statistical Office does not produce descriptive statistics about his data. Data produced by office are often the only one available based on total survey. Another problem with uncertainty in category 6A is time scale. For emission in 2011 we use data from 1950 on. And the uncertainty is varies among particular years and there is no tool how to handle this correctly. That's why we most of time use expert judgment to assess the uncertainty.

**Tab. 8-14 Uncertainty estimates for sector Waste**

| Gas | Category | AD uncertainity [%] | EF uncetrainity [%] | Origin of the parameters |
|---|---|---|---|---|
| $CH_4$ | 6A Landfills | 30 | 40 | Combined uncertainty of quantification parameters Expert judgement M. Havránek, verification P. Slavíková (CENIA) |
| $CH_4$ | 6B.1 Communal wastewater | 21 | 50 | Combined uncertainty of quantification parameters Expert judgement M. Havránek |
| $N_2O$ | 6B1 Communal wastewater | 26 | 50 | AD Expert judgement M. Havránek; EF IPCC default |
| $CH_4$ | 6B2 Industrial wastewater | 40 | 50 | Combined uncertainty of quantification parameters + IPCC Default values, Expert judgement M. Havránek |
| $CO_2$ | 6C HW/IW incineration | 15 | 5 | AD Expert judgement M. Havránek; EF IPCC default |
| $N_2O$ | 6C HW/IW incineration | 20 | 70 | AD Expert judgement M. Havránek; EF IPCC default |
| $CH_4$ | 6C HW/IW incineration | NA | NA | NA |
| $CO_2$ | 1A1a MSW incineration | 20 | 20 | AD Expert judgement M. Havránek; EF IPCC default |
| $N_2O$ | 1A1a MSW incineration | 20 | 70 | AD Expert judgement M. Havránek; EF IPCC default |
| $CH_4$ | 1A1a MSW incineration | NA | NA | NA |

### 8.4.5 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, we used bottom-up data provided by the official sources (Ministry of Industry and Trade, MIT) with addition with data from ISOH – information system on waste management run by MoE/CENIA. However, the inaccuracy or uncertainty of this data is not quantified but estimated by expert judgment. We cross-checked the data on incineration with the top-down data produced by other State agencies.

### 8.4.6 Source-specific recalculations

No recalculations performed in this submission.

### 8.4.7 Source-specific planned improvements

We do not plan any improvement in this particular sub-category. We might eventually try to split part of this category to energy sector as we did with MSW if data are available. We always encourage state administration to gather data useful for GHG inventories.

# 9 Other (CRF sector 7)

No sector 7 is defined in the Czech inventory.

# 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 Good Practice Guidance reports (IPCC, 2000; IPCC, 2003) 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 Overview of former recalculations

### 10.1.1 Recalculations performed in the submission 2010

#### *10.1.1.1 Recalculations in sector 1 Energy*

***Recalculation in sectors 1A1, 1A2, 1A3e, 1A4 and 1A5 since 2003***

The recalculation involves improvement and specification of activity data by using questionnaires elaborated by the Czech Statistical Office (CzSO) for IEA and Eurostat, while the emissions and oxidation factors remain unchanged. This recalculation was facilitated by concluding a Memorandum of understanding between CHMI and CzSO on data exchange, which made the questionnaires mentioned above available for the inventory team. In the past, the activity data were taken from the annually published “Energy balances of the Czech Republic” and were less suitable for conversion to UNFCCC/CRF categorization.

The year 2003 was chosen as the starting year because data for detailed splitting for 1A2 (i.e. 1A2a - 1A2f) have been available since 2003.

The reasons for this recalculation were discussed during the "In-country review" (October 2009, Prague) with the ERT that supported this concept. In addition, the last EU check called "Consistency Report CZ 2009" found obvious inconsistencies in 1A2 category allocation.

***Recalculation (addition of a missing fuel type) in sub-sector 1A2f since 2003***

The reasons for this recalculation were discussed during the "In-country review" (October 2009, Prague) with the ERT, which suggested the addition of a missing fuel type "Other fuels" used mainly in cement kilns to improve the completeness of the process.

***Recalculation of $CH_4$ emission in sub-sector 1A3e since 1990***

The reasons for this recalculation were discussed during the recent "In-country review" (October 2009, Prague) with the ERT, which suggested substitution of the non-transparent $CH_4$ EF by the IPCC default value.

***Recalculation of emissions (addition of missing gas) in 1B2b (Fugitive emissions - Natural Gas) since 1990***

Based on the above inquiry, the value of the $CO_2/CH_4$ ratio in Natural Gas was found and thus it was possible to estimate the relevant emissions of $CO_2$ in sub-sector 1B2b and thus to improve completeness.

#### *10.1.1.2 Recalculations in sector 2 Industrial Processes*

One recalculation in the period 2004 - 2007 was performed for $N_2O$ emissions from $HNO_3$ production. Estimation of these emissions in the Czech Republic is based on the use of technology-specific emissions factor taking into consideration process conditions in Czech plants. The emission factors respect the three levels of pressure employed (0.1, 0.4 and 0.7 MPa) and relevant cases of $NO_X$ and/or $N_2O$ abatements: selective catalytic reduction (SCR) of $NO_X$, non-selective catalytic reduction (NSCR) of $NO_X$ that also reduces emissions of $N_2O$, and recently introduced $N_2O$ mitigation based on catalytic $N_2O$ decomposition for 0.7 MPa technology.

For 0.4 MPa technology in combination with NSCR, an emission factor of 1.09 kg $N_2O$/t $HNO_3$ was used for 1990 - 2003 while, starting from 2004, this EF was increased to 2.72 kg $N_2O$/t $HNO_3$. However, new plant measurements revealed that the original EF 1.09 kg $N_2O$/t $HNO_3$ is suitable even for the years after 2003.

Consequently, in the recalculation, EF = 1.09 kg $N_2O$/t $HNO_3$ was used over the whole time period since 1990 for the 0.4 MPa technology combined with NSCR. This recalculation improves the quality of the inventory in accordance with good practice and improves the time series consistency. The approaches used for the other technologies mentioned above remain unchanged.

#### *10.1.1.3 Recalculations in sector 4 Agriculture*

The following recalculations regarding $N_2O$ emissions were performed for the whole time period since 1990 as a consequence of discussions with the ERT during the "in-country review" in October 2009

***$N_2O$ from manure management (non-KC)***

According to the recommendation from the Good Practice Guidance 2000 (IPCC, 2000), the default parameters characterizing AWMS for dairy cattle, non-dairy cattle, and swine were taken from Tables B-3 through B-6 in the Revised 1996 Guidelines (IPCC, 1997)(Reference Manual) instead of the existing values taken from Table 4-21. The values for the other animals remained unchanged.

***$N_2O$ emissions from agricultural soils - Animal manure applied to soils (KC)***

In the recalculation, the more suitable equation 4.23 from the Good Practice Guidance 2000 (IPCC, 2000) was used instead of the existing equation from the Revised 1996 Guidelines, p. 4.93 (IPCC, 1997).

***$N_2O$ emissions from agricultural soils - Crop residues (KC)***

The Tier 1a method described in the Good Practice Guidance 2000 (IPCC, 2000) was used to estimate emissions in this category. The reasons for this recalculation were:

- The default value for $Frac_{BURN}$ (0.1) has been used although burning of crop residues does not occur in the CR.
- Because of the small error in the existing calculation spreadsheets, the residues from pulses have not been included in the calculations.
- The amount of crops has been transformed to dry matter using a default $Frac_{DM}$ value of 0.85. This is in accordance with the Revised 1996 Guidelines (IPCC, 1997) but, according to the 2000 GPG (IPCC, 2000), the crops $Frac_{DM}$ should not be employed if the simple Tier 1 (Tier 1a) method is used.

***$N_2O$ emissions from 4.D.1.3 N-fixing crops***

In recalculation of emissions from N-fixing crops, the production of soya beans has also been included (even though this production is very limited in the Czech Republic).

#### *10.1.1.4 Recalculations in sector 5 LULUCF*

All recalculations in LULUCF sector were performed for the whole time period since 1990.

1. Several LULUCF categories were recalculated following the revision of biomass conversion and expansion factors (BCEFs). These factors were revised utilizing the new data from the Czech landscape inventory (CzechTerra). This statistical inventory covers the entire territory of the country and its first cycle was conducted during the years 2008 and 2009. The application of the new BCEFs affects all the LULUCF categories related to forest land, namely:

- 5.A.1. Forest Land remaining Forest Land
- 5.A.2. Land converted to Forest Land (all relevant sub-categories)
- 5.B.2.1 Forest land converted to Cropland
- 5.C.2.1 Forest land converted to Grassland
- 5.D.2.1 Forest land converted to Wetlands
- 5.E.2.1 Forest land converted to Settlements

2. This inventory submission additionally contains estimates of carbon stock change in dead organic matter following the conversion of Forest land to other land use categories. This implementation concerns the following categories:

- 5.B.2.1 Forest land converted to Cropland
- 5.C.2.1 Forest land converted to Grassland
- 5.D.2.1 Forest land converted to Wetlands
- 5.E.2.1 Forest land converted to Settlements

### 10.1.2 Recalculations performed in the submission 2011

#### *10.1.2.1 Recalculation in sector 1 Energy*

***Recalculation of Road Transportation (1A3b)***

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 1A3b (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 (1B2a)***

During the centralised review in September 2010, the Expert review team (ERT) identified a potential problem in the incomplete reporting of category 1B2a-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.

#### *10.1.2.2 Recalculation in sector 2 Industrial Processes*

***Recalculation of Soda Ash Use (2A4)***

During the centralised review in September 2010, the Expert review team (ERT) identified a potential problem in the incomplete reporting of category 2A4 (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 Gg $CO_2$).

***Recalculation of Mineral Products - Other (2A7.2)***

$CO_2$ 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. 2A7.2 Brick and ceramics is not a significant category for $CO_2$ emissions (approximately 150 Gg $CO_2$) 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 (2C1)***

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.

#### *10.1.2.3 Recalculation in sector 6 "Waste"*

***Recalculation of Solid Waste Disposal on Land – Managed Waste Disposal in Land (6A1) and Waste incineration - Other (6C2)***

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 6C (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 6A1 category (Managed landfills).

### 10.1.3 Recalculation performed in the submission 2012

#### *10.1.3.1 Recalculation in sector 1 Energy*

***Recalculation of 1A Energy - stationary combustion***

Expert review team (ERT) during In country review in August/September 2011 raised recommendation to prolong data series in subcategories 1A2a – 1A2f 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 1A except of 1A3 – mobile combustion (i.e. 1A1, 1A2, 1A4, 1A5, 1AD, 1A3e). In 1A1, 1A4, 1A5, 1AD and 1A3e was recalculation carried out using data from CzSO Questionnaires since 1995. In 1A2 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 1A 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 1A3a and 1C1a, 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 1A3 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 1B Fugitive Emissions from Fuels (1B1 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 1B Fugitive Emissions from Fuels (1B1 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.

#### *10.1.3.2 Recalculation in sector 2 Industrial Processes*

***Recalculation of Metal Production – Iron and Steel Production (2C1)***

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.

### *10.1.3.3 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 an 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
2. More accurate animal population data (not rounded up to thousands) reported (cattle, swine, sheep, poultry).
3. More accurate data for cattle population reported (not rounded to thousands) for the period since 2006.
4. 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.
5. 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 4A 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 4B 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 4D Agricultural soils (4D1b, 4D2 and 4D3)***

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 (4D1b)
2. pasture, range and paddocks (4D2)
3. atmospheric deposition (4D3.1)
4. N lost through leaching and run-off (4D3.2)

Also these changes apply for the entire reporting period.

### *10.1.3.4 Recalculation in sector 5 LULUCF*

***Recalculation of LULUCF – Other (5G)***

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 5A Forest Land, the corresponding emissions are reported under 5G 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 Gg $CO_2$ 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).

#### 10.1.3.5 Recalculation in sector 6 Waste

First recalculation was minor changes in activity data in 6A (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 6C2 MSW incineration under 1A1A. 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.

## 10.2 New recalculations performed in this submission

### 10.2.1 Recalculation in sector 1A Energy

#### *10.2.1.1 Recalculation in sector 1A 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 1A 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.

#### *10.2.1.2 Recalculation of gaseous fuel in 1A 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 1A Energy.

#### *10.2.1.3 Recalculation/reallocation of solid fuels in sectors 1A1c Energy - Manufacture of Solid Fuels and Other Energy Industries and 1A2 Energy- Manufacturing Industries and Construction*

One of the improvements implemented by the Czech Republic considers reallocation of solid fuels and associated emissions between 1A1c and 1A2. 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 1A2 autoproducers. The QA/QC procedure ascertained that this consumption of solid fuels should be included in 1A1c category; in this submission solid fuels were reallocated. This reallocation affects consumption of solid fuels and associated emissions in 1A1c category and in 1A2a-1A2f (autoproducers consumption).

#### *10.2.1.4 Recalculation in sector 1A2c 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 1A2c, 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.

#### *10.2.1.5 Recalculation in 1A3 Energy - Road Transportation - Diesel Oil*

QC/QC procedures identified typographic error in this category - $N_2O$ emissions, 2010. This issue has been rectified.

#### *10.2.1.6 Recalculation in sector 1A4b 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.

#### *10.2.1.7 Recalculation in sector 1AD Energy - Feedstocks and non-energy use of fuels*

In category 1AD 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.

#### *10.2.1.8 Recalculation in sector 1B1b 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.

### 10.2.2 Recalculation in sector 2 Industrial processes

#### *10.2.2.1 Recalculation in sector Cement Production (2A1)*

In this submission the recalculation of $CO_2$ emissions was performed. In 2003-2005 period was discovered computational error, which was now corrected.

#### *10.2.2.2 Recalculation in sector Soda Ash Use (2A4 2)*

The activity data for this category were verified for 2009 and 2010, which introduced also recalculation of $CO_2$ emissions.

#### *10.2.2.3 Recalculation in sector Other – Glass Production (2A7 1)*

For 2005 was found the error in reported $CO_2$ emissions in this category. This discrepancy was corrected in this submission.

### 10.2.2.4 Recalculation in sector 2F3 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.

### 10.2.2.5 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.

### 10.2.2.6 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

2. 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 4D.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.

### 10.2.2.7 Recalculation in sector 4D Agricultural Soils (4D1 3, 4D1 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 4D1 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 4D1 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.

### *10.2.2.8 Recalculation in sector 5 "LULUCF" (5G)*

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.

## 10.3 Response to the review process and planned improvements in the inventory

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, 2011 and 2012). 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 1B2a-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:

(a) $CO_2$ emissions from 1A Stationary Combustion

(b) $CO_2$, $CH_4$ and $N_2O$ emissions from 1A3a Civil Aviation

(c) $CH_4$ and $N_2O$ emissions from 1A4b Residential

(d) $CH_4$ emissions from 1B1b Solid Fuel Transformation

(e) $N_2O$ emissions from 4D1 3 N-fixing crops

(f) $N_2O$ emissions from 4D1 4 Crop residue

(g) $CH_4$ emissions from 6A Solid Waste Disposal

(h) $CH_4$ and $N_2O$ emissions from 6C Waste Incineration.

Issues (a), (c) – (f) 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 Gg (i.e. 0.27 % of total GHG emissions) higher.

Other issues (b), (g), (h) 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.

Unfortunately, the relevant draft of the ARR has not been made available at the time of writing this report. Therefore, it was not possible to take into account in this submission (15 April 2013) possible finding of ERT except those mentioned in the Saturday paper.

Overview of all actual recalculation (compared with the April’s 2012 submission) is given above (Chapter 10.2)

### 10.3.1 Overview of implemented improvements in the 2013 submission

The following table summarises the main changes and that were performed in 2013 submissions in comparison with previous submissions. Most of changes were implemented in order to comply with the relevant recommendations made by the Expert Review Teams in recent UNFCCC reviews (considered mainly in ARR 2010 and ARR 2011). Other changes were motivated by endeavours of the Czech team to improve the inventory quality.

In September 2012, the Czech Republic was subjected to the centralised review in Bonn. However, the relevant draft of the ARR 2012 was not submitted so far. Therefore possible improvements based on ARR 2012 will be addressed only in the 2014 submission (except findings formulated in “Saturday paper” as potential problems that were resolved in time – resubmission in October 2012).

Other changes were motivated by endeavours of the Czech team to improve the inventory quality. Some of them were performed in accordance with Improvement Plan.

For changes in methodological descriptions please see Tab. 10-2.

**Tab. 10-1 Table of implemented improvements in the 2013 submission**

| Topic / Category, gas | Description of the change | Reason (motive) of the change | Reference to NIR or CRF Table |
|---|---|---|---|
| **Sector: General issues** | | | |
| **QA/QC** | Improvement and updating of QA/QC plan | ARR 2010, para 27, 37d<br>ARR 2011, para 30, 31, 55b | NIR, chapter 1.5<br>NIR, chapters 3 – 8 |
| **Improvement plan** | Updating of the Improvement plan focused on gradual implementation of higher tiers methods | ARR 2010, para 16, para 37a<br>ARR 2011,. para 32,33 | NIR, chapter 10.3.2 |
| **Archiving** | Updating and improvement of the central archiving system | ARR 2010, para 34, 38b<br>ARR 2011, para 48 | NIR, chapter 1.3.3 |
| | | | |
| **Sector: Energy – emissions from combustion** | | | |
| **1A stationary combustion, $CO_2$** | Recalculation of $CO_2$ emissions based on the Revised 1996 Guidelines default emission factors 1995 – 2010 | Improvement suggested by ERT | NIR, chapter 3.7.1 |
| **1A, Natural Gas, $CO_2$** | New country specific $CO_2$ emission factor for Natural Gas Combustion | Improvement suggested by Party | NIR, chapter 3.7.1, Annex 2 |
| **1A1c, 1A2, Solid Fuels $CO_2$, $CH_4$, $N_2O$** | Recalculation/ reallocation of Solid Fuels between 1A1c and 1A2 | Improvement suggested by Party | NIR, chapter 3.7.1 |
| **1A2c, Liquid Fuels $CO_2$, $CH_4$, $N_2O$** | Recalculation of activity data in 1A2c in period 2004 – 2010 | Improvement suggested by EU ESD | NIR, chapter 3.7.1 |
| **1A3b, $N_2O$** | Correction fo typographic error in 2010 | Improvement suggested by Party | NIR, chapter 3.7.1 |
| **1A4b, Biomass $CO_2$, $CH_4$, $N_2O$** | Calculation of emissions from charcoal use in the entire time series | Improvement suggested by ERT | NIR, chapter 3.7.1 |
| **1AD 10 Other-Other Oil (Solvents)** | Correction of typographic error, issue connected to sector 3 | Improvement suggested by Party | NIR, chapter 5.5 |
| **Sector: Energy – fugitive emissions** | | | |
| **1B1b, $CH_4$** | Calculation of emissions from charcoal production in the entire time series | Improvement suggested by ERT | NIR, chapter 3.9.5.2 |
| **Sector: Industrial processes and Solvent use** | | | |
| **2A** | Change on NIR chapter 4.2 with focus on transparency of methodology used for calculations | Improvement suggested by Party | NIR, chapter 4.2 |
| **2A1** | Recalculation of $CO_2$ emissions in 2003 – 2005 period | Improvement suggested by Party | NIR, chapter 4.2.1 |
| **2A4** | Recalculation of $CO_2$ emissions in 2009 – 2010 period | Improvement suggested by Party | NIR, chapter 4.2.4 |
| **2A7.1** | Recalculation of $CO_2$ emissions in 2005 | Improvement suggested by Party | NIR, chapter 4.2.5 |
| **2B2 $N_2O$** | Improved explanation of usage of mitigations technologies in context with decrease of $N_2O$ emissions | ARR 2011, para 92 | NIR, chapter 4.3 |
| **2 F** | Calculation methodology now includes life cycles of equipment | Improvement suggested by EU ESD, TERT | NIR, chapter 4.7.6 |
| **3A, 3B, 3C $CO_2$** | Correction of typographic error in 2010 | Improvement suggested by Party | NIR, chapter 5.5 |
| **Sector: Agriculture** | | | |
| **4D1 $N_2O$** | Activity data about crop residue and N-fixing crops were added 1990-2011. The detailed description of changes and previous recalculation (resubmission 2012). | Improvement suggested by ERT | NIR, chapter 6.4 |

**Tab. 10-2 Methodological descriptions in submission 2013**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | DESCRIPTION OF METHODS | RECALCULATIONS | REFERENCE |
|---|---|---|---|
| **Total (Net Emissions)** | | | |
| **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 | | | |
| **2. Industrial Processes** | | | |
| A. Mineral Products | √ | √ | |
| B. Chemical Industry | | | |
| C. Metal Production | | | |
| D. Other Production | | | |
| E. Production of Halocarbons and $SF_6$ | | | |
| F. Consumption of Halocarbons and $SF_6$ | √ | √ | |
| G. Other | | | |
| **3. Solvent and Other Product Use** | √ | √ | |
| **4. Agriculture** | | | |
| A. Enteric Fermentation | | | |
| B. Manure Management | | | |
| C. Rice Cultivation | | | |
| D. Agricultural Soils | √ | √ | More detailed information for each recalculation is provided in Table 10-1 |
| E. Prescribed Burning of Savannas | | | |
| F. Field Burning of Agricultural Residues | | | |
| G. Other | | | |
| **5. Land Use, Land-Use Change and Forestry** | | | |
| A. Forest Land | | √ | |
| B. Cropland | | | |
| C. Grassland | | | |
| D. Wetlands | | | |
| E. Settlements | | | |
| F. Other Land | | | |
| G. Other | | | |
| **6. Waste** | | | |
| A. Solid Waste Disposal on Land | | | |
| B. Waste-water Handling | | | |
| C. Waste Incineration | | | |
| D. Other | | | |
| **7. Other (as specified in Summary 1.A)** | | | |
| | | | |
| **Memo Items:** | | | |
| **International Bunkers** | | | |
| Aviation | | | |
| Marine | | | |
| **Multilateral Operations** | | | |
| **$CO_2$ Emissions from Biomass** | | √ | |

| 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** | | | |

### 10.3.2 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 2A Mineral Product (e.g. 2A1 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. The results will be presented in the next submission.

Specific suggestions for improvements in the individual sectors are described in the sections entitled “Source-specific planned improvements”, which are included in all the sector chapters.

**Tab. 10-3 Plan of Improvements for key categories**

| Sec. | Key Categories (KC) | GHG | % *) of GHG | Type of KC | Present situation (CRF Tab Sum 3) | Planned improvement | For submission |
|---|---|---|---|---|---|---|---|
| **1A** | 1A Stationary Combustion - Solid Fuels | $CO_2$ | 45.8 | LA,TA | Country specific factors for coals, for other fuels default EFs | Update of these factors from EU ETS data | 2014 |
| **1A** | 1A.3.b Transport - Road Transportation | $CO_2$ | 11.3 | LA,TA | Default EFs | Country specific EFs for gasoline, motor diesel oil, LPG and CNG | 2015 |
| **1A** | 1A Stationary Combustion - Liquid Fuels | $CO_2$ | 3.5 | LA,TA | Default EFs | Country specific EFs for fuel oils | 2015 |
| **1A** | 1A5b Mobile sources in Agricult. & Forestry | $CO_2$ | 0.8 | LA | Default EFs | Country specific EFs for gasoline and motor diesel oil | 2015 |
| **1A** | 1A3b Transport - Road Transportation | $N_2O$ | 0.5 | LA,TA | Default EFs | Country specific EFs for gasoline and motor diesel oil | 2015 |
| **2** | 2C1 Iron and Steel Production | $CO_2$ | 4 | LA,TA | Tier 1 | Tier 2, implementation needs EU ETS data | 2014 |
| **2** | 2F1-6 F-gases Use - ODS substitutes | F-gas | 0.8 | LA,TA | Tier 2 | Split of 2F11 domestic refrigeration into its correct categories | 2014 |
| **2** | 2B2 Nitric Acid Production | $N_2O$ | 0.3 | TA | Tier 2, 3 | Tier 3: Direct $N_2O$ measurements from EU ETS reporting forms | 2015 |
| **4** | 4D1 Agricultural Soils, Direct Emissions | $N_2O$ | 2.1 | LA,TA | Tier 2 | Defaults EFs from 2006 Guidelines, Country specific parameters for crops | 2015 |
| **4** | 4D3 Agricultural Soils, Indirect Emissions | $N_2O$ | 1.3 | LA,TA | Tier 1 | Application of defaults EFs from 2006 Guidelines with regard to good practice principle | 2015 |
| **5** | 5A1 Forest Land remaining Forest Land | $CO_2$ | -6.1 | LA,TA | Tier 3 | No specific improvement is currently planned | |
| **6** | 6A Solid Waste Disposal on Land | $CH_4$ | 1.9 | LA, TA | Tier 2 | Specification/estimate of waste composition with regard to good practice principle | 2014 |
| **6** | 6C Waste incineration | $CH_4$ | 0.1 | LA, TA | Tier 1 | Specification/estimation of incinerated waste composition with regard to good practice principle | 2014 |

# Part 2: Supplementary Information Required under Article 7, paragraph 1

# 11 KP LULUCF

Emission and removal estimates from land use, land-use change and forestry (LULUCF) activities under Article 3.3 and 3.4 of the Kyoto Protocol.

## 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).

The current text partly reflects the recommendations in the latest review. However, as the review report had not been made available to the inventory team at the time of compiling this inventory submission, any further recommendations will be considered for implementation in the next inventory submission.

### 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 land 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.

### 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. The accounting for KP LULUCF activities will be performed for the entire commitment period

### 11.1.3 Implementation and application of activities and elected activities under Article 3.3 and Article 3.4

Due to the tight links imposed between the emission inventory under the Convention and that under the Kyoto Protocol, most of the methodological approaches are applicable identically for the emission estimates of KP LULUCF activities and those reported for the LULUCF sector under the Convention.

Hence, reference is frequently made to the corresponding methodologies described in Chapter 7 of the NIR 2013 text, while additional and specific information related to the 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:***
  - 5.A.2.1. Cropland converted to Forest Land
  - 5.A.2.2. Grassland converted to Forest Land
  - 5.A.2.3. Wetlands converted to Forest Land
  - 5.A.2.4. Settlements converted to Forest Land
- ***D activity may represent the following situations:***
  - 5.B.2.1. Forest land converted to Cropland
  - 5.C.2.1. Forest land converted to Grassland
  - 5.D.2.1. Forest land converted to Wetlands
  - 5.E.2.1. Forest land converted to Settlements
- ***FM activities relate to emissions and removals correspondingly as described in category 5A1 Forest land remaining Forest land***

In this way, *AR* activities generally always represent a 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 the Kyoto Protocol 1st Commitment Period, 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 applied in determining how land was classified.

Since only one activity of the listed Article 3.4 activities was elected 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 the 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, GPG for LULUCF, IPCC 2003). Considering the small area of the country and its specific conditions, there is no applicable stratification that would justify reporting on 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 the KP and UNFCCC reporting purposes permit a truly detailed spatial assessment and identification of *AR* and *D* activities at the level of the individual cadastral units. 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 thousands individual cadastral units (Fig. 11.1). Specifically in 2011, the areas of *AR* and *D* were estimated at the level of 12 990 cadastral units, including 33 integrated cadastral units in the country. The mean area of these 12 990 units that enter the analysis of land-use change was 6.07 $km^2$. 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 applied in the Czech Republic.

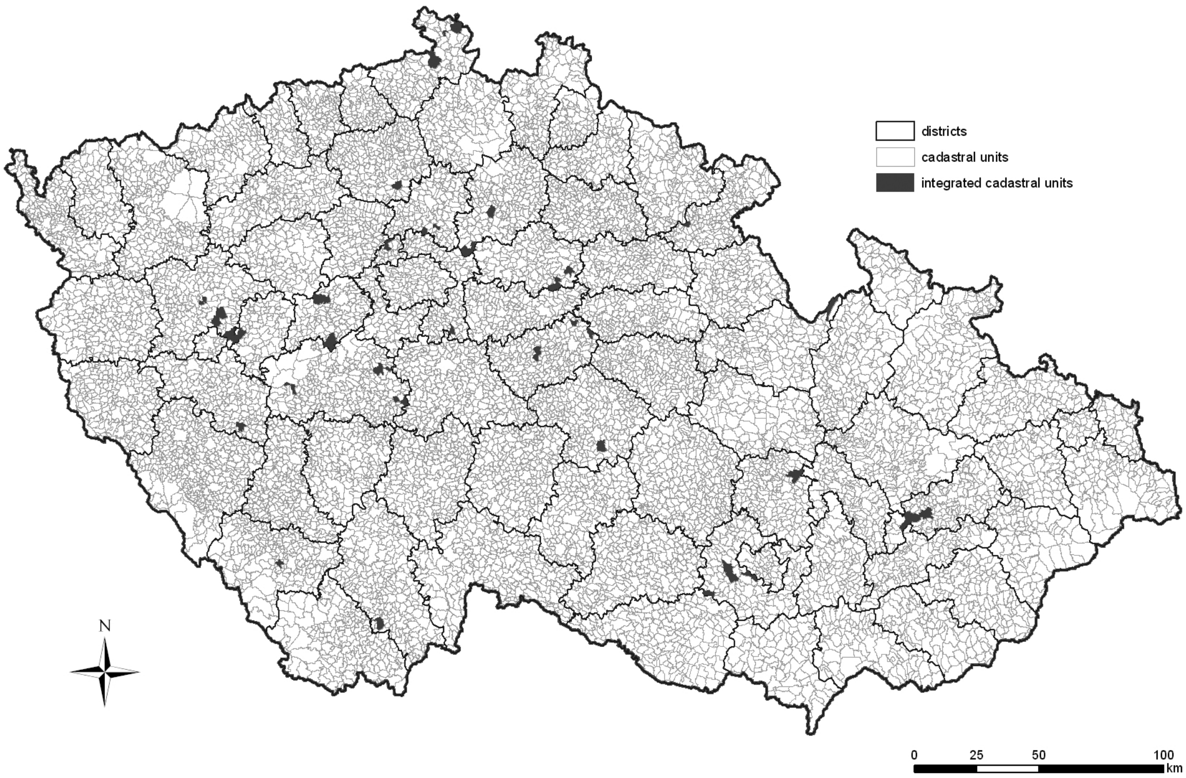



**Fig. 11.1: The spatial detail of the land use representation and land-use change identification system used for detecting land use change associated with ARD activities. In 2011, the areas of ARD were estimated at the level of 12 990 individual cadastral units including 33 integrated cadastral units.**

### 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 7.2.1 of the Czech NIR 2010 submission. The result is a system of consistent representation of land areas, ranking as Reporting Method 1 of the GPG for LULUCF (IPCC, 2003), 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) and Settlements (S) to Forest Land (F), categorized as *AR* (kha/year) and land use change from F to land use categories C, G, W and S, 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 | Total | F to C | F to G | F to W | F to S | Total |
| **1990** | 0.71 | 0.52 | 0.01 | 0.00 | 1.24 | 0.10 | 0.09 | 0.02 | 0.28 | 0.49 |
| **1991** | 0.40 | 0.12 | 0.00 | 0.02 | 0.54 | 0.28 | 0.35 | 0.07 | 0.17 | 0.87 |
| **1992** | 0.21 | 0.12 | 0.01 | 0.00 | 0.34 | 0.14 | 0.25 | 0.04 | 0.31 | 0.74 |
| **1993** | 0.09 | 0.12 | 0.01 | 0.18 | 0.39 | 0.19 | 0.07 | 0.02 | 0.55 | 0.82 |
| **1994** | 0.20 | 0.21 | 0.12 | 0.90 | 1.43 | 0.11 | 0.08 | 0.02 | 0.38 | 0.59 |
| **1995** | 0.31 | 0.36 | 0.02 | 0.47 | 1.16 | 0.15 | 0.08 | 0.02 | 0.27 | 0.52 |
| **1996** | 0.86 | 0.40 | 0.03 | 0.50 | 1.79 | 0.18 | 0.35 | 0.02 | 0.36 | 0.90 |
| **1997** | 0.31 | 0.43 | 0.04 | 0.90 | 1.69 | 0.23 | 0.17 | 0.04 | 0.37 | 0.80 |
| **1998** | 0.48 | 0.68 | 0.10 | 2.25 | 3.51 | 0.39 | 0.39 | 0.05 | 0.53 | 1.37 |
| **1999** | 0.33 | 0.45 | 0.04 | 0.72 | 1.54 | 0.12 | 0.08 | 0.05 | 0.60 | 0.84 |
| **2000** | 0.47 | 0.54 | 0.08 | 2.36 | 3.46 | 0.10 | 0.14 | 0.06 | 0.37 | 0.67 |
| **2001** | 0.44 | 0.49 | 0.04 | 1.15 | 2.12 | 0.07 | 0.08 | 0.02 | 0.33 | 0.49 |
| **2002** | 1.13 | 0.94 | 0.03 | 2.54 | 4.64 | 0.04 | 0.06 | 0.08 | 0.32 | 0.50 |
| **2003** | 0.70 | 0.57 | 0.03 | 0.72 | 2.02 | 0.08 | 0.14 | 0.05 | 0.52 | 0.78 |
| **2004** | 0.75 | 0.84 | 0.02 | 0.64 | 2.26 | 0.10 | 0.07 | 0.03 | 0.50 | 0.69 |
| **2005** | 0.86 | 0.90 | 0.01 | 0.58 | 2.35 | 0.10 | 0.09 | 0.03 | 0.43 | 0.66 |
| **2006** | 1.05 | 0.65 | 0.03 | 0.45 | 2.18 | 0.05 | 0.06 | 0.03 | 0.32 | 0.47 |
| **2007** | 0.92 | 0.58 | 0.02 | 0.92 | 2.45 | 0.02 | 0.07 | 0.02 | 0.26 | 0.38 |
| **2008** | 0.80 | 0.47 | 0.09 | 0.91 | 2.27 | 0.10 | 0.05 | 0.03 | 0.26 | 0.44 |
| **2009** | 0.78 | 0.67 | 0.09 | 1.10 | 2.65 | 0.04 | 0.11 | 0.03 | 0.28 | 0.47 |
| **2010** | 1.10 | 0.63 | 0.08 | 0.93 | 2.74 | 0.10 | 0.09 | 0.06 | 0.32 | 0.56 |
| **2011** | 0.81 | 0.61 | 0.11 | 1.43 | 2.95 | 0.07 | 0.07 | 0.06 | 0.24 | 0.44 |

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 2.08 kha per year during the 1990 to 2011 period, which yields a cumulative area of 45.7 kha. For the same period, the mean area of *D* reached 0.66 kha per year, which amounts to 14.5 kha for the entire period. The difference between *AR* and *D* basically corresponds to the net increment of cadastral forest land as shown in Fig. 7-4 of NIR 2011.

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 in the UNFCCC CRF Reporter. 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 5A1 of the Convention reporting. Although not explicitly labelled, 5A1 is identical with the category of Forest Land remaining Forest Land (FLRFL) used in the KP reporting of FM. 5A2 represents Land converted to Forest land, remaining in conversion status for the period of 20 years. 5A1 and 5A2 form the entire category 5A Forest Land used in the Convention reporting. Residual afforestation (RA) represents the fraction of AR areas afforested prior 1990, which form a part of 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 | 5A2 | 5A | FLRFL | RA | FM |
| **1990** | 372.1 | 152.4 | 455.4 | 1 503.8 | 40.6 | 52.6 | 2 576.9 | 2 524.3 | 51.4 | 2 575.7 |
| **1991** | 375.3 | 153.0 | 455.5 | 1 500.2 | 40.7 | 51.9 | 2 576.7 | 2 524.8 | 50.1 | 2 574.9 |
| **1992** | 378.7 | 154.2 | 454.3 | 1 500.3 | 41.9 | 47.1 | 2 576.5 | 2 529.4 | 45.0 | 2 574.4 |
| **1993** | 381.3 | 154.9 | 452.6 | 1 499.7 | 41.4 | 46.1 | 2 576.1 | 2 530.0 | 43.6 | 2 573.5 |
| **1994** | 384.9 | 155.0 | 450.9 | 1 502.1 | 39.8 | 44.2 | 2 576.9 | 2 532.8 | 40.2 | 2 573.0 |
| **1995** | 388.3 | 155.6 | 451.2 | 1 503.0 | 38.9 | 40.6 | 2 577.5 | 2 537.0 | 35.5 | 2 572.4 |
| **1996** | 391.0 | 157.3 | 450.5 | 1 502.0 | 38.1 | 39.5 | 2 578.4 | 2 538.9 | 32.6 | 2 571.5 |
| **1997** | 394.4 | 157.4 | 450.1 | 1 503.2 | 36.0 | 38.1 | 2 579.2 | 2 541.1 | 29.5 | 2 570.6 |
| **1998** | 400.9 | 157.8 | 452.8 | 1 499.1 | 33.7 | 36.8 | 2 581.1 | 2 544.3 | 24.7 | 2 569.1 |
| **1999** | 403.7 | 159.7 | 448.9 | 1 504.1 | 32.2 | 33.1 | 2 581.8 | 2 548.7 | 19.5 | 2 568.1 |
| **2000** | 408.1 | 161.8 | 447.7 | 1 503.6 | 31.0 | 32.4 | 2 584.5 | 2 552.1 | 15.3 | 2 567.5 |
| **2001** | 413.2 | 163.0 | 446.5 | 1 503.0 | 29.8 | 30.7 | 2 586.1 | 2 555.5 | 11.5 | 2 566.9 |
| **2002** | 419.0 | 164.5 | 444.5 | 1 499.2 | 28.3 | 34.6 | 2 590.2 | 2 555.6 | 10.7 | 2 566.3 |
| **2003** | 426.3 | 166.1 | 443.3 | 1 493.2 | 27.0 | 35.4 | 2 591.3 | 2 555.9 | 9.5 | 2 565.4 |
| **2004** | 431.9 | 166.9 | 440.9 | 1 489.8 | 26.8 | 36.6 | 2 592.8 | 2 556.3 | 8.4 | 2 564.7 |
| **2005** | 438.0 | 167.5 | 439.4 | 1 486.0 | 26.3 | 37.3 | 2 594.5 | 2 557.2 | 6.8 | 2 564.0 |
| **2006** | 442.4 | 169.4 | 437.6 | 1 482.9 | 25.9 | 37.9 | 2 596.2 | 2 558.2 | 5.3 | 2 563.5 |
| **2007** | 448.2 | 170.7 | 435.7 | 1 479.1 | 26.1 | 38.5 | 2 598.2 | 2 559.7 | 3.4 | 2 563.1 |
| **2008** | 455.2 | 173.0 | 433.9 | 1 471.9 | 27.1 | 38.9 | 2 600.0 | 2 561.1 | 1.5 | 2 562.6 |
| **2009** | 461.5 | 174.2 | 432.0 | 1 466.7 | 27.6 | 40.0 | 2 602.1 | 2 562.1 | 0.0 | 2 562.1 |
| **2010** | 465.9 | 176.2 | 430.8 | 1 461.6 | 28.1 | 41.5 | 2 604.2 | 2 561.5 | 0.0 | 2 561.5 |
| **2011** | 470.6 | 178.3 | 428.3 | 1 456.2 | 29.1 | 43.9 | 2 606.6 | 2 561.0 | 0.0 | 2 561.0 |

Since the Czech inventory system adopts the 20-year default period for preserving lands under conversion status as recommended by GPG for LULUCF (IPCC, 2003), the areas of the sub-category *Forest land remaining Forest land in KP reporting* are equal to the areas in the category 5A1 under Convention reporting. 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 becomes equal to FM and the area of RA becomes zero. At the same time, the *FM* area becomes smaller than that reported under 5A1 under the Convention reporting (5A1 is not explicitly shown in Tab. 11-2, but it is equal to 5A - 5A2). This is due to the actual *D* activities that are not compensated by any areas of afforested land, because since 2010 these are registered exclusively under *AR* activities.

### 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, while additional codes for the small fraction of aggregated cadastral units were prepared by the LULUCF emission inventory team.

The spatial resolution of the adopted land-use representation and land-use change identification system is depicted in Figs. 11-2 and 11-3, which show the identified units with *AR* and *D* activities, respectively, in 2011.

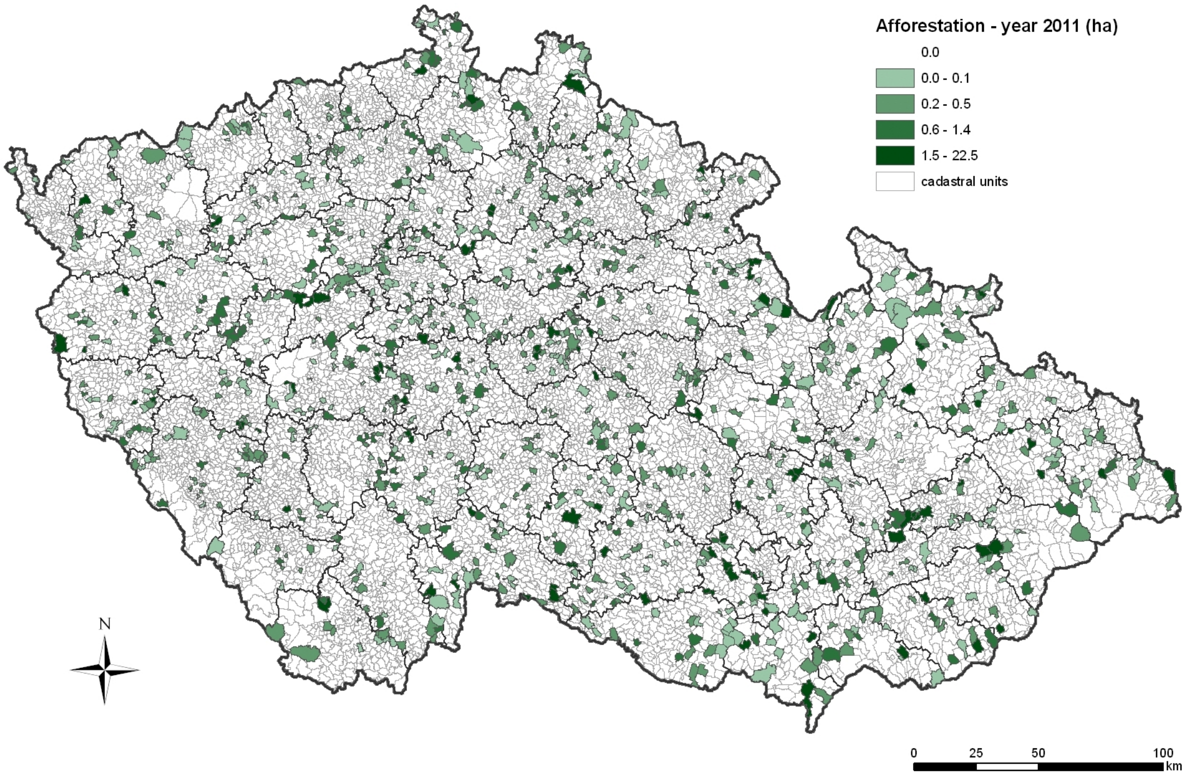



**Fig. 11-2: The cadastral units with identified afforestation (*AR*) activities in 2011.**

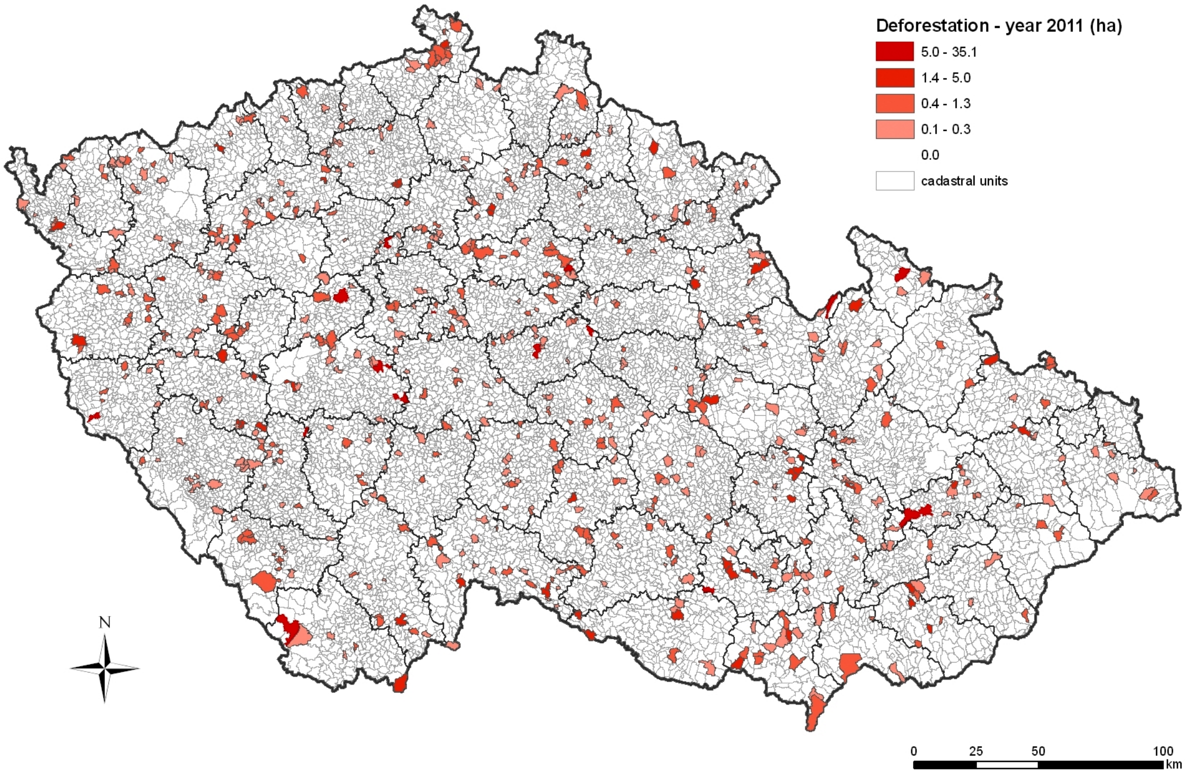



**Fig. 11. 3: The cadastral units with identified deforestation (*D*) activities in 2011.**

## 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 7 (LULUCF) of the 2013 NIR submission. Hence, reference is often made to these methodologies, while additional and specific information related to the Kyoto Protocol LULUCF activities is highlighted here.

For *AR* activities, the applicable methodology of GPG for LULUCF (IPCC, 2003) for estimating emissions and removals is given in Chapter 3.2.2. Correspondingly, the emissions due to *D* were estimated based on the guidance given in Chapters 3.3.2, 3.4.2, 3.5.2 and 3.6.2. For specific details on the approaches employed, country-specific activity data and factors, Chapter 7 of the NIR 2013 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. Hence, some methodological differences result from the fact that the Convention reporting uses only three pools, aggregating above-ground and below-ground biomass into living biomass, and dead wood and litter into dead organic matter (see Table 3.1.2 in GPG for LULUCF, IPCC 2003).

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, namely beech, oak, pine and spruce (Chapter 7.3.1 of NIR 2013).

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 the litter carbon pool for AR and D activities was estimated jointly with the soil carbon pool. This 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 7.3.2.2, NIR 2013). Therefore, the notation key “IE” (included elsewhere) was used in the CRF Tables to indicate that the litter carbon stock change is estimated inherently with changes in the soil carbon pool. Complementarily, for sub-categories involving Wetland and Settlements, “NA” was used in association with the soil carbon pool, as no adopted applicable methodology is listed for this pool in GPG for LULUCF (IPCC, 2003) for the symmetric types of land-use conversion events.

The carbon stock change in deadwood was estimated for all types of *D* events. It was based on the information on standing and lying deadwood that was obtained from the recently (2008 to 2009) conducted field campaign of the landscape inventory project CzechTerra (MoE 2007; www.czechterra.cz). This project provides relevant data on mean standing deadwood biomass (2.17 t/ha) and volume of lying deadwood (7.5 $m^3$/ha) 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 the 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 a land use change was adopted in this calculation.

For the *FM* activity, which resembles category *5A1 Forest Land remaining Forest Land,* the Tier 1 methodology assumption of GPG for LULUCF (IPCC, 2003), cf. 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 on what Tier 1 reporting means in terms of using 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 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 carbon stock change of deadwood for *FM* activity may later 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 emissions of $CO_2$ may arise from liming on forest soil. Note that liming on forest soil is not included in the Convention reporting, where the emission reporting concerning liming is restricted to the agricultural land-use categories of Cropland and Grassland. Since some liming on Forest Land occurs in the Czech Republic, it is reported in this submission in the corresponding CRF KP LULUCF table for FM. For these emissions, the methodology described in Section 3.3.1.2.1 of GPG for LULUCF (IPCC, 2003) was used. The activity data in terms of forest area and amount of limestone applied were taken from the national report on Czech forestry (Green report, MA 2012). In 2011, the amount of lime applied to forest soils equalled 29 t and concerned an area of 26 ha.

Additional greenhouse gases ($CO_2$, $CH_4$ and $N_2O$) are reported from biomass burning. Burning is confined to the activity of FM and thus matches the corresponding estimates under the Convention for the land-use category *5A1 Forest Land remaining Forest Land*. The emissions are estimated identically as described in Section 7.3.2.1 of the NIR 2013 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 2013, Section 7.4.2.2 for land use category *5.B.2.1*.

#### *11.3.1.2 Justification when 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, 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 (GPG for LULUCF, IPCC 2003). 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 likely 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 7 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 have recently been acquired in the Czech Republic offer additional support for this trend. Specifically, information on 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 the 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 initial field sampling during 2008 and 2009 and the results are already available (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 1 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<br>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 dead wood estimated by the CzechTerra campaign, representing the situation as of 2009, is larger for most of the decay stage classes as compared to the estimates by NFI conducted as of 2003. To envisage this trend more clearly, dead wood 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 2.

**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<br>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 2, we see that the total carbon content held in dead wood 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 of 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.

Secondly, we provide justification for omitting the soil carbon pool (and inherently 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 a well-established soil model YASSO (Liski et al., 2003, 2005) in combination with a similarly known and established forest scenario model EFISCEN (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 the YASSO model application 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)*

The adopted data and methods have not changed since the previous submission and hence no recalculations were performed in this submission.

#### *11.3.1.5 Uncertainty estimates*

The uncertainty estimates were prepared following the methodological guidance of GPG for LULUCF (IPCC, 2003). The uncertainty estimation was revised in NIR 2012 submission (inventory year 2010). The details of this revision are described in Section 7.3.3 of the NIR text. It also partly concerns the previously (previous NIR submissions) 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).

The estimated overall uncertainty for *AR* activities reached 38.5 %. The overall uncertainty for *D* reached 64.8 %. As for *FM*, the overall uncertainty reached 16.6 %. This is similar as reported in the previous NIR submission, but smaller than in earlier reports due to the above described revision in uncertainty calculation procedure and values adopted (see Section 7.3.3).

#### *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 the direct comparison difficult. Specifically for *FM*, a direct comparison with the emission estimates of the related category 5A1 under the Convention reporting will reveal some differences. There are two aspects to be considered when comparing the quantitative estimates of these categories.

First, the KP LULUCF reporting of *FM* additionally includes the contribution of forest areas afforested prior 1990. In this inventory, these are registered in the sub-category "Residual afforested land from before 1990 (in conversion status)". Second, the KP LULUCF reporting of *FM* also includes the emissions from lime application in forests, while the Convention reporting considers lime application only for the land use categories Cropland and Grassland (this issue was, however, addressed by including emissions from lime application on forest land under category *5G Other* since the 2012 NIR for inventory year 2010). It was verified that, once the two aspects are properly sorted out, the *FM* reporting matches that of category 5A1 under the Convention.

#### *11.3.1.7 The year of the onset of an activity, if after 2008*

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 KP LULUCF emission inventory, there is no issue related to distinguishing harvesting or forest disturbance from deforestation. Harvesting and forest disturbance always occur on Forest land, while deforestation is a cadastral change of land use from Forest land to other 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 decision. Hence, no permanent loss of forest cover may occur prior this approval, which is reflected in cadastral land use. 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 not qualified as deforestation in terms of Art. 3.3. KP LULUCF activity.

### 11.4.4 Information on estimated emissions and removals of activities under Art. 3.3

In 2011, the estimated removals from *AR* activities reached -356.9 Gg $CO_2$ eq. The estimated emissions from *D* reached 163.3 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 2003) 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 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.).

### 11.5.4 Information on estimated emissions and removals of Forest Management activity under Art. 3.4

In 2011, the estimated removals from *FM* reached -7 569 Gg $CO_2$ eq. The details 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", there was one key category identified among the KP LULUCF activities, namely *FM*. Similarly to its associated LULUCF category *5A1 Forest land remaining Forest land*, it was identified by level assessment. Emissions or removals through other activities are not expected to increase substantially. Hence, no other activity is identified as key (Chapter 5.4.4, IPCC 2003).

## 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 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 2012 to 31st of December 2012 is provided in standard electronic format in Annex 6.

## 12.2 Summary of information reported in the SEF tables

The total number of AAUs in the registry at the end of the year 2012 corresponded to 747,756,091 t $CO_2$ eq., of which 460,124,758 units were in the Party holding account and 287,631,333 in the retirement account.

The number of ERUs in registry corresponded to 223,615 t $CO_2$ eq., in the entity holding accounts and 3,839,463 in the retirement account.

The CER units in the registry corresponded to 13,483,053 t $CO_2$ eq., of which 987,929 units were in the entity holding accounts and 12,495,124 were in the retirement account.

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 765,302,222 t $CO_2$ eq.

The Czech Republic's assigned amount equals 789,859,031 t $CO_2$ eq.

It should be noted that due to software problems associated with transition to Consolidated System of EU Registries there could be some errors in the SEF tables and re-submission at a later date is possible.

## 12.3 Discrepancies and notifications

No CDM notifications and non-replacements occurred in 2012.

No invalid units exist as at 31 December 2012.

No discrepant transactions occurred in 2012.

## 12.4 Publicly accessible information

Due to transition to Consolidated System of EU Registries the public reports are currently available on the European Union Transaction Log (EUTL) webpage to which a link is provided from the national registry webpage. Links to additional information including Kyoto mechanisms are also provided.

## 12.5 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 (2011), which is calculated below[20].

5 x 133,495,504.059416 = **667,477,525 tonnes $CO_2$ eq.**

[20] *For CPR calculation used Czech Republic's total $CO_2$ equivalent emissions without LULUCF in 2011 (source: CZE-2013-2011-v1.2.xls, Summary2, cell: H57).*

# 13 Information on changes in National System

As reported in the Chapter 1.5, new QA/QC plan has been recently developed and implemented, which can be considered as an important improvement in the national system. Moreover, recommendations of expert review teams (annual UNFCCC reviews) are gradually implemented, mainly by recalculations aimed at the improvement of accuracy and by addressing the existing gaps regarding completeness.

The national system as described in the “Czech Republic’s Initial Report under the Kyoto Protocol” (MoE, 2006) has undergone a minor staffing change.

1. Ing. Eva Krtkova has been hired as sectoral expert to support inventory in Industrial Processes.

No other significant changes were made and the main pillars of the national 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 Previous Review Recommendations

In document FCCC/ARR/2011/CZE ERT reiterated the problems and recommendations identified by the SIAR in document IAR/2011/CZE/2/1, namely that the Party must: “provide information on national holding, cancellation and retirement accounts; display in the public reports the identifier of the representative of the account holder, using the Party identifier and a number unique to that representative within the Party’s registry; make all required information on JI projects publicly available, including project documentation and reports; and state clearly and explicitly what this information relates to, not only in the NIR but also on the public website.”

During the 2011 In-country review, the Czech Republic has demonstrated that, as a result of updates to the Seringas system, the registry public interface can now provide information on national holding, cancellation and retirement accounts and not just on authorized legal entities’ accounts and can now also provide identifiers of the representative of the account holder. The required information on JI projects is publicly available at http://www.mzp.cz/www/jiprojec.nsf/viewEN.xsp.

The Annual Review Report for the 2012 centralized review was not published as of April 2013.

## 14.2 Changes to National Registry

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

(1) Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

(2) Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

(3) Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

(4) Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

(5) The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

(6) The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

(7) All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

    a. With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);
    b. The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
    c. With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
    d. The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
    e. In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry of the Czech Republic have therefore occurred in 2012, as a consequence of the transition to the CSEUR platform:

| Reporting item | Submision |
|---|---|
| 15/CMP.1 annex II.E<br>Paragraph 32. (a)<br>Change of name or contact | No change in the name or contact information of the registry administrator occurred during the reported period. |
| 15/CMP.1 annex II.E<br>Paragraph 32. (b) Change of cooperation arrangement | The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012.<br><br>A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes:<br>• Readiness questionnaire<br>• Application logging<br>• Change management procedure<br>• Disaster recovery<br>• Manual Intervention<br>• Operational Plan<br>• Roles and responsibilities<br>• Security Plan<br>• Time Validation Plan<br>• Version change Management<br><br>The documents above are provided as an appendix to this document.<br><br>A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues. |
| 15/CMP.1 annex II.E<br>Paragraph 32. (c) Change to database or capacity of national registry | In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR).<br><br>The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.<br><br>During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to **successful certification on 1 June 2012.** |
| 15/CMP.1 annex II.E<br>Paragraph 32. (d) Change of conformance to technical standards | The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.<br><br>During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012. |
| 15/CMP.1 annex II.E<br>Paragraph 32. (e) Change of discrepancies procedures | The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and **the operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. |

| | |
|---|---|
| 15/CMP.1 annex II.E<br>Paragraph 32. (f) Change of security | The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. |
| 15/CMP.1 annex II.E<br>Paragraph 32. (g) Change of list of publicly available information | The overall change to a Consolidated System of EU Registries also triggered changes to the list of publicly available information. The public reports are currently available on the European Union Transaction Log (EUTL) webpage to which a link is provided from the national registry webpage. |
| 15/CMP.1 annex II.E<br>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<br>Paragraph 32. (i) Change of data integrity measures | The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan.** The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. |
| 15/CMP.1 annex II.E<br>Paragraph 32. (j) Change of test results | On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted. |

# 15 Information on Minimization of Adverse Impact in Accordance with Article 3, paragraph 14

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 1990–2010 and inventory report 2012 and will be also provided in the European Union submission for the year 2013. 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 will most probably decide to postpone this measure. |
| (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 planned CCS programme or demonstration project in the Czech Republic. There has been no development in this area in 2012. |
| (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 environmental efficiency of these activities. | 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. |
| (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,<br>inter alia:<br>- Increasing energy independence of remote regions in Georgia with solar thermal and photovoltaic systems<br>- Construction of biomass heating plant and heat distribution network in Bosnia and Herzegovina<br>- Development of biogas and photovoltaic energy sources in rural areas of Vietnam<br>- Subsidizing biodigesters construction in rural areas of Cambodia to stimulate the emerging market<br>All of the above mentioned projects are being implemented in the period 2011 – 2013. |

# 16 Other Information

No other information submitted in 2011.

# References

Adamec V., Dufek J., Jedlička J. (2005): Inventories of emissions of GHG form transport, Report of CDV for CHMI, Transport Research Centre, Brno (in Czech)

Adamec V., Jedlička J., Dufek J. et al. (2005): Study of trends in transport in 2004 from the standpoint of the environment, Transport Research Centre (CDV), Brno (in Czech)

Alfeld, K. (1998): Methane Emissions Produced by the Gas Industry Worldwide, IGU Study Group 8.1: Methane emissions, Essen

ARR 2010: Report of the individual review of the annual submission of the Czech Republic submitted in 2010 (FCCC/ARR/2010/CZE)

ARR 2011: Report of the individual review of the annual submission of the Czech Republic submitted in 2011 (FCCC/ARR/2110/CZE)

Bláha J. (1986): Nutrition and Feeding of Farm Animals, p. 63-64. (in Czech)

Carmona, M.R., Armesto, J.J., Aravena, J.C. & Perez, C.A.: Coarse woody debris biomass in successional and primary temperate forests in Chiloe Island, Chile. Forest Ecology and Management 164: 265-275, 2002.

CCA (2012): Data 2011, Czech Cement Association Prague, http://www.svcement.cz/data/data-2011

Čapla, L., Havlát, M. (2006): Calculating the Carbon Dioxide Emission Factor for Natural Gas / Výpočet emisního faktoru pro zemní plyn, Plyn, Vol. 86, p. 62-65 (in Czech)

Černý, M., Pařez, J., Malík, Z. (1996): Growth and yield tables for the main tree species of the Czech Republic. App. 3, Ministry of Agriculture, Czech Forestry Act 84/1996 (in Czech)

Černý, M., Cienciala, E., Russ, R. Methodology for Carbon Stock Monitoring (Ver. 3.2) (2002):. Report for the Face Foundation. IFER - Institute of Forest Ecosystem Research, Jílove u Prahy, Czech Republic, 70 pp

Černý, M., Pařez, J., Zatloukal, V. (2006): Growing stock estimated by FNI CR 2001-2004. Lesnická práce, 9 (85): 10-12

Černý, M. (1990): Biomass of Picea abies (L.) Karst. in Midwestern Bohemia. Scand.J.For.Res. 5, 83-95

Černý, M.: Use of the growth models of main tree species of the Czech Republic in combination with the data of the Czech National Forest Inventory. In: Neuhöferová P (ed) The growth functions in forestry. Korf´s growth function and its use in forestry and world reputation. Kostelec nad Černými lesy, Prague 2005 (in Czech).

Černý, M. (2009): Development of a Dynamic Observation Network Providing Information on the State and changes In Terrestrial Ecosystems and Land Use. Annual Report to the project CzechTerra - – Adaptation of Landscape Carbon Reservoirs in the Context Of Global Change, 2007-2011, Funded by the Ministry of Environment of the Czech Republic (SP/2d1/93/07). Jilove u Prahy, (in Czech).

CHMI (2006): National Greenhouse Gas Inventory Report, NIR (reported inventory 2004), CHMI Praha, 2006 (http://unfccc.int/national_reports)

CHMI (2007): National Greenhouse Gas Inventory Report, NIR (reported inventory 2005), CHMI Praha, 2007 (http://unfccc.int/national_reports)

CHMI (2008): National Greenhouse Gas Inventory Report, NIR (reported inventory 2006), CHMI Praha, 2008 (http://unfccc.int/national_reports)

CHMI (2009): National Greenhouse Gas Inventory Report, NIR (reported inventory 2007), CHMI Praha, 2009 (http://unfccc.int/national_reports)

CHMI (2010): Czech Informative Inventory Report (IIR), Submission under the UNECE / CLRTAP Convention, Czech Hydrometeorological Institute, Prague, March 2010.

CHMI (2010): National Greenhouse Gas Inventory Report, NIR (reported inventory 2008), CHMI Praha, 2010 (http://unfccc.int/national_reports)

CHMI (2011): National Greenhouse Gas Inventory Report, NIR (reported inventory 2009), CHMI Praha, 2011 (http://unfccc.int/national_reports)

CHMI (2012): National Greenhouse Gas Inventory Report, NIR (reported inventory 2010), CHMI Praha, 2012 (http://unfccc.int/national_reports)

CHMI (2012b): Development of the system of monitoring, inventories and projections of greenhouse gas in the Czech Republic. Task 5 - Proposal to improve the current state of the of greenhouse gas inventories including uncertainty analysis. Project for the State Environmental Fund of the Czech Republic, Prague, November 2012 (In Czech).

Cienciala E., Cerny M., Tatarinov F., Apltauer A. and Exnerova Z. (2006b): Biomass functions applicable to Scots pine. Trees 20: 483-495

Cienciala E., Henžlík V., Zatloukal V. (2006a): Assessment of carbon stock change in forests – adopting IPCC LULUCF Good Practice Guidance in the Czech Republic. Forestry Journal (Zvolen), 52(1-2): 17-28

Cienciala E., Cerny M., Tatarinov F., Apltauer A. and Exnerova Z. (2006b): Biomass functions applicable to Scots pine. Trees 20: 483-495, 2006b.

Cienciala E., Apltauer J. (2007): Additional Information to LULUCF activities arising from the Kyoto protocol. Report to the Czech Ministry of Environment (in Czech)

Cienciala E., Apltauer J., Exnerova Z. and Tatarinov F. (2008a): Biomass functions applicable to oak trees grown in Central-European forestry. Journal of Forest Science 54, 109-120

Cienciala, E., Exnerova, Z. & Schelhaas, M.J. (2008b): Development of forest carbon stock and wood production in the Czech Republic until 2060. Annals of Forest Science 65: 603

CLA (2012): Data 2011, Czech Lime Association Prague

Čabajová K. (2009): Year of Potatoes - 2008. Thesis of Faculty of Medicine at the Masaryk University in Brno (in Czech)

Čermák a kol. (2008).: Conventional and ecological feed, USB AFC Ceske Budejovice, ISBN 978-80-739-141-3, p.135-138 (In Czech, tables)¨

ČSN EN ISO 6976 (2006): Natural Gas – Calculation of gross calorific value, net calorific value, density, relative density and Wobbe number, Czech Standards Institute

CzSO (2004): Production, use and disposal of waste in year 2003, Czech Statistical Office, Prague 2004 (in Czech)

CzSO (2010): Energy Questionnaire - IEA - Eurostat – UNECE (CZECH_COAL, CZECH_OIL, CZECH_GAS, CZECH_REN, Prague 2010

CzSO (2011): Energy Questionnaire - IEA - Eurostat – UNECE (CZECH_COAL, CZECH_OIL, CZECH_GAS, CZECH_REN, Prague 2011

CzSO (2011): Development of overall and specific consumption of fuels and energy in relation to product, Prague 2011

CzSO (2010): Statistical Yearbook of the Czech Republic 2009, Czech Statistical Office, Prague 2010

CzSO (2011): Statistical Yearbook of the Czech Republic 2010, Czech Statistical Office, Prague 2011

Dohányos M., Zábranská J. (2000): Proposals for refining the calculation of methane emissions from municipal and industrial wastewater; Report for CHMI, Prague (in Czech)

Dolejš (1994): Emissions of greenhouse gases in agriculture in the Czech Republic, Report for PROINCOM Pardubice, Research Institute of Animal Production, Uhříněves, Prague (in Czech)

Dufek, J. (2005): Verification and evaluation of weight criteria of available data sources $N_2O$ from transportation, Report CDV Brno for CHMI, Brno (in Czech)

Dufek, J., Huzlík, J., Adamec, V. (2006): Methodology for determination of emission stress of air pollutants in the Czech Republic, CDV, Brno (in Czech)

Dvořák F., Novák M. (2010): Significant structural changes in selected branches of chemical industry in the Czech Republic / Významné strukturální změny ve vybraných oborech chemického průmyslu na území ČR, VŠCHT Praha (in Czech)

Exnerová Z., Cienciala E. (2009).: Greenhouse gas inventory of agriculture in the Czech Republic, Plant, Soil and Environment 55, 311-319

ETS (2011): Database of ETS installations – preliminary version for CHMI

FAOSTAT (2005): Food Balance Sheets, Food and agriculture organization, URL: http://faostat.fao.org/faostat/, 2005

FMI (2007): National Forest Inventory in the Czech Republic 2001-2004. Introduction, Methods, Results. 224 pp. Forest Management Institute, Brandýs n. Labem, 2007.

Fott, P., Vácha D., Neužil V., Bláha J. (2009): Reference approach for estimation of $CO_2$ emissions from fossil fuels and its significance for GHG inventories in the Czech Republic. Ochrana ovzduší 21 (No.1), 2009, p. 26 - 30 (in Czech)

Fott, P. (1999): Carbon emission factors of coal and lignite: Analysis of Czech coal data and comparison with European values. Environmental Science and Policy (Elsevier), 2, 1999, p. 347 - 354

Geimplová, H. (2010): NMVOC emission inventory in year 2009. Report for CHMI, Prague (in Czech)

Geimplová, H. (2011): NMVOC emission inventory in year 2010. Report for CHMI, Prague (in Czech)

Geimplová, H. (2012): NMVOC emission inventory in year 2011. Report for CHMI, Prague (in Czech)

Green C., Tobin B., O'Shea M., Farrell E., Byrne K. (2006): Above- and belowground biomass measurements in an unthinned stand of Sitka spruce (Picea sitchensis (Bong) Carr.). European Journal of Forest Research DOI 10.107/s10342-005-0093-3

Havránek M. (2001): Emissions of greenhouse gases from the waste sector in CR, Thesis. Institute of the Environment, Faculty of Sciences, Charles University and CHMI, Prague (in Czech)

Havránek M. (2007): Emissions of methane from solid waste disposal sites in the Czech Republic during 1990-2005: Application of first order decay model, Charles University Environment Center Working Paper WP2007/02, Prague

Hok P. (2009): Special material for the purpose of solving GHG inventory of $CH_4$ emissions that are produced in OKD mines in 2000-2008 period, OKD Inc., Ostrava (in Czech)

Hons P., Mudřík Z. (2003): Czech country-specific data for estimation of methane emissions from enteric fermentation of cattle. AGROBIO report for CHMI, Prague (in Czech)

Ingr I. (2003): Processing of agricultural products. Brno: MZLU, 249 s., ISBN 8071575208 (in Czech)

Internal study material of Faculty of Agronomy, South Bohemia University. Clover / Jeteloviny. www.zf.jcu.cz, *opr.zf.jcu.cz/docs/predmety/-eb721c77ad.doc* (in Czech)

IPCC (1995): IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 1-3, IPCC / OECD / IEA, 1995

IPCC (1997): Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 1-3, IPCC 1997

IPCC (1997b) Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, Chapter 4, Agriculture, p.140, IPCC 1997

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

IPCC (2003): Good Practice Guidance for Land Use, Land Use Change and Forestry, IPCC 2003

IPCC (2006): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 1-5, IPCC 2006.

IPCC (2007): IPCC Fourth Assessment Report: Climate Change 2007, Geneva (www.ipcc.ch)

IPR (2012): Integrated Pollution Register, http://www.irz.cz/

Jančík, F., Homolka, P. & Koukolová, V. (2010): Prediction of parameters characterizing rumen degradation of dry matter in grass silage (certified methodology). ISBN 978-80-7403-054-3 (in Czech)

Jedlička J., Dufek J., Adamec V. (2005): Greenhouse gas emission balance, (In: 20th International Air Protection Conference p. 96-99, ISBN 80-969365-2-2, High Tatras - Štrbské Pleso (Slovakia), November 23 – 25

Jedlička J., Adamec, V., Dostál, I., Dufek, J., Effenberger, K., Cholava, R., Jandová, V., Špička, I. (2009): Study of transport trends from environmental viewpoint in the Czech Republic 2008, Transport Research Centre (CDV), Brno

Jedlička J., Jandová, V., Dostál, I., Špička, L., Tichý, J. (2012): Study on transport trends from environmental viewpoint in the Czech Republic 2011, Transport Research Centre (CDV), Brno

Jelínek A, Plíva P., Vostoupal B. (1996): Determining VOC emissions from agricultural activities in the Czech Republic, Report for CHMI, Research Institute of Agricultural Technology, Prague (in Czech)

Karbanová L. (2008): Emission Inventory of HFCs, PFCs and $SF_6$ in exported and imported products, Thesis. Faculty of the Environment, Jan Evangelista Purkyně University in Ústí nad Labem, Ústí nad Labem (in Czech)

Karjalainen, T., Pussinen, A., Liski, J., Nabuurs, G.-J., Erhard, M., Eggers, T., Sonntag, M. & Mohren, G.M.J. (2002): An approach towards an estimate of the impact of forest management and climate change on the European forest sector carbon budget: Germany as a case study. Forest Ecology and Management 162(1):87-103

Kolář F, Havlíková M., Fott P. (2004): Recalculation of emission series of methane from enteric fermentation of cattle. Report of CHMI, Prague (in Czech)

Koukolová V., Homolka P. (2008): Rating digestible neutral-detergent fiber in the diet of cattle. Methodology, 29 p., ISBN 978-80-7403-016-1 (in Czech)

Koukolová, V., Koukol O., Homolka P., Jančík F. (2010): Rumen degradability of neutral detergent fiber and organic matter digestibility of red clover (certified methodology), 25 p, ISBN 978-80-7403-041-3 (in Czech)

Koukolová V., Homolka P., Kudrna V. (2010): The Scientific Committee on Animal Nutrition, Effect of structural carbohydrates on rumen fermentation, animal health and milk quality. Research Institute of Animal Production Prague, ISBN 978-80-7403-066-6 (in Czech)

Kvapilík J., Růžička Z., Bucek P. a kol. (2010): Annual report - Yearbook of cattle in Czech Republic (in Czech)

Lehtonen A., Cienciala E., Tatarinov F. and Mäkipää, R. (2007): Uncertainty estimation of biomass expansion factors for Norway spruce in the Czech Republic. Annals of Forest Science 64(2): 133-140, 2007.

Lehtonen A., Makipaa R., Heikkinen J., Sievanen R. and Liski J. (2004): Biomass expansion factors (BEFs) for Scots pine, Norway spruce and birch according to stand age for boreal forests. Forest Ecology and Management 188: 211-224

Liski, J., Nissinen, A., Erhard, M. & Taskinen, O. (2003): Climatic effects on litter decomposition from arctic tundra to tropical rainforest. Global Change Biology 9(4): 575-584. doi:10.1046/j.1365-2486.2003.00605.x

Liski, J., Palosuo, T., Peltoniemi, M. & Sievänen, R. (2005): Carbon and decomposition model Yasso for forest soils. Ecological Modelling 189(1-2): 168-182. doi:10.1016/j.ecolmodel.2005.03.005.

MA (2012): Report about forest and forestry conditions in the Czech Republic 2011 (Green Report), Ministry of Agriculture, ISBN 978-80-7434-063-5, Prague 2012, pp. 137.

Macků, J., Sirota, I., Homolová, K. (2007): Carbon balance in forest topsoil of the Czech Republic. VaV 640/18/03 Czech Carbo – Study of carbon in terrestrial ecosystems of the Czech Republic - interim project report. Czech Carbo VaV/640/18/03. Prague (in Czech)

Marek V. (2002): Development of Land Resources in the Czech Republic. Proceedings of the Czech National Soil Conference, Prague (in Czech)

Markvart M., Bernauer B. (2006): Dominant sources of GHG in chemical industry in the Czech Republic in years 2003 - 2005, Report for CHMI, Prague (in Czech)

Markvart M., Bernauer B. (2000): Emission trends in nitrous oxide from industrial processes in the nineties, Report for CHMI, Prague (in Czech)

Markvart M., Bernauer B. (2004): Emissions of nitrous oxide in the Czech Republic in years 2000 - 2003, Report for CHMI, Prague (in Czech)

Markvart M., Bernauer B. (2008): Emissions of GHG in chemical industry in the Czech Republic in years 2005 - 2007, Report for CHMI, Prague (in Czech)

Markvart M., Bernauer B. (2009): Emissions of GHG in chemical industry in the Czech Republic in years 2006 - 2008, Report for CHMI, Prague (in Czech)

Markvart M., Bernauer B. (2010): Emissions of GHG in chemical industry in the Czech Republic in years 2007 - 2009, Report for CHMI, Prague (in Czech)

Markvart M., Bernauer B. (2011): Emissions of GHG in chemical industry in the Czech Republic in years 2008 - 2010, Report for CHMI, Prague 2011 (in Czech)

Markvart M., Bernauer B. (2012): Emissions of GHG in chemical industry in the Czech Republic in years 2008 - 2011, Report for CHMI, Prague (in Czech)

Markvart M., Bernauer B. (2007): Emissions of $N_2O$ and $CO_2$ in chemical industry in the Czech Republic in years 2004 - 2006, Report for CHMI, Prague (in Czech)

Markvart M., Bernauer B. (2003): Nitrogen industry as a source of nitrous oxide emissions in the Czech Republic, Report for CHMI, Prague (in Czech)

MoE (1997): Second National Communication of the Czech Republic on the UN Framework Convention on Climate Change, MoE CR, Prague

MoE (2006): Czech Republic's Initial report under the Kyoto Protocol. Ministry of Environment of the Czech Republic, Prague

MoE (2010): Statistical Environmental Yearbooks of the Czech Republic. Ministry of Environment of the Czech Republic, Prague 1995-2009

MoE (2009): Fifth National Communication of the Czech Republic on the UNFCCC, MoE CR Prague 2009 (www.mzp.cz)

Mining Yearbooks, 1994 - 2012 (in Czech)

MIT (2008): RES in the Czech Republic 2008, Ministry of industry and trade, October 2009

MIT (2009): Statistics of waste energy use during 1905-2009: results of statistical survey, Ministry of industry and trade, March 2010

MoT (1999): Transport Yearbook. Ministry of Transport and Communications of the Czech Republic, Prague, 2000

MoT (2005): Transport Yearbook. Ministry of Transport and Communications of the Czech Republic, Prague, 2006

MoT (2010): Transport Yearbook. Ministry of Transport and Communications of the Czech Republic, Prague, 2011

MONTANEX (2008): Czech Mining Office and The Employers' Association of Mining and Oil Industries, Mining Yearbooks, Montanex Inc., 2005-2007

Mudřík Z., Havránek F. (2006): Czech country-specific data for estimation of methane emissions from enteric fermentation of cattle- updated data (pers.communication, October, 2006)

Petrikovič P., Sommer A., Čerešňáková Z., Svetlanská M., Chrenková M., Chrastinová L., Poláčiková M., Bencová E., Dolešová P. (2000): The nutritive value of feeds. Research Institute of Animal Production Nitra: ISBN 80-88872-12-X, 320 s. (in Czech)

Petrikovič P., Sommer A. (2002): Nutrient requirements for beef cattle. Research Institute of Animal Production Nitra: ISBN 80-88872-21-9, 62 p. (in Czech)

Poustka J. (2007): The analysis of milk and milk products. Presentation on Institute of Chemical Technology (ICT) (in Czech)

Pozdíšek J., Ponížil A. (2010): Possibilities of using LOS for feeding ruminants, Presentation of Research Institute of cattle breeding Rapotín in Jihlava, 9.3.2010 (in Czech)

Prokop P. (2011): $CO_2$ emission factors and emissions from underground coal mining in the Ostrava-Karvina area, Technical University of Ostrava, Ostrava

Řeháček, V. (2011): Antropogenic emissions of SF6, CFCs and PFCs in the Czech Republic in 2011, Report for CHMI, Prague 2011 (in Czech)

Řeháček V., Michálek L. (2005): Information on emissions of greenhouse gases containing fluorine in CR in 2004, Report for CHMI, Prague (in Czech)

Sálusová D., Kovář J. and Zavázal P. (2006): Czech agriculture by statistic view. CzSO Prague (in Czech)

Schwappach A., Neumann J. (1923): Ertrags tafeln der Wichtigeren Holzarten, Neudamm 1923.

Sommer, A., Čerešňáková, Z., Frydrych, Z., Králík, O., Králíková, Z., Krása, A., Pajtáš, M., Petrikovič, P., Pozdíšek, J., Šimek, M., Třináctý, J., Vencl, B., Zeman, L. (1994): Nutrient requirements tables and nutritive value of feeds for ruminants. CAAS - commission nutrition of farm animals, Pohořelice, 196 p. ISBN 80-901598-1-8 (in Czech)

Šefrna, L., Janderková, J. (2007): Organic carbon content in soil associations of the map 1:500000, Agricultural soils. VaV 640/18/03 Czech Carbo – Study of carbon in terrestrial ecosystems of the Czech Republic - interim project report. Czech Carbo VaV/640/18/03. Prague (in Czech)

Straka, F. (2001): Calculation of emissions from landfills in CR, Institute for Research and Use of Fuels, Prague (in Czech)

Supply of Basic Final Refinery Products in the CR, Czech Statistical Office, Prague 1995 - 2005

SVÚOM (2005): Commentary on the emission inventory of NMVOC for 2004 in the sector "Solvent use and applications - 060000", SVÚOM Ltd. Prague (in Czech)

Takla G., Nováček P. (1997): Emissions of mine gases in the Ostrava-Karviná coal-mining area and potential for minimization, Proceedings from the conference Emissions of Natural Gas - economic and environmental impacts, Czech Gas Association (in Czech)

Takla, G. (2002): Methane emissions from deep coal mining, national conference "Natural Gas Emissions - New Clean Air Act and international reliability of the methane emission inventory in the Czech Republic", Czech Gas Association (in Czech)

Third National Communication of the Czech Republic on the UN Framework Convention on Climate Change, MoE CR, Prague 2001

Tománková, O., Homolka, P., (2010): Prediction of intestinal digestibility of crude protein escaped degradation in the rumen of ruminants combined method (certified methodology). ISBN 978-80-7403-063-5 (in Czech)

Třináctý J. (2010): Animal nutrition and its impact on the performance and health of the animal (Research Institute of cattle breeding Rapotín). Conference on the "Application of new knowledge in the field of nutrition for livestock to common farming practice" within the Rural Development Programme of the Czech Republic (in Czech)

Turek B. (2000). Milk in human nutrition. National Institute of Public Health (NIPH) (in Czech)

UN ECE (1999): EMEP / CORINAIR Atmospheric Emission Inventory Guidebook, UN ECE - EMEP 1999

UNFCCC (2006): Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11, FCCC/SBSTA/2006/9 (www.unfccc.int)

UNFCCC (2009): Annotated outline of the National Inventory Report including reporting elements under the Kyoto Protocol, UNFCCC, Bonn, 2009 (www.unfccc.int)

Vácha, D. (2004): Methodology for $CO_2$ emissions estimates for cement production and $CO_2$ emissions and removals form lime production and use, CHMI Report (in Czech)

Vacková. L.; Vácha, D. (2008): F-gases emissions form import and export of products; Air Protection 2008; Tatry – Štrbské pleso (in Czech)

Wikkerink J.B.W. (2006): Improvement in the determination of methane emissions from gas distribution in the Netherlands, 23rd World Gas Conference, Amsterdam 2006

Willey (2005): Ullmans's encyclopedia of Industrial Chemistry, Release 2005, 7th Edition, John Willey 2005

Wirth C., Schumacher J. and Schulze E.-D. (2004): Generic biomass functions for Norway spruce in Central Europe - a-meta-analysis approach toward prediction and uncertainty estimation. Tree Physiology 24, 121-139

Wutzler T., Wirth C. and Schumacher J. (2008): Generic biomass functions for Common beech (Fagus sylvatica L.) in Central Europe - predictions and components of uncertainty, Canadian Journal of Forest Research 38(6): 1661–1675

Zábranská J. (2004): Proposals for update of the calculation of methane emissions from municipal and industrial wastewater in 2002 - 2003; University of Chemical Technology, Report for CUEC, Prague (in Czech)

Zanat, J.; Dorda, P.; Grezl, T. (1997): Conference Emissions of Natural Gas, economic and environmental issues, Czech Association of Gas, Prague

Web pages (online status checked in March 2013)
http://www.suas.cz/
http://www.dpb.cz/
http://www.svcement.cz/
http://www.dpb.cz/
http://www.hz.cz/cz/

# 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 |
| CzSO | Czech Statistical Office |
| 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 |
| 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) |
| LDV | Light Duty Vehicle |
| LPG | Liquid Petroleum Gas |
| 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 System |

| | |
|---|---|
| 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

**Tab. A1- 1 Spreadsheet for Tier 1 KC Analysis, 2011 – Level Assessment including LULUCF**

| Cat | IPCC Source Categories | GHG | Em or Rem, Gg | Absol., Gg | LA, % | Cumul, % |
|---|---|---|---|---|---|---|
| 1A | 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 65 099 | 65 099 | 45.80 | 45.80 |
| 1A | 1.A.3.b Transport - Road Transportation | $CO_2$ | 16 124 | 16 124 | 11.34 | 57.15 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 15 181 | 15 181 | 10.68 | 67.83 |
| 5 | 5.A.1 Forest Land remaining Forest Land | $CO_2$ | -7 635 | 7 635 | 5.37 | 73.20 |
| 2 | 2.C.1 Iron and Steel Production | $CO_2$ | 5 623 | 5 623 | 3.96 | 77.16 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 4 965 | 4 965 | 3.49 | 80.65 |
| 1B | 1.B.1.a Coal Mining and Handling | $CH_4$ | 3 283 | 3 283 | 2.31 | 82.96 |
| 4 | 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 2 989 | 2 989 | 2.10 | 85.06 |
| 6 | 6.A Solid Waste Disposal on Land | $CH_4$ | 2 745 | 2 745 | 1.93 | 86.99 |
| 4 | 4.A Enteric Fermentation | $CH_4$ | 2 003 | 2 003 | 1.41 | 88.40 |
| 4 | 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 1 776 | 1 776 | 1.25 | 89.65 |
| 2 | 2.A.1 Cement Production | $CO_2$ | 1 665 | 1 665 | 1.17 | 90.82 |
| 2 | 2.A.3 Limestone and Dolomite Use | $CO_2$ | 1 151 | 1 151 | 0.81 | 91.63 |
| 2 | 2.F.1-6 F-gases Use - ODS substitutes | HFC, PFC | 1 130 | 1 130 | 0.80 | 92.43 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CO_2$ | 1 091 | 1 091 | 0.77 | 93.20 |
| 2 | 2.A.2 Lime Production | $CO_2$ | 691 | 691 | 0.49 | 93.68 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CH_4$ | 666 | 666 | 0.47 | 94.15 |
| 4 | 4.B Manure Management | $N_2O$ | 664 | 664 | 0.47 | 94.62 |
| 1A | 1.A.3.b Transport - Road Transportation | $N_2O$ | 660 | 660 | 0.46 | 95.08 |
| 2 | 2.B.1 Ammonia Production | $CO_2$ | 553 | 553 | 0.39 | 95.47 |
| 6 | 6.B Wastewater Handling | $CH_4$ | 516 | 516 | 0.36 | 95.84 |
| 2 | 2.B.2 Nitric Acid Production | $N_2O$ | 418 | 418 | 0.29 | 96.13 |
| 4 | 4.B Manure Management | $CH_4$ | 379 | 379 | 0.27 | 96.40 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CO_2$ | 377 | 377 | 0.27 | 96.66 |
| 1A | 1.A Stationary Combustion - Biomass | $CH_4$ | 343 | 343 | 0.24 | 96.90 |
| 5 | 5.C.2 Land converted to Grassland | $CO_2$ | -331 | 331 | 0.23 | 97.14 |
| 5 | 5.A.2 Land converted to Forest Land | $CO_2$ | -329 | 329 | 0.23 | 97.37 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CO_2$ | 326 | 326 | 0.23 | 97.60 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CO_2$ | 315 | 315 | 0.22 | 97.82 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $N_2O$ | 299 | 299 | 0.21 | 98.03 |
| 1A | 1.A.3.c Transport - Railways | $CO_2$ | 282 | 282 | 0.20 | 98.23 |
| 1B | 1.B.1.a Coal Mining and Handling | $CO_2$ | 255 | 255 | 0.18 | 98.41 |
| 4 | 4.D.2 Pasture, Range and Padock Manure | $N_2O$ | 254 | 254 | 0.18 | 98.59 |
| 3 | 3 Solvents and Other Product Use | $CO_2$ | 237 | 237 | 0.17 | 98.75 |
| 3 | 3 Solvents and Other Product Use | $N_2O$ | 233 | 233 | 0.16 | 98.92 |
| 6 | 6.B Wastewater Handling | $N_2O$ | 205 | 205 | 0.14 | 99.06 |
| 6 | 6.C Waste Incineration | $CO_2$ | 187 | 187 | 0.13 | 99.19 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $CH_4$ | 159 | 159 | 0.11 | 99.31 |
| 1A | 1.A.3.e Transport - Other Transportation | $CO_2$ | 144 | 144 | 0.10 | 99.41 |
| 1A | 1.A Stationary Combustion - Biomass | $N_2O$ | 120 | 120 | 0.08 | 99.49 |
| 2 | 2.B.5 Other | $N_2O$ | 94 | 94 | 0.07 | 99.56 |
| 5 | 5.E.2 Land converted to Settlements | $CO_2$ | 87 | 87 | 0.06 | 99.62 |
| 5 | 5.B.2 Land converted to Cropland | $CO_2$ | 86 | 86 | 0.06 | 99.68 |
| 5 | 5.B.1 Cropland remaining Cropland | $CO_2$ | 61 | 61 | 0.04 | 99.72 |
| 2 | 2.C.1 Iron and Steel Production | $CH_4$ | 56 | 56 | 0.04 | 99.76 |
| 5 | 5.A.1 Forest Land remaining Forest Land | $CH_4$ | 55 | 55 | 0.04 | 99.80 |
| 5 | 5.D.2. Land converted to Wetlands | $CO_2$ | 32 | 32 | 0.02 | 99.82 |
| 2 | 2.F.8 F-gases Use - Electrical Equipment | $SF_6$ | 31 | 31 | 0.02 | 99.85 |
| 2 | 2.F.7 F-gases Use - Semiconductore Manufacture | PFC, $SF_6$ | 29 | 29 | 0.02 | 99.87 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CH_4$ | 26 | 26 | 0.02 | 99.89 |
| 1A | 1.A.3.b Transport - Road Transportation | $CH_4$ | 25 | 25 | 0.02 | 99.90 |
| 2 | 2.B.5 Other | $CH_4$ | 24 | 24 | 0.02 | 99.92 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $N_2O$ | 23 | 23 | 0.02 | 99.94 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CO_2$ | 13 | 13 | 0.01 | 99.94 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $N_2O$ | 13 | 13 | 0.01 | 99.95 |
| 1A | 1.A.3.d Transport - Navigation | $CO_2$ | 9 | 9 | 0.01 | 99.96 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $N_2O$ | 9 | 9 | 0.01 | 99.97 |
| 5 | 5.F.2. Land converted to Cropland | $N_2O$ | 6 | 6 | 0.00 | 99.97 |
| 5 | 5.A.1 Forest Land remaining Forest Land | $N_2O$ | 6 | 6 | 0.00 | 99.98 |
| 1A | 1.A.3.c Transport - Railways | $N_2O$ | 5 | 5 | 0.00 | 99.98 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CO_2$ | 5 | 5 | 0.00 | 99.98 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $N_2O$ | 4 | 4 | 0.00 | 99.98 |
| 6 | 6.C Waste Incineration | $N_2O$ | 4 | 4 | 0.00 | 99.99 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CH_4$ | 3 | 3 | 0.00 | 99.99 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CH_4$ | 3 | 3 | 0.00 | 99.99 |
| 2 | 2.F.9 F-gases Use - Other SF6 | $SF_6$ | 3 | 3 | 0.00 | 99.99 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $N_2O$ | 2 | 2 | 0.00 | 100.00 |
| 5 | 5.C.1 Grassland remaining Grassland | $CO_2$ | 2 | 2 | 0.00 | 100.00 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CH_4$ | 2 | 2 | 0.00 | 100.00 |
| 2 | 2.A.4 Soda Ash Use | $CO_2$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CH_4$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A.3.c Transport - Railways | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.a Transport - Civil Aviation | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 5 | 5G Other - Liming of Forest Land | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 5 | 5.D.1 Wetlands remaining Wetlands | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| 5 | 5.E.1 Settlements remaining Settlements | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| 5 | 5.F.1 Other Land remaining Other Land | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| | TOTAL | | **125 536** | **142 126** | **100** | |

**Tab. A1- 2 Spreadsheet for Tier 1 KC Analysis, 2011 – Level Assessment excluding LULUCF**

| Cat | IPCC Source Categories | GHG | Emissions, Gg | Absol., Gg | LA, % | Cumul, % |
|---|---|---|---|---|---|---|
| 1A | 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 65 099 | 65 099 | 48.76 | 48.76 |
| 1A | 1.A.3.b Transport - Road Transportation | $CO_2$ | 16 124 | 16 124 | 12.08 | 60.84 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 15 181 | 15 181 | 11.37 | 72.21 |
| 2 | 2.C.1 Iron and Steel Production | $CO_2$ | 5 623 | 5 623 | 4.21 | 76.43 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 4 965 | 4 965 | 3.72 | 80.15 |
| 1B | 1.B.1.a Coal Mining and Handling | $CH_4$ | 3 283 | 3 283 | 2.46 | 82.60 |
| 4 | 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 2 989 | 2 989 | 2.24 | 84.84 |
| 6 | 6.A Solid Waste Disposal on Land | $CH_4$ | 2 745 | 2 745 | 2.06 | 86.90 |
| 4 | 4.A Enteric Fermentation | $CH_4$ | 2 003 | 2 003 | 1.50 | 88.40 |
| 4 | 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 1 776 | 1 776 | 1.33 | 89.73 |
| 2 | 2.A.1 Cement Production | $CO_2$ | 1 665 | 1 665 | 1.25 | 90.98 |
| 2 | 2.A.3 Limestone and Dolomite Use | $CO_2$ | 1 151 | 1 151 | 0.86 | 91.84 |
| 2 | 2.F.1-6 F-gases Use - ODS substitutes | HFC, PFC | 1 130 | 1 130 | 0.85 | 92.69 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CO_2$ | 1 091 | 1 091 | 0.82 | 93.50 |
| 2 | 2.A.2 Lime Production | $CO_2$ | 691 | 691 | 0.52 | 94.02 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CH_4$ | 666 | 666 | 0.50 | 94.52 |
| 4 | 4.B Manure Management | $N_2O$ | 664 | 664 | 0.50 | 95.02 |
| 1A | 1.A.3.b Transport - Road Transportation | $N_2O$ | 660 | 660 | 0.49 | 95.51 |
| 2 | 2.B.1 Ammonia Production | $CO_2$ | 553 | 553 | 0.41 | 95.93 |
| 6 | 6.B Wastewater Handling | $CH_4$ | 516 | 516 | 0.39 | 96.31 |
| 2 | 2.B.2 Nitric Acid Production | $N_2O$ | 418 | 418 | 0.31 | 96.63 |
| 4 | 4.B Manure Management | $CH_4$ | 379 | 379 | 0.28 | 96.91 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CO_2$ | 377 | 377 | 0.28 | 97.19 |
| 1A | 1.A Stationary Combustion - Biomass | $CH_4$ | 343 | 343 | 0.26 | 97.45 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CO_2$ | 326 | 326 | 0.24 | 97.69 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CO_2$ | 315 | 315 | 0.24 | 97.93 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $N_2O$ | 299 | 299 | 0.22 | 98.15 |
| 1A | 1.A.3.c Transport - Railways | $CO_2$ | 282 | 282 | 0.21 | 98.37 |
| 1B | 1.B.1.a Coal Mining and Handling | $CO_2$ | 255 | 255 | 0.19 | 98.56 |
| 4 | 4.D.2 Pasture, Range and Padock Manure | $N_2O$ | 254 | 254 | 0.19 | 98.75 |
| 3 | 3 Solvents and Other Product Use | $CO_2$ | 237 | 237 | 0.18 | 98.93 |
| 3 | 3 Solvents and Other Product Use | $N_2O$ | 233 | 233 | 0.17 | 99.10 |
| 6 | 6.B Wastewater Handling | $N_2O$ | 205 | 205 | 0.15 | 99.25 |
| 6 | 6.C Waste Incineration | $CO_2$ | 187 | 187 | 0.14 | 99.39 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $CH_4$ | 159 | 159 | 0.12 | 99.51 |
| 1A | 1.A.3.e Transport - Other Transportation | $CO_2$ | 144 | 144 | 0.11 | 99.62 |
| 1A | 1.A Stationary Combustion - Biomass | $N_2O$ | 120 | 120 | 0.09 | 99.71 |
| 2 | 2.B.5 Other | $N_2O$ | 94 | 94 | 0.07 | 99.78 |
| 2 | 2.C.1 Iron and Steel Production | $CH_4$ | 56 | 56 | 0.04 | 99.82 |
| 2 | 2.F.8 F-gases Use - Electrical Equipment | $SF_6$ | 31 | 31 | 0.02 | 99.85 |
| 2 | 2.F.7 F-gases Use - Semiconductore Manufacture | PFC, $SF_6$ | 29 | 29 | 0.02 | 99.87 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CH_4$ | 26 | 26 | 0.02 | 99.89 |
| 1A | 1.A.3.b Transport - Road Transportation | $CH_4$ | 25 | 25 | 0.02 | 99.91 |
| 2 | 2.B.5 Other | $CH_4$ | 24 | 24 | 0.02 | 99.92 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $N_2O$ | 23 | 23 | 0.02 | 99.94 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CO_2$ | 13 | 13 | 0.01 | 99.95 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $N_2O$ | 13 | 13 | 0.01 | 99.96 |
| 1A | 1.A.3.d Transport - Navigation | $CO_2$ | 9 | 9 | 0.01 | 99.97 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $N_2O$ | 9 | 9 | 0.01 | 99.97 |
| 1A | 1.A.3.c Transport - Railways | $N_2O$ | 5 | 5 | 0.00 | 99.98 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CO_2$ | 5 | 5 | 0.00 | 99.98 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $N_2O$ | 4 | 4 | 0.00 | 99.98 |
| 6 | 6.C Waste Incineration | $N_2O$ | 4 | 4 | 0.00 | 99.99 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CH_4$ | 3 | 3 | 0.00 | 99.99 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CH_4$ | 3 | 3 | 0.00 | 99.99 |
| 2 | 2.F.9 F-gases Use - Other SF6 | $SF_6$ | 3 | 3 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $N_2O$ | 2 | 2 | 0.00 | 100.00 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CH_4$ | 2 | 2 | 0.00 | 100.00 |
| 2 | 2.A.4 Soda Ash Use | $CO_2$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CH_4$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A.3.c Transport - Railways | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.a Transport - Civil Aviation | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| | TOTAL | | **133 495** | **133 495** | **100** | |

## Tab. A1- 3 Spreadsheet for Tier 1 KC Analysis, 2011 – Trend Assessment including LULUCF

| Cat | IPCC Source Categories | GHG | Abs.,BY, Gg | Abs.,CY, Gg | LA, % | Dif | TA | Rel TA,% | Cum TA,% |
|---|---|---|---|---|---|---|---|---|---|
| 1A | 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 110 713 | 65 099 | 45.80 | -0.273 | 12.51 | 21.65 | 21.65 |
| 1A | 1.A.3.b Transport - Road Transportation | $CO_2$ | 6 239 | 16 124 | 11.34 | 1.041 | 11.81 | 20.44 | 42.09 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 12 165 | 15 181 | 10.68 | 0.626 | 6.69 | 11.58 | 53.67 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 13 518 | 4 965 | 3.49 | -1.295 | 4.52 | 7.83 | 61.51 |
| 5 | 5.A.1 Forest Land remaining Forest Land | $CO_2$ | 4 777 | 7 635 | 5.37 | 0.802 | 4.31 | 7.46 | 68.97 |
| 2 | 2.C.1 Iron and Steel Production | $CO_2$ | 12 533 | 5 623 | 3.96 | -0.801 | 3.17 | 5.49 | 74.45 |
| 1B | 1.B.1.a Coal Mining and Handling | $CH_4$ | 7 601 | 3 283 | 2.31 | -0.888 | 2.05 | 3.55 | 78.00 |
| 6 | 6.A Solid Waste Disposal on Land | $CH_4$ | 1 663 | 2 745 | 1.93 | 0.822 | 1.59 | 2.75 | 80.75 |
| 2 | 2.F.1-6 F-gases Use - ODS substitutes | HFC, PFC | 0 | 1 130 | 0.80 | 1.428 | 1.14 | 1.97 | 82.72 |
| 4 | 4.A Enteric Fermentation | $CH_4$ | 4 219 | 2 003 | 1.41 | -0.679 | 0.96 | 1.66 | 84.37 |
| 4 | 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 5 484 | 2 989 | 2.10 | -0.407 | 0.86 | 1.48 | 85.85 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $CH_4$ | 1 335 | 159 | 0.11 | -6.948 | 0.78 | 1.35 | 87.20 |
| 5 | 5.B.1 Cropland remaining Cropland | $CO_2$ | 1 089 | 61 | 0.04 | -16.366 | 0.70 | 1.22 | 88.42 |
| 4 | 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 3 503 | 1 776 | 1.25 | -0.544 | 0.68 | 1.18 | 89.60 |
| 2 | 2.A.3 Limestone and Dolomite Use | $CO_2$ | 678 | 1 151 | 0.81 | 0.839 | 0.68 | 1.18 | 90.78 |
| 1A | 1.A.3.b Transport - Road Transportation | $N_2O$ | 132 | 660 | 0.46 | 1.228 | 0.57 | 0.99 | 91.77 |
| 4 | 4.B Manure Management | $N_2O$ | 1 708 | 664 | 0.47 | -1.146 | 0.54 | 0.93 | 92.69 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CO_2$ | 0 | 377 | 0.27 | 1.428 | 0.38 | 0.66 | 93.35 |
| 2 | 2.B.2 Nitric Acid Production | $N_2O$ | 1 127 | 418 | 0.29 | -1.265 | 0.37 | 0.64 | 93.99 |
| 4 | 4.B Manure Management | $CH_4$ | 1 001 | 379 | 0.27 | -1.215 | 0.32 | 0.56 | 94.55 |
| 1A | 1.A Stationary Combustion - Biomass | $CH_4$ | 56 | 343 | 0.24 | 1.263 | 0.30 | 0.53 | 95.08 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CO_2$ | 37 | 326 | 0.23 | 1.316 | 0.30 | 0.52 | 95.61 |
| 2 | 2.A.2 Lime Production | $CO_2$ | 1 337 | 691 | 0.49 | -0.506 | 0.25 | 0.43 | 96.03 |
| 5 | 5.C.2 Land converted to Grassland | $CO_2$ | 187 | 331 | 0.23 | 0.864 | 0.20 | 0.35 | 96.38 |
| 1A | 1.A.3.e Transport - Other Transportation | $CO_2$ | 484 | 144 | 0.10 | -1.920 | 0.20 | 0.34 | 96.72 |
| 1A | 1.A.3.c Transport - Railways | $CO_2$ | 651 | 282 | 0.20 | -0.879 | 0.17 | 0.30 | 97.02 |
| 6 | 6.C Waste Incineration | $CO_2$ | 23 | 187 | 0.13 | 1.304 | 0.17 | 0.30 | 97.32 |
| 3 | 3 Solvents and Other Product Use | $CO_2$ | 550 | 237 | 0.17 | -0.895 | 0.15 | 0.26 | 97.58 |
| 5 | 5.A.2 Land converted to Forest Land | $CO_2$ | 280 | 329 | 0.23 | 0.577 | 0.13 | 0.23 | 97.81 |
| 1A | 1.A Stationary Combustion - Biomass | $N_2O$ | 27 | 120 | 0.08 | 1.201 | 0.10 | 0.18 | 97.98 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CO_2$ | 146 | 5 | 0.00 | -28.924 | 0.10 | 0.17 | 98.15 |
| 6 | 6.B Wastewater Handling | $N_2O$ | 162 | 205 | 0.14 | 0.638 | 0.09 | 0.16 | 98.31 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CO_2$ | 326 | 315 | 0.22 | 0.393 | 0.09 | 0.15 | 98.46 |
| 3 | 3 Solvents and Other Product Use | $N_2O$ | 215 | 233 | 0.16 | 0.505 | 0.08 | 0.14 | 98.60 |
| 2 | 2.A.1 Cement Production | $CO_2$ | 2 489 | 1 665 | 1.17 | -0.068 | 0.08 | 0.14 | 98.74 |
| 5 | 5.B.2 Land converted to Cropland | $CO_2$ | 226 | 86 | 0.06 | -1.189 | 0.07 | 0.13 | 98.87 |
| 1B | 1.B.1.a Coal Mining and Handling | $CO_2$ | 456 | 255 | 0.18 | -0.358 | 0.06 | 0.11 | 98.98 |
| 6 | 6.B Wastewater Handling | $CH_4$ | 825 | 516 | 0.36 | -0.172 | 0.06 | 0.11 | 99.09 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $N_2O$ | 495 | 299 | 0.21 | -0.227 | 0.05 | 0.08 | 99.17 |
| 5 | 5.C.1 Grassland remaining Grassland | $CO_2$ | 59 | 2 | 0.00 | -31.065 | 0.04 | 0.07 | 99.24 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CH_4$ | 897 | 666 | 0.47 | 0.080 | 0.04 | 0.07 | 99.30 |
| 2 | 2.B.5 Other | $N_2O$ | 84 | 94 | 0.07 | 0.541 | 0.04 | 0.06 | 99.37 |
| 2 | 2.C.1 Iron and Steel Production | $CH_4$ | 127 | 56 | 0.04 | -0.845 | 0.03 | 0.06 | 99.42 |
| 4 | 4.D.2 Pasture, Range and Padock Manure | $N_2O$ | 317 | 254 | 0.18 | 0.179 | 0.03 | 0.06 | 99.48 |
| 1A | 1.A.3.d Transport - Navigation | $CO_2$ | 56 | 9 | 0.01 | -4.564 | 0.03 | 0.05 | 99.53 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CO_2$ | 1 601 | 1 091 | 0.77 | -0.039 | 0.03 | 0.05 | 99.58 |
| 2 | 2.F.7 F-gases Use - Semiconductore Manufacture | PFC, $SF_6$ | 0 | 29 | 0.02 | 1.428 | 0.03 | 0.05 | 99.63 |
| 5 | 5.E.2 Land converted to Settlements | $CO_2$ | 86 | 87 | 0.06 | 0.444 | 0.03 | 0.05 | 99.68 |
| 2 | 2.F.8 F-gases Use - Electrical Equipment | $SF_6$ | 78 | 31 | 0.02 | -1.062 | 0.02 | 0.04 | 99.72 |
| 5 | 5.D.2. Land converted to Wetlands | $CO_2$ | 23 | 32 | 0.02 | 0.715 | 0.02 | 0.03 | 99.75 |
| 5 | 5.A.1 Forest Land remaining Forest Land | $CH_4$ | 100 | 55 | 0.04 | -0.387 | 0.02 | 0.03 | 99.78 |
| 2 | 2.B.5 Other | $CH_4$ | 15 | 24 | 0.02 | 0.790 | 0.01 | 0.02 | 99.80 |
| 2 | 2.B.1 Ammonia Production | $CO_2$ | 807 | 553 | 0.39 | -0.031 | 0.01 | 0.02 | 99.82 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $N_2O$ | 34 | 13 | 0.01 | -1.270 | 0.01 | 0.02 | 99.84 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CH_4$ | 21 | 26 | 0.02 | 0.628 | 0.01 | 0.02 | 99.86 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CO_2$ | 4 | 13 | 0.01 | 1.115 | 0.01 | 0.02 | 99.88 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $N_2O$ | 20 | 23 | 0.02 | 0.574 | 0.01 | 0.02 | 99.89 |
| 5 | 5.F.2. Land converted to Cropland | $N_2O$ | 21 | 6 | 0.00 | -1.889 | 0.01 | 0.01 | 99.91 |
| 5 | 5G Other - Liming of Forest Land | $CO_2$ | 12 | 0 | 0.00 | -924.641 | 0.01 | 0.01 | 99.92 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CH_4$ | 14 | 3 | 0.00 | -2.734 | 0.01 | 0.01 | 99.93 |
| 1A | 1.A.3.b Transport - Road Transportation | $CH_4$ | 26 | 25 | 0.02 | 0.348 | 0.01 | 0.01 | 99.94 |
| 1A | 1.A.3.a Transport - Civil Aviation | $N_2O$ | 6 | 0 | 0.00 | -28.933 | 0.00 | 0.01 | 99.95 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $N_2O$ | 7 | 9 | 0.01 | 0.621 | 0.00 | 0.01 | 99.96 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $N_2O$ | 0 | 4 | 0.00 | 1.316 | 0.00 | 0.01 | 99.96 |
| 2 | 2.F.9 F-gases Use - Other SF6 | $SF_6$ | 0 | 3 | 0.00 | 1.428 | 0.00 | 0.01 | 99.97 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CH_4$ | 7 | 2 | 0.00 | -2.957 | 0.00 | 0.01 | 99.97 |
| 6 | 6.C Waste Incineration | $N_2O$ | 0 | 4 | 0.00 | 1.304 | 0.00 | 0.01 | 99.98 |
| 1A | 1.A.3.c Transport - Railways | $N_2O$ | 12 | 5 | 0.00 | -0.879 | 0.00 | 0.01 | 99.99 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $N_2O$ | 0 | 2 | 0.00 | 1.428 | 0.00 | 0.00 | 99.99 |
| 5 | 5.A.1 Forest Land remaining Forest Land | $N_2O$ | 10 | 6 | 0.00 | -0.387 | 0.00 | 0.00 | 99.99 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CH_4$ | 3 | 3 | 0.00 | 0.568 | 0.00 | 0.00 | 99.99 |
| 2 | 2.A.4 Soda Ash Use | $CO_2$ | 0 | 1 | 0.00 | 1.428 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CH_4$ | 0 | 1 | 0.00 | 1.428 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $N_2O$ | 1 | 0 | 0.00 | -4.564 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CH_4$ | 1 | 0 | 0.00 | -30.571 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $CH_4$ | 1 | 0 | 0.00 | -1.943 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.c Transport - Railways | $CH_4$ | 1 | 0 | 0.00 | -0.879 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $N_2O$ | 0 | 0 | 0.00 | -1.943 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $CH_4$ | 0 | 0 | 0.00 | -4.564 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CH_4$ | 0 | 0 | 0.00 | 1.316 | 0.00 | 0.00 | 100.00 |
| 5 | 5.D.1 Wetlands remaining Wetlands | $CO_2$ | 0 | 0 | 0.00 | | 0.00 | 0.00 | 100.00 |
| 5 | 5.E.1 Settlements remaining Settlements | $CO_2$ | 0 | 0 | 0.00 | | 0.00 | 0.00 | 100.00 |
| 5 | 5.F.1 Other Land remaining Other Land | $CO_2$ | 0 | 0 | 0.00 | | 0.00 | 0.00 | 100.00 |
| | TOTAL | | **202 909** | **142 126** | **100** | | **57.76** | **100.00** | |

**Tab. A1- 4 Spreadsheet for Tier 1 KC Analysis, 2011 – Trend Assessment excluding LULUCF**

| Cat | IPCC Source Categories | GHG | Em / BY, Gg | Em / CY, Gg | Rel, % | Dif | TA | Rel TA,% | Cum TA,% |
|---|---|---|---|---|---|---|---|---|---|
| 1A | 1.A.3.b Transport - Road Transportation | $CO_2$ | 6 239 | 16 124 | 12.08 | 1.082 | 13.06 | 24.19 | 24.19 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 110 713 | 65 099 | 48.76 | -0.232 | 11.32 | 20.97 | 45.17 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 12 165 | 15 181 | 11.37 | 0.667 | 7.59 | 14.05 | 59.22 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 13 518 | 4 965 | 3.72 | -1.254 | 4.66 | 8.64 | 67.86 |
| 2 | 2.C.1 Iron and Steel Production | $CO_2$ | 12 533 | 5 623 | 4.21 | -0.760 | 3.20 | 5.93 | 73.79 |
| 1B | 1.B.1.a Coal Mining and Handling | $CH_4$ | 7 601 | 3 283 | 2.46 | -0.847 | 2.08 | 3.86 | 77.65 |
| 6 | 6.A Solid Waste Disposal on Land | $CH_4$ | 1 663 | 2 745 | 2.06 | 0.863 | 1.77 | 3.29 | 80.93 |
| 2 | 2.F.1-6 F-gases Use - ODS substitutes | HFC, PFC | 0 | 1 130 | 0.85 | 1.469 | 1.24 | 2.30 | 83.23 |
| 4 | 4.A Enteric Fermentation | $CH_4$ | 4 219 | 2 003 | 1.50 | -0.638 | 0.96 | 1.77 | 85.01 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $CH_4$ | 1 335 | 159 | 0.12 | -6.907 | 0.82 | 1.53 | 86.53 |
| 4 | 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 5 484 | 2 989 | 2.24 | -0.366 | 0.82 | 1.52 | 88.05 |
| 2 | 2.A.3 Limestone and Dolomite Use | $CO_2$ | 678 | 1 151 | 0.86 | 0.880 | 0.76 | 1.41 | 89.46 |
| 4 | 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 3 503 | 1 776 | 1.33 | -0.504 | 0.67 | 1.24 | 90.70 |
| 1A | 1.A.3.b Transport - Road Transportation | $N_2O$ | 132 | 660 | 0.49 | 1.269 | 0.63 | 1.16 | 91.86 |
| 4 | 4.B Manure Management | $N_2O$ | 1 708 | 664 | 0.50 | -1.105 | 0.55 | 1.02 | 92.88 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CO_2$ | 0 | 377 | 0.28 | 1.469 | 0.42 | 0.77 | 93.65 |
| 2 | 2.B.2 Nitric Acid Production | $N_2O$ | 1 127 | 418 | 0.31 | -1.224 | 0.38 | 0.71 | 94.36 |
| 1A | 1.A Stationary Combustion - Biomass | $CH_4$ | 56 | 343 | 0.26 | 1.304 | 0.33 | 0.62 | 94.98 |
| 4 | 4.B Manure Management | $CH_4$ | 1 001 | 379 | 0.28 | -1.174 | 0.33 | 0.62 | 95.60 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CO_2$ | 37 | 326 | 0.24 | 1.357 | 0.33 | 0.61 | 96.21 |
| 2 | 2.A.2 Lime Production | $CO_2$ | 1 337 | 691 | 0.52 | -0.465 | 0.24 | 0.45 | 96.66 |
| 1A | 1.A.3.e Transport - Other Transportation | $CO_2$ | 484 | 144 | 0.11 | -1.879 | 0.20 | 0.38 | 97.03 |
| 6 | 6.C Waste Incineration | $CO_2$ | 23 | 187 | 0.14 | 1.345 | 0.19 | 0.35 | 97.38 |
| 1A | 1.A.3.c Transport - Railways | $CO_2$ | 651 | 282 | 0.21 | -0.838 | 0.18 | 0.33 | 97.71 |
| 3 | 3 Solvents and Other Product Use | $CO_2$ | 550 | 237 | 0.18 | -0.854 | 0.15 | 0.28 | 97.99 |
| 1A | 1.A Stationary Combustion - Biomass | $N_2O$ | 27 | 120 | 0.09 | 1.242 | 0.11 | 0.21 | 98.20 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CO_2$ | 146 | 5 | 0.00 | -28.884 | 0.10 | 0.19 | 98.39 |
| 6 | 6.B Wastewater Handling | $N_2O$ | 162 | 205 | 0.15 | 0.679 | 0.10 | 0.19 | 98.58 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CO_2$ | 326 | 315 | 0.24 | 0.434 | 0.10 | 0.19 | 98.77 |
| 3 | 3 Solvents and Other Product Use | $N_2O$ | 215 | 233 | 0.17 | 0.546 | 0.10 | 0.18 | 98.95 |
| 1B | 1.B.1.a Coal Mining and Handling | $CO_2$ | 456 | 255 | 0.19 | -0.318 | 0.06 | 0.11 | 99.06 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CH_4$ | 897 | 666 | 0.50 | 0.121 | 0.06 | 0.11 | 99.18 |
| 6 | 6.B Wastewater Handling | $CH_4$ | 825 | 516 | 0.39 | -0.131 | 0.05 | 0.09 | 99.27 |
| 4 | 4.D.2 Pasture, Range and Padock Manure | $N_2O$ | 317 | 254 | 0.19 | 0.220 | 0.04 | 0.08 | 99.35 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $N_2O$ | 495 | 299 | 0.22 | -0.186 | 0.04 | 0.08 | 99.42 |
| 2 | 2.B.5 Other | $N_2O$ | 84 | 94 | 0.07 | 0.582 | 0.04 | 0.08 | 99.50 |
| 2 | 2.C.1 Iron and Steel Production | $CH_4$ | 127 | 56 | 0.04 | -0.804 | 0.03 | 0.06 | 99.56 |
| 2 | 2.A.1 Cement Production | $CO_2$ | 2 489 | 1 665 | 1.25 | -0.027 | 0.03 | 0.06 | 99.62 |
| 2 | 2.F.7 F-gases Use - Semiconductore Manufacture | PFC, $SF_6$ | 0 | 29 | 0.02 | 1.469 | 0.03 | 0.06 | 99.68 |
| 1A | 1.A.3.d Transport - Navigation | $CO_2$ | 56 | 9 | 0.01 | -4.523 | 0.03 | 0.06 | 99.74 |
| 2 | 2.F.8 F-gases Use - Electrical Equipment | $SF_6$ | 78 | 31 | 0.02 | -1.021 | 0.02 | 0.04 | 99.79 |
| 2 | 2.B.5 Other | $CH_4$ | 15 | 24 | 0.02 | 0.831 | 0.01 | 0.03 | 99.82 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CH_4$ | 21 | 26 | 0.02 | 0.669 | 0.01 | 0.02 | 99.84 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $N_2O$ | 34 | 13 | 0.01 | -1.229 | 0.01 | 0.02 | 99.86 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CO_2$ | 4 | 13 | 0.01 | 1.156 | 0.01 | 0.02 | 99.88 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $N_2O$ | 20 | 23 | 0.02 | 0.615 | 0.01 | 0.02 | 99.90 |
| 1A | 1.A.3.b Transport - Road Transportation | $CH_4$ | 26 | 25 | 0.02 | 0.389 | 0.01 | 0.01 | 99.91 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CH_4$ | 14 | 3 | 0.00 | -2.693 | 0.01 | 0.01 | 99.93 |
| 1A | 1.A.3.a Transport - Civil Aviation | $N_2O$ | 6 | 0 | 0.00 | -28.892 | 0.00 | 0.01 | 99.94 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $N_2O$ | 7 | 9 | 0.01 | 0.662 | 0.00 | 0.01 | 99.94 |
| 2 | 2.B.1 Ammonia Production | $CO_2$ | 807 | 553 | 0.41 | 0.009 | 0.00 | 0.01 | 99.95 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $N_2O$ | 0 | 4 | 0.00 | 1.357 | 0.00 | 0.01 | 99.96 |
| 2 | 2.F.9 F-gases Use - Other SF6 | $SF_6$ | 0 | 3 | 0.00 | 1.469 | 0.00 | 0.01 | 99.96 |
| 6 | 6.C Waste Incineration | $N_2O$ | 0 | 4 | 0.00 | 1.345 | 0.00 | 0.01 | 99.97 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CH_4$ | 7 | 2 | 0.00 | -2.916 | 0.00 | 0.01 | 99.98 |
| 1A | 1.A.3.c Transport - Railways | $N_2O$ | 12 | 5 | 0.00 | -0.838 | 0.00 | 0.01 | 99.98 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $N_2O$ | 0 | 2 | 0.00 | 1.469 | 0.00 | 0.00 | 99.99 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CH_4$ | 3 | 3 | 0.00 | 0.609 | 0.00 | 0.00 | 99.99 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CO_2$ | 1 601 | 1 091 | 0.82 | 0.002 | 0.00 | 0.00 | 99.99 |
| 2 | 2.A.4 Soda Ash Use | $CO_2$ | 0 | 1 | 0.00 | 1.469 | 0.00 | 0.00 | 99.99 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CH_4$ | 0 | 1 | 0.00 | 1.469 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $N_2O$ | 1 | 0 | 0.00 | -4.523 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CH_4$ | 1 | 0 | 0.00 | -30.531 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $CH_4$ | 1 | 0 | 0.00 | -1.902 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.c Transport - Railways | $CH_4$ | 1 | 0 | 0.00 | -0.838 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $N_2O$ | 0 | 0 | 0.00 | -1.902 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $CH_4$ | 0 | 0 | 0.00 | -4.523 | 0.00 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CH_4$ | 0 | 0 | 0.00 | 1.357 | 0.00 | 0.00 | 100.00 |
| | TOTAL | | **196 039** | **133 495** | **100** | | **53.99** | **100.00** | |

## Tab. A1- 5 Spreadsheet for Tier 1 KC Analysis, 1990 – Level Assessment including LULUCF

| Cat | IPCC Source Categories | GHG | Em or Rem, Gg | Absol., Gg | LA, % | Cumul, % |
|---|---|---|---|---|---|---|
| 1A | 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 110 713 | 110 713 | 54.56 | 54.56 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 13 518 | 13 518 | 6.66 | 61.23 |
| 2 | 2.C.1 Iron and Steel Production | $CO_2$ | 12 533 | 12 533 | 6.18 | 67.40 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 12 165 | 12 165 | 6.00 | 73.40 |
| 1B | 1.B.1.a Coal Mining and Handling | $CH_4$ | 7 601 | 7 601 | 3.75 | 77.14 |
| 1A | 1.A.3.b Transport - Road Transportation | $CO_2$ | 6 239 | 6 239 | 3.07 | 80.22 |
| 4 | 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 5 484 | 5 484 | 2.70 | 82.92 |
| 5 | 5.A.1 Forest Land remaining Forest Land | $CO_2$ | -4 777 | 4 777 | 2.35 | 85.27 |
| 4 | 4.A Enteric Fermentation | $CH_4$ | 4 219 | 4 219 | 2.08 | 87.35 |
| 4 | 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 3 503 | 3 503 | 1.73 | 89.08 |
| 2 | 2.A.1 Cement Production | $CO_2$ | 2 489 | 2 489 | 1.23 | 90.31 |
| 4 | 4.B Manure Management | $N_2O$ | 1 708 | 1 708 | 0.84 | 91.15 |
| 6 | 6.A Solid Waste Disposal on Land | $CH_4$ | 1 663 | 1 663 | 0.82 | 91.97 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CO_2$ | 1 601 | 1 601 | 0.79 | 92.76 |
| 2 | 2.A.2 Lime Production | $CO_2$ | 1 337 | 1 337 | 0.66 | 93.42 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $CH_4$ | 1 335 | 1 335 | 0.66 | 94.07 |
| 2 | 2.B.2 Nitric Acid Production | $N_2O$ | 1 127 | 1 127 | 0.56 | 94.63 |
| 5 | 5.B.1 Cropland remaining Cropland | $CO_2$ | 1 089 | 1 089 | 0.54 | 95.17 |
| 4 | 4.B Manure Management | $CH_4$ | 1 001 | 1 001 | 0.49 | 95.66 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CH_4$ | 897 | 897 | 0.44 | 96.10 |
| 6 | 6.B Wastewater Handling | $CH_4$ | 825 | 825 | 0.41 | 96.51 |
| 2 | 2.B.1 Ammonia Production | $CO_2$ | 807 | 807 | 0.40 | 96.91 |
| 2 | 2.A.3 Limestone and Dolomite Use | $CO_2$ | 678 | 678 | 0.33 | 97.24 |
| 1A | 1.A.3.c Transport - Railways | $CO_2$ | 651 | 651 | 0.32 | 97.56 |
| 3 | 3 Solvents and Other Product Use | $CO_2$ | 550 | 550 | 0.27 | 97.83 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $N_2O$ | 495 | 495 | 0.24 | 98.08 |
| 1A | 1.A.3.e Transport - Other Transportation | $CO_2$ | 484 | 484 | 0.24 | 98.31 |
| 1B | 1.B.1.a Coal Mining and Handling | $CO_2$ | 456 | 456 | 0.22 | 98.54 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CO_2$ | 326 | 326 | 0.16 | 98.70 |
| 4 | 4.D.2 Pasture, Range and Padock Manure | $N_2O$ | 317 | 317 | 0.16 | 98.86 |
| 5 | 5.A.2 Land converted to Forest Land | $CO_2$ | -280 | 280 | 0.14 | 98.99 |
| 5 | 5.B.2 Land converted to Cropland | $CO_2$ | 226 | 226 | 0.11 | 99.11 |
| 3 | 3 Solvents and Other Product Use | $N_2O$ | 215 | 215 | 0.11 | 99.21 |
| 5 | 5.C.2 Land converted to Grassland | $CO_2$ | -187 | 187 | 0.09 | 99.30 |
| 6 | 6.B Wastewater Handling | $N_2O$ | 162 | 162 | 0.08 | 99.38 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CO_2$ | 146 | 146 | 0.07 | 99.46 |
| 1A | 1.A.3.b Transport - Road Transportation | $N_2O$ | 132 | 132 | 0.06 | 99.52 |
| 2 | 2.C.1 Iron and Steel Production | $CH_4$ | 127 | 127 | 0.06 | 99.58 |
| 5 | 5.A.1 Forest Land remaining Forest Land | $CH_4$ | 100 | 100 | 0.05 | 99.63 |
| 5 | 5.E.2 Land converted to Settlements | $CO_2$ | 86 | 86 | 0.04 | 99.67 |
| 2 | 2.B.5 Other | $N_2O$ | 84 | 84 | 0.04 | 99.72 |
| 2 | 2.F.8 F-gases Use - Electrical Equipment | $SF_6$ | 78 | 78 | 0.04 | 99.75 |
| 5 | 5.C.1 Grassland remaining Grassland | $CO_2$ | 59 | 59 | 0.03 | 99.78 |
| 1A | 1.A Stationary Combustion - Biomass | $CH_4$ | 56 | 56 | 0.03 | 99.81 |
| 1A | 1.A.3.d Transport - Navigation | $CO_2$ | 56 | 56 | 0.03 | 99.84 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CO_2$ | 37 | 37 | 0.02 | 99.86 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $N_2O$ | 34 | 34 | 0.02 | 99.87 |
| 1A | 1.A Stationary Combustion - Biomass | $N_2O$ | 27 | 27 | 0.01 | 99.89 |
| 1A | 1.A.3.b Transport - Road Transportation | $CH_4$ | 26 | 26 | 0.01 | 99.90 |
| 6 | 6.C Waste Incineration | $CO_2$ | 23 | 23 | 0.01 | 99.91 |
| 5 | 5.D.2. Land converted to Wetlands | $CO_2$ | 23 | 23 | 0.01 | 99.92 |
| 5 | 5.F.2. Land converted to Cropland | $N_2O$ | 21 | 21 | 0.01 | 99.93 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CH_4$ | 21 | 21 | 0.01 | 99.94 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $N_2O$ | 20 | 20 | 0.01 | 99.95 |
| 2 | 2.B.5 Other | $CH_4$ | 15 | 15 | 0.01 | 99.96 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CH_4$ | 14 | 14 | 0.01 | 99.97 |
| 5 | 5G Other - Liming of Forest Land | $CO_2$ | 12 | 12 | 0.01 | 99.97 |
| 1A | 1.A.3.c Transport - Railways | $N_2O$ | 12 | 12 | 0.01 | 99.98 |
| 5 | 5.A.1 Forest Land remaining Forest Land | $N_2O$ | 10 | 10 | 0.01 | 99.98 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CH_4$ | 7 | 7 | 0.00 | 99.99 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $N_2O$ | 7 | 7 | 0.00 | 99.99 |
| 1A | 1.A.3.a Transport - Civil Aviation | $N_2O$ | 6 | 6 | 0.00 | 99.99 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CO_2$ | 4 | 4 | 0.00 | 100.00 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CH_4$ | 3 | 3 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $N_2O$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $CH_4$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A.3.c Transport - Railways | $CH_4$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CH_4$ | 1 | 1 | 0.00 | 100.00 |
| 6 | 6.C Waste Incineration | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 2 | 2.F.1-6 F-gases Use - ODS substitutes | HFC, PFC | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| 2 | 2.F.7 F-gases Use - Semiconductore Manufacture | PFC, $SF_6$ | 0 | 0 | 0.00 | 100.00 |
| 2 | 2.F.9 F-gases Use - Other SF6 | $SF_6$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 2 | 2.A.4 Soda Ash Use | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 5 | 5.D.1 Wetlands remaining Wetlands | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| 5 | 5.E.1 Settlements remaining Settlements | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| 5 | 5.F.1 Other Land remaining Other Land | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| | TOTAL | | **192 421** | **202 909** | **100** | |

**Tab. A1- 6 Spreadsheet for Tier 1 KC Analysis, 1990 – Level Assessment excluding LULUCF**

| Cat | IPCC Source Categories | GHG | Emissions, Gg | Absol., Gg | LA, % | Cumul, % |
|---|---|---|---|---|---|---|
| 1A | 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 110 713 | 110 713 | 56.48 | 56.48 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 13 518 | 13 518 | 6.90 | 63.37 |
| 2 | 2.C.1 Iron and Steel Production | $CO_2$ | 12 533 | 12 533 | 6.39 | 69.76 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 12 165 | 12 165 | 6.21 | 75.97 |
| 1B | 1.B.1.a Coal Mining and Handling | $CH_4$ | 7 601 | 7 601 | 3.88 | 79.85 |
| 1A | 1.A.3.b Transport - Road Transportation | $CO_2$ | 6 239 | 6 239 | 3.18 | 83.03 |
| 4 | 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 5 484 | 5 484 | 2.80 | 85.83 |
| 4 | 4.A Enteric Fermentation | $CH_4$ | 4 219 | 4 219 | 2.15 | 87.98 |
| 4 | 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 3 503 | 3 503 | 1.79 | 89.77 |
| 2 | 2.A.1 Cement Production | $CO_2$ | 2 489 | 2 489 | 1.27 | 91.03 |
| 4 | 4.B Manure Management | $N_2O$ | 1 708 | 1 708 | 0.87 | 91.91 |
| 6 | 6.A Solid Waste Disposal on Land | $CH_4$ | 1 663 | 1 663 | 0.85 | 92.75 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CO_2$ | 1 601 | 1 601 | 0.82 | 93.57 |
| 2 | 2.A.2 Lime Production | $CO_2$ | 1 337 | 1 337 | 0.68 | 94.25 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $CH_4$ | 1 335 | 1 335 | 0.68 | 94.93 |
| 2 | 2.B.2 Nitric Acid Production | $N_2O$ | 1 127 | 1 127 | 0.57 | 95.51 |
| 4 | 4.B Manure Management | $CH_4$ | 1 001 | 1 001 | 0.51 | 96.02 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CH_4$ | 897 | 897 | 0.46 | 96.48 |
| 6 | 6.B Wastewater Handling | $CH_4$ | 825 | 825 | 0.42 | 96.90 |
| 2 | 2.B.1 Ammonia Production | $CO_2$ | 807 | 807 | 0.41 | 97.31 |
| 2 | 2.A.3 Limestone and Dolomite Use | $CO_2$ | 678 | 678 | 0.35 | 97.66 |
| 1A | 1.A.3.c Transport - Railways | $CO_2$ | 651 | 651 | 0.33 | 97.99 |
| 3 | 3 Solvents and Other Product Use | $CO_2$ | 550 | 550 | 0.28 | 98.27 |
| 1A | 1.A Stationary Combustion - Solid Fuels | $N_2O$ | 495 | 495 | 0.25 | 98.52 |
| 1A | 1.A.3.e Transport - Other Transportation | $CO_2$ | 484 | 484 | 0.25 | 98.77 |
| 1B | 1.B.1.a Coal Mining and Handling | $CO_2$ | 456 | 456 | 0.23 | 99.00 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CO_2$ | 326 | 326 | 0.17 | 99.17 |
| 4 | 4.D.2 Pasture, Range and Padock Manure | $N_2O$ | 317 | 317 | 0.16 | 99.33 |
| 3 | 3 Solvents and Other Product Use | $N_2O$ | 215 | 215 | 0.11 | 99.44 |
| 6 | 6.B Wastewater Handling | $N_2O$ | 162 | 162 | 0.08 | 99.52 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CO_2$ | 146 | 146 | 0.07 | 99.59 |
| 1A | 1.A.3.b Transport - Road Transportation | $N_2O$ | 132 | 132 | 0.07 | 99.66 |
| 2 | 2.C.1 Iron and Steel Production | $CH_4$ | 127 | 127 | 0.06 | 99.73 |
| 2 | 2.B.5 Other | $N_2O$ | 84 | 84 | 0.04 | 99.77 |
| 2 | 2.F.8 F-gases Use - Electrical Equipment | $SF_6$ | 78 | 78 | 0.04 | 99.81 |
| 1A | 1.A Stationary Combustion - Biomass | $CH_4$ | 56 | 56 | 0.03 | 99.84 |
| 1A | 1.A.3.d Transport - Navigation | $CO_2$ | 56 | 56 | 0.03 | 99.87 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CO_2$ | 37 | 37 | 0.02 | 99.89 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $N_2O$ | 34 | 34 | 0.02 | 99.90 |
| 1A | 1.A Stationary Combustion - Biomass | $N_2O$ | 27 | 27 | 0.01 | 99.92 |
| 1A | 1.A.3.b Transport - Road Transportation | $CH_4$ | 26 | 26 | 0.01 | 99.93 |
| 6 | 6.C Waste Incineration | $CO_2$ | 23 | 23 | 0.01 | 99.94 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $CH_4$ | 21 | 21 | 0.01 | 99.95 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $N_2O$ | 20 | 20 | 0.01 | 99.96 |
| 2 | 2.B.5 Other | $CH_4$ | 15 | 15 | 0.01 | 99.97 |
| 1A | 1.A Stationary Combustion - Liquid Fuels | $CH_4$ | 14 | 14 | 0.01 | 99.98 |
| 1A | 1.A.3.c Transport - Railways | $N_2O$ | 12 | 12 | 0.01 | 99.98 |
| 1A | 1.A.5.b Mobile sources in Agriculture and Forestry | $CH_4$ | 7 | 7 | 0.00 | 99.99 |
| 1A | 1.A Stationary Combustion - Gaseous Fuels | $N_2O$ | 7 | 7 | 0.00 | 99.99 |
| 1A | 1.A.3.a Transport - Civil Aviation | $N_2O$ | 6 | 6 | 0.00 | 99.99 |
| 1B | 1.B.1.b Fugitive Emission from Oil, Natural Gas and Other | $CO_2$ | 4 | 4 | 0.00 | 100.00 |
| 2 | 2.A.7 Glass, Bricks and Ceramics | $CH_4$ | 3 | 3 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $N_2O$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $CH_4$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A.3.c Transport - Railways | $CH_4$ | 1 | 1 | 0.00 | 100.00 |
| 1A | 1.A.3.a Transport - Civil Aviation | $CH_4$ | 1 | 1 | 0.00 | 100.00 |
| 6 | 6.C Waste Incineration | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.e Transport - Other Transportation | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A.3.d Transport - Navigation | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - MSW | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| 2 | 2.F.1-6 F-gases Use - ODS substitutes | HFC, PFC | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| 2 | 2.F.7 F-gases Use - Semiconductore Manufacture | PFC, $SF_6$ | 0 | 0 | 0.00 | 100.00 |
| 2 | 2.F.9 F-gases Use - Other SF6 | $SF_6$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $N_2O$ | 0 | 0 | 0.00 | 100.00 |
| 2 | 2.A.4 Soda Ash Use | $CO_2$ | 0 | 0 | 0.00 | 100.00 |
| 1A | 1.A Stationary Combustion - Other fuels - 1A2 | $CH_4$ | 0 | 0 | 0.00 | 100.00 |
| | TOTAL | | **196 039** | **196 039** | **100** | |

# Annex 2: Detailed discussion of methodology and data for estimating $CO_2$ emissions from fossil fuel combustion

## 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.

The net calorific value of Natural Gas can be computed on the basis of the molar composition according to

$$Q_m = \sum w_i \bullet Q_{mi} \quad \text{(A2-1)}$$

$$Q_v = Q_m \bullet d \quad \text{(A2-2)}$$

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. A2- 1 lists the net calorific values of the basic components of Natural Gas.

**Tab. A2- 1 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

$$CEF_{TJ} = CEF_m / Q_m \quad \text{(A2-3)}$$

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

$$EF\,(CO_2) = CEF_{TJ} \bullet M_{CO2} / M_C \quad \text{(A2-4)}$$

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

$$EF\ (CO_2) = 0.269 \bullet (Q_v/3.6)^2 - 2.988 \bullet (Q_v/3.6) + 59.212 \qquad \text{(A2-5)}$$

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.

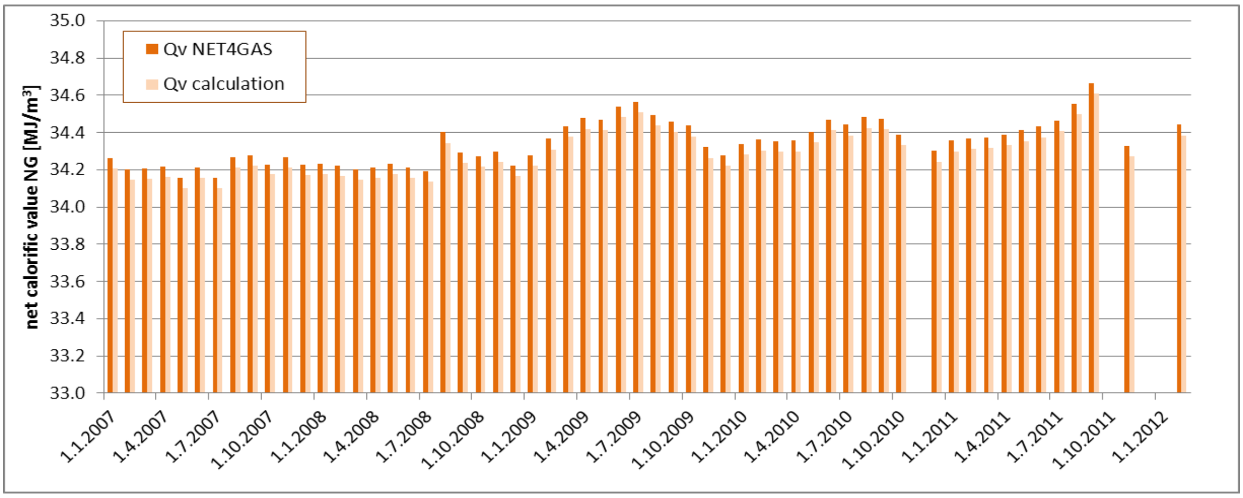


**Fig. A2- 1 Net calorific values given in NET4GAS Ltd. reports and net calorific values calculated on the basis of composition of Natural Gas in 1.1.2007 – 1.2.2012 (both values are given at 15°C)**

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

$$EF\ (CO_2) = 0.787 \bullet Q_v + 28.21 \qquad \text{(A2-6)}$$

where $Q_v$ [MJ/m$^3$] is the net calorific value of Natural Gas at 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 processed by RWE Transgas were used for comparison. This dataset contains data from 2003, 2004 and 2009 and evaluation of findings resulted in the correlation

$$EF\ (CO_2) = 0.6876 \bullet Q_v + 31.619 \qquad \text{(A2-7))}$$

The second source for comparison is the work of Čapla and Havlát (2006), where the correlation resulted in equation (A2-5).

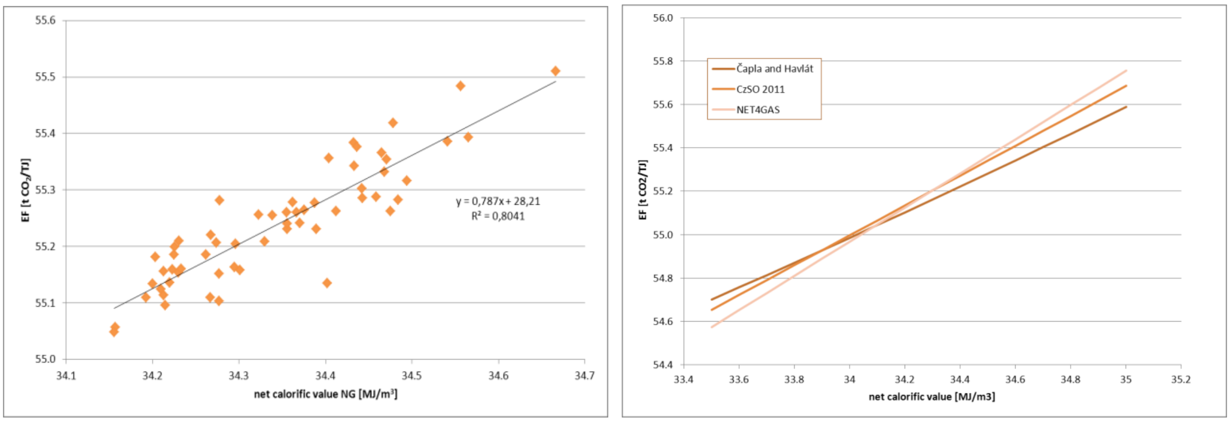


**Fig. A2- 2 Correlation of EF [t $CO_2$/TJ] and net calorific value of Natural Gas and Comparison of three approaches used for calculation**

Fig. A2- 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. A2- 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. A2- 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.

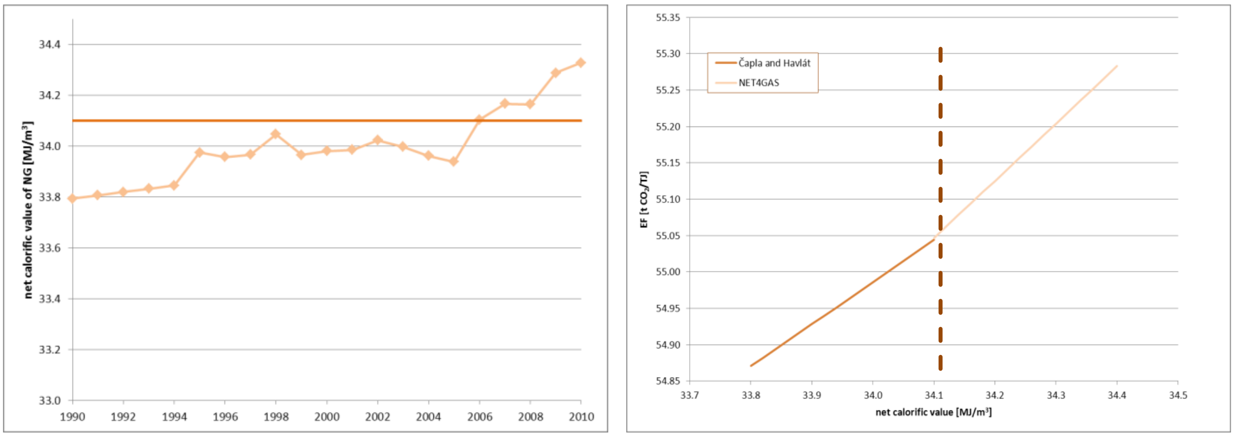


**Fig. A2- 3 Trend in Natural Gas NCV 1990 – 2010 and Correlation between NCV and EF combined from two approaches – Čapla and Havlát (NCV lower than 34.1 MJ/m$^3$) and computed correlation on the basis of NET4GAS dataset (NCV higher than 34.1 MJ/m$^3$)**

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. A2- 2 lists all the calculated emission factors for both correlations; the recommended values are in bold.

**Tab. A2- 2 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. 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 2011 the correlation relation based on the NET4GAS, Ltd. dataset was used (eq. A2-6):

$$EF\ (CO_2) = 0.787 \bullet Qv + 28.21$$

The availability of analyses of the Natural Gas composition should be ensured in the coming years. Only then could correlation between emission factor and net calorific value be determined; this should then be used for calculation of the specific emission factor for the specific year. If these analyses will not be available, the correlation for 2011 can be used. However, in this case, it would be necessary to obtain new data on analyses that could be used for the inventory year 2013 (2015 submission).

Starting with this submission updated emission factors will be used for all categories in 1A Energy, so this recalculation affects the whole Energy sector.

For other detailed discussion of methodology and data for estimating $CO_2$ emissions from fossil fuel combustion please see the discussion of methodology in Chapter 3.4 and in the Annex 4.

# Annex 3: Other detailed methodological descriptions for individual source or sink categories, *including for KP-LULUCF activities*

## Methodology for Road Transport (1A3b)

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).*

*Location: http://www.cdv.cz/metodiky/*

# Annex 4: $CO_2$ Reference Approach and comparison with Sectoral Approach, and relevant information on the national energy balance

The IPCC Reference Approach (IPCC, 1997) is based on determining carbon dioxide emissions from domestic consumption of individual fuels (called also as apparent consumption).

In CRF Reporter are in category 1AD *Feedstock and non-energy use of fuels* included also consumptions of fuels which are for the purpose of inventory transferred to other sectors (in Czech Republic it means sectors 2C, 2B and 3). The carbon contained in Coke consumed in blast furnaces, Other oil for $NH_3$ production and Other Oil in Solvents is then in CRF Reporter automatically deducted from the Reference Approach. The TJ from the fuels in 1AD are then subtracted from the Reference Approach and the final value corresponds to the Apparent energy consumption. So the formula for calculating Apparent energy consumption is

*Reference Approach – TJ(fixed) in 1AD = Apparent energy consumption*.

Tab. A4- 1 and Tab. A4- 2 provide overview of 1AD category.

The difference of activity data between Reference and Sectoral Approaches is presented in Tab. A4- 3.

**Tab. A4- 1 1AD Feedstock and non-energy use of fuels – fuel consumption**

| | Naphtha [TJ] | Naphtha Fraction of carbon stored | Naphtha - fixed [TJ] | Lubricants [TJ] | Lubricants Fraction of carbon stored | Lubricants - fixed [TJ] | Bitumen [TJ] | Bitumen Fraction of carbon stored | Bitumen - fixed [TJ] |
|---|---|---|---|---|---|---|---|---|---|
| **1990** | 22 614 | 0.5 | 11 307 | 17 788 | 0.5 | 8 894 | 10 902 | 1 | 10 902 |
| **1991** | 21 521 | 0.5 | 10 761 | 3 524 | 0.5 | 1 762 | 14 665 | 1 | 14 665 |
| **1992** | 23 441 | 0.5 | 11 721 | 6 300 | 0.5 | 3 150 | 13 497 | 1 | 13 497 |
| **1993** | 26 965 | 0.5 | 13 483 | 4 252 | 0.5 | 2 126 | 15 683 | 1 | 15 683 |
| **1994** | 26 064 | 0.5 | 13 032 | 12 515 | 0.5 | 6 258 | 7 670 | 1 | 7 670 |
| **1995** | 22 543 | 0.5 | 11 272 | 6 752 | 0.5 | 3 376 | 14 349 | 1 | 14 349 |
| **1996** | 26 875 | 0.5 | 13 437 | 5 788 | 0.5 | 2 894 | 10 048 | 1 | 10 048 |
| **1997** | 24 733 | 0.5 | 12 366 | 5 145 | 0.5 | 2 572 | 7 396 | 1 | 7 396 |
| **1998** | 26 269 | 0.5 | 13 135 | 7 998 | 0.5 | 3 999 | 14 791 | 1 | 14 791 |
| **1999** | 30 187 | 0.5 | 15 094 | 7 677 | 0.5 | 3 838 | 14 630 | 1 | 14 630 |
| **2000** | 24 411 | 0.5 | 12 205 | 9 164 | 0.5 | 4 582 | 15 193 | 1 | 15 193 |
| **2001** | 29 343 | 0.5 | 14 672 | 7 355 | 0.5 | 3 678 | 14 992 | 1 | 14 992 |
| **2002** | 25 929 | 0.5 | 12 965 | 6 350 | 0.5 | 3 175 | 16 037 | 1 | 16 037 |
| **2003** | 26 580 | 0.5 | 13 290 | 6 511 | 0.5 | 3 256 | 18 851 | 1 | 18 851 |
| **2004** | 34 101 | 0.6 | 20 461 | 7 476 | 0.5 | 3 738 | 21 342 | 1 | 21 342 |
| **2005** | 37 957 | 0.7 | 26 570 | 7 596 | 0.5 | 3 798 | 21 584 | 1 | 21 584 |
| **2006** | 34 101 | 0.8 | 27 281 | 7 717 | 0.5 | 3 859 | 24 598 | 1 | 24 598 |
| **2007** | 30 623 | 0.8 | 24 498 | 8 481 | 0.5 | 4 240 | 21 825 | 1 | 21 825 |
| **2008** | 37 358 | 0.8 | 29 887 | 6 230 | 0.5 | 3 115 | 22 388 | 1 | 22 388 |
| **2009** | 34 235 | 0.8 | 27 388 | 5 426 | 0.5 | 2 713 | 18 569 | 1 | 18 569 |
| **2010** | 40 312 | 0.8 | 32 250 | 6 350 | 0.5 | 3 175 | 17 203 | 1 | 17 203 |
| **2011** | 37 112 | 0.8 | 29 689 | 7 114 | 0.5 | 3 557 | 16 640 | 1 | 16 640 |

*Liquid Fuels: Naphtha-fixed [TJ] + Lubricants -fixed [TJ] + Bitumen [TJ] + Other Oil ($NH_3$) [TJ] + Other Oil (Solvents) [TJ]*
*Solid Fuels : Coal Oils and Tars - fixed [TJ] + Coke consumed in blast furnaces [TJ]*

**Tab. A4- 2 1AD Feedstock and non-energy use of fuels – fuel consumption**

| | Coal Oils and Tars [TJ] | Coal Oils and Tars Fraction of carbon stored | Coal Oils and Tars - fixed [TJ] | Coke in BF [TJ] | Coke in BF Fraction of carbon stored | Coke in BF - fixed [TJ] | Other Oil ($NH_3$) [TJ] | Other Oil ($NH_3$) Fraction of carbon stored | Other Oil ($NH_3$) - fixed [TJ] | Other Oil (Solvents) [TJ] | Other Oil (Solvents) Fraction of carbon stored | Other Oil (Solvents)- fixed [TJ] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1990** | 14 281 | 0.75 | 10 711 | 118 229 | 1 | 10 902 | 11 113 | 0.99 | 11 002 | 7 504 | 1 | 7 504 |
| **1991** | 13 412 | 0.75 | 10 059 | 82 841 | 1 | 14 665 | 10 770 | 0.99 | 10 663 | 7 003 | 1 | 7 003 |
| **1992** | 12 846 | 0.75 | 9 635 | 96 506 | 1 | 13 497 | 11 104 | 0.99 | 10 993 | 6 497 | 1 | 6 497 |
| **1993** | 11 515 | 0.75 | 8 636 | 72 545 | 1 | 15 683 | 10 383 | 0.99 | 10 279 | 5 946 | 1 | 5 946 |
| **1994** | 10 850 | 0.75 | 8 138 | 77 645 | 1 | 7 670 | 11 593 | 0.99 | 11 477 | 5 475 | 1 | 5 475 |
| **1995** | 11 813 | 0.75 | 8 860 | 71 031 | 1 | 14 349 | 10 235 | 0.99 | 10 132 | 5 206 | 1 | 5 206 |
| **1996** | 12 060 | 0.75 | 9 045 | 74 161 | 1 | 10 048 | 11 015 | 0.99 | 10 905 | 5 074 | 1 | 5 074 |
| **1997** | 9 609 | 0.75 | 7 207 | 80 374 | 1 | 7 396 | 10 095 | 0.99 | 9 994 | 5 049 | 1 | 5 049 |
| **1998** | 8 324 | 0.75 | 6 243 | 77 663 | 1 | 14 791 | 10 407 | 0.99 | 10 303 | 4 989 | 1 | 4 989 |
| **1999** | 7 438 | 0.75 | 5 579 | 56 083 | 1 | 14 630 | 8 864 | 0.99 | 8 776 | 4 963 | 1 | 4 963 |
| **2000** | 7 496 | 0.75 | 5 622 | 66 292 | 1 | 15 193 | 10 144 | 0.99 | 10 043 | 4 828 | 1 | 4 828 |
| **2001** | 7 496 | 0.75 | 5 622 | 62 499 | 1 | 14 992 | 8 538 | 0.99 | 8 453 | 4 574 | 1 | 4 574 |
| **2002** | 18 388 | 0.71 | 12 965 | 64 727 | 1 | 16 037 | 7 449 | 0.99 | 7 374 | 4 434 | 1 | 4 434 |
| **2003** | 19 285 | 0.72 | 13 854 | 70 603 | 1 | 18 851 | 9 696 | 0.99 | 9 599 | 4 236 | 1 | 4 236 |
| **2004** | 21 388 | 0.74 | 15 848 | 73 560 | 1 | 21 342 | 9 721 | 0.99 | 9 624 | 4 156 | 1 | 4 156 |
| **2005** | 17 921 | 0.69 | 12 396 | 63 079 | 1 | 21 584 | 8 478 | 0.99 | 8 393 | 4 081 | 1 | 4 081 |
| **2006** | 18 118 | 0.86 | 15 520 | 71 436 | 1 | 24 598 | 8 086 | 0.99 | 8 005 | 4 069 | 1 | 4 069 |
| **2007** | 17 976 | 0.85 | 15 312 | 73 173 | 1 | 21 825 | 7 575 | 0.99 | 7 499 | 4 059 | 1 | 4 059 |
| **2008** | 19 647 | 0.83 | 16 280 | 67 459 | 1 | 22 388 | 8 487 | 0.99 | 8 402 | 3 856 | 1 | 3 856 |
| **2009** | 13 415 | 0.74 | 9 959 | 49 978 | 1 | 18 569 | 8 739 | 0.99 | 8 651 | 3 732 | 1 | 3 732 |
| **2010** | 17 101 | 0.73 | 12 484 | 55 841 | 1 | 17 203 | 8 510 | 0.99 | 8 425 | 3 539 | 1 | 3 539 |
| **2011** | 16 044 | 0.74 | 11 790 | 53 048 | 1 | 16 640 | 7 616 | 0.99 | 7 540 | 3 231 | 1 | 3 231 |

*Liquid Fuels: Naphtha-fixed [TJ] + Lubricants -fixed [TJ] + Bitumen [TJ] + Other Oil ($NH_3$) [TJ] + Other Oil (Solvents) [TJ]*
*Solid Fuels : Coal Oils and Tars - fixed [TJ] + Coke consumed in blast furnaces [TJ]*

**Tab. A4- 3 Comparison of the Sectoral and Reference approaches – activity data**

| | Reference Approach [PJ] | Sectoral Approach [PJ] | Apparent energy consumption [PJ] | Difference [%] |
|---|---|---|---|---|
| **1990** | 1 925 | 1 708 | 1 746 | 2.23 |
| **1991** | 1 772 | 1 641 | 1 634 | -0.43 |
| **1992** | 1 632 | 1 477 | 1 480 | 0.16 |
| **1993** | 1 586 | 1 462 | 1 457 | -0.34 |
| **1994** | 1 510 | 1 348 | 1 380 | 2.38 |
| **1995** | 1 535 | 1 386 | 1 410 | 1.78 |
| **1996** | 1 594 | 1 448 | 1 469 | 1.45 |
| **1997** | 1 604 | 1 414 | 1 479 | 4.55 |
| **1998** | 1 539 | 1 349 | 1 408 | 4.38 |
| **1999** | 1 422 | 1 296 | 1 312 | 1.26 |
| **2000** | 1 526 | 1 382 | 1 407 | 1.83 |
| **2001** | 1 553 | 1 401 | 1 438 | 2.63 |
| **2002** | 1 526 | 1 364 | 1 404 | 2.93 |
| **2003** | 1 547 | 1 395 | 1 413 | 1.30 |
| **2004** | 1 565 | 1 406 | 1 416 | 0.75 |
| **2005** | 1 547 | 1 412 | 1 407 | -0.41 |
| **2006** | 1 573 | 1 415 | 1 419 | 0.22 |
| **2007** | 1 573 | 1 406 | 1 423 | 1.21 |
| **2008** | 1 510 | 1 358 | 1 358 | 0.06 |
| **2009** | 1 390 | 1 291 | 1 269 | -1.72 |
| **2010** | 1 466 | 1 335 | 1 333 | -0.18 |
| **2011** | 1 419 | 1 280 | 1 293 | 1.02 |

**Tab. A4- 4 Comparison of the Reference Approach and the total of emitted $CO_2$**

| | Reference Approach [Gg] | Sectoral Approach [Gg] | Difference [%] |
|---|---|---|---|
| **1990** | 148 497 | 145 561 | 2.02 |
| **1991** | 139 404 | 139 718 | -0.22 |
| **1992** | 125 296 | 124 105 | 0.96 |
| **1993** | 122 558 | 123 030 | -0.38 |
| **1994** | 115 053 | 113 358 | 1.50 |
| **1995** | 116 477 | 115 343 | 0.98 |
| **1996** | 119 737 | 119 119 | 0.52 |
| **1997** | 121 038 | 115 512 | 4.78 |
| **1998** | 114 015 | 109 255 | 4.36 |
| **1999** | 105 024 | 104 205 | 0.79 |
| **2000** | 115 126 | 113 035 | 1.85 |
| **2001** | 116 625 | 113 603 | 2.66 |
| **2002** | 113 734 | 110 329 | 3.09 |
| **2003** | 114 533 | 112 801 | 1.54 |
| **2004** | 114 520 | 113 329 | 1.05 |
| **2005** | 113 587 | 113 794 | -0.18 |
| **2006** | 115 010 | 114 165 | 0.74 |
| **2007** | 115 937 | 113 870 | 1.82 |
| **2008** | 109 709 | 109 277 | 0.39 |
| **2009** | 102 625 | 104 307 | -1.61 |
| **2010** | 106 725 | 107 330 | -0.56 |
| **2011** | 105 131 | 103 604 | 1.47 |

*The difference of $CO_2$ emissions between Reference and Sectoral Approaches*

The following tables present the data of the national energy balance by IEA categories. Calorific values for unit conversion are presented in Chapter 3.

**Tab. A4- 5 Energy Balance of solid fuels 2011**

| 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 | 5183 | 6 082 | 46 639 | 2 586 | 205 |
| Total Imports (Balance) | 1181 | 1 023 | 76 | 566 | 251 |
| Total Exports (Balance) | 2537 | 3 065 | 1 144 | 524 | 12 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 |
| Stock Changes (National Territory) | -47 | 780 | -1 470 | 115 | -10 |
| Inland Consumption (Calculated) | 3780 | 4 820 | 44 101 | 2 743 | 434 |
| Statistical Differences | 492 | 515 | -706 | 0 | 0 |
| Transformation Sector | 3288 | 3 720 | 40 909 | 2 023 | 12 |
| Main Activity Producer Electricity Plants | 0 | 1 243 | 25 991 | 0 | 0 |
| Main Activity Producer CHP Plants | 0 | 2 209 | 10 113 | 0 | 1 |
| Main Activity Producer Heat Plants | 0 | 44 | 176 | 1 | 2 |
| Autoproducer Electricity Plants | 0 | 0 | 312 | 0 | 0 |
| Autoproducer CHP Plants | 0 | 223 | 2 650 | 0 | 0 |
| Autoproducer Heat Plants | 0 | 1 | 21 | 1 | 0 |
| Patent Fuel Plants (Transformation) | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Transformation) | 3288 | 0 | 0 | 111 | 0 |
| BKB Plants (Transformation) | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Transformation) | 0 | 0 | 1 646 | 0 | 0 |
| Blast Furnaces (Transformation) | 0 | 0 | 0 | 1 910 | 9 |
| Coal Liquefaction Plants (Transformation) | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transformation) | 0 | 0 | 0 | 0 | 0 |
| Energy Sector | 0 | 0 | 0 | 0 | 49 |
| Own Use in Electricity, CHP and Heat Plants | 0 | 0 | 0 | 0 | 0 |
| Coal Mines | 0 | 0 | 0 | 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 | 49 |
| 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 | 34 | 11 | 0 | 0 |
| Total Final Consumption | 0 | 551 | 3 887 | 720 | 373 |
| Total Non-Energy Use | 0 | 0 | 0 | 0 | 310 |
| Final Energy Consumption | 0 | 551 | 3 887 | 720 | 63 |
| Industry Sector | 0 | 443 | 2 574 | 692 | 63 |
| Iron and Steel | 0 | 34 | 52 | 647 | 25 |
| Chemical (including Petrochemical) | 0 | 167 | 2 100 | 0 | 17 |
| Non-Ferrous Metals | 0 | 0 | 0 | 6 | 0 |
| Non-Metallic Minerals | 0 | 210 | 42 | 29 | 21 |
| Transport Equipment | 0 | 0 | 27 | 0 | 0 |
| Machinery | 0 | 0 | 31 | 4 | 0 |
| Mining and Quarrying | 0 | 2 | 5 | 0 | 0 |
| Food, Beverages and Tobacco | 0 | 17 | 73 | 6 | 0 |
| Paper, Pulp and Printing | 0 | 12 | 217 | 0 | 0 |
| Wood and Wood Products | 0 | 0 | 2 | 0 | 0 |
| Construction | 0 | 1 | 7 | 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 | 108 | 1 312 | 28 | 0 |
| Commercial and Public Services | 0 | 4 | 77 | 6 | 0 |
| Residential | 0 | 102 | 1 200 | 20 | 0 |
| Agriculture/Forestry | 0 | 2 | 27 | 2 | 0 |
| Fishing | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Other) | 0 | 0 | 8 | 0 | 0 |

**Tab. A4- 6 Energy Balance of solid fuels 2011 – continue**

| SOLID FUELS | BKB-PB [kt/year] | Gas Works Gas [TJ/year] | Coke Oven Gas [TJ/year] | Blast Furnace Gas [TJ/year] | Oxy. Steel Furnace Gas [TJ/year] |
|---|---|---|---|---|---|
| Indigenous Production | 0 | 17 962 | 20 602 | 21 181 | 1872 |
| Total Imports (Balance) | 162 | 0 | 0 | 0 | 0 |
| Total Exports (Balance) | 8 | 0 | 0 | 0 | 0 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 |
| Stock Changes (National Territory) | -3 | 0 | 0 | 0 | 0 |
| Inland Consumption (Calculated) | 151 | 17 962 | 20 602 | 21 181 | 1872 |
| Statistical Differences | 0 | 0 | 0 | 0 | -800 |
| Transformation Sector | 0 | 17 741 | 6 711 | 7 891 | 654 |
| Main Activity Producer Electricity Plants | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer CHP Plants | 0 | 0 | 6 711 | 7 891 | 654 |
| Main Activity Producer Heat Plants | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Electricity Plants | 0 | 10 | 0 | 0 | 0 |
| Autoproducer CHP Plants | 0 | 17 731 | 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 | 221 | 8 012 | 3 946 | 0 |
| Own Use in Electricity, CHP and Heat Pl. | 0 | 0 | 0 | 0 | 0 |
| Coal Mines | 0 | 221 | 0 | 0 | 0 |
| Patent Fuel Plants (Energy) | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Energy) | 0 | 0 | 8 012 | 2 154 | 0 |
| BKB Plants (Energy) | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Energy) | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Energy) | 0 | 0 | 0 | 1 792 | 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 | 334 | 559 | 25 |
| Total Final Consumption | 151 | 0 | 5 545 | 8 785 | 1993 |
| Total Non-Energy Use | 0 | 0 | 0 | 0 | 0 |
| Final Energy Consumption | 151 | 0 | 5 545 | 8 785 | 1993 |
| Industry Sector | 0 | 0 | 5 545 | 8 785 | 1993 |
| Iron and Steel | 0 | 0 | 5 340 | 8 750 | 1993 |
| Chemical (including Petrochemical) | 0 | 0 | 0 | 0 | 0 |
| Non-Ferrous Metals | 0 | 0 | 0 | 0 | 0 |
| Non-Metallic Minerals | 0 | 0 | 61 | 1 | 0 |
| Transport Equipment | 0 | 0 | 0 | 0 | 0 |
| Machinery | 0 | 0 | 144 | 34 | 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 | 151 | 0 | 0 | 0 | 0 |
| Commercial and Public Services | 0 | 0 | 0 | 0 | 0 |
| Residential | 151 | 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 |

## *LIQUID FUELS*

**Tab. A4- 7 Energy Balance of Crude Oil, Refinery Gas and Additives/Oxygenates – 2011**

| LIQUID FUELS | Crude Oil [kt/year] | Refinery Feedstocks [kt/year] | Additives Oxygenates [kt/year] |
|---|---|---|---|
| Indigenous Production | 165 | 0 | 171 |
| From Other Sources | 0 | 0 | 343 |
| From Other Sources - Coal | 0 | 0 | 0 |
| From Other Sources - Natural Gas | 0 | 0 | 0 |
| From Other Sources - Renewables | 0 | 0 | 343 |
| Backflows to Refineries | 0 | 63 | 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) | 6 925 | 0 | 16 |
| Total Exports (Balance) | 19 | 0 | 0 |
| International Marine Bunkers | 0 | 0 | 0 |
| Interproduct Transfers | 0 | 0 | 0 |
| Products Transferred | 0 | 152 | 0 |
| Direct Use | 0 | 0 | 175 |
| Stock Changes (National Territory) | 27 | -2 | -1 |
| Refinery Intake (Calculated) | 7 098 | 213 | 354 |
| Gross Inland Deliveries (Calculated) | 0 | 0 | 0 |
| Statistical Differences | 0 | 0 | 0 |
| Gross Inland Deliveries (Observed) | 0 | 0 | 0 |
| Refinery Intake (Observed) | 7 098 | 213 | 354 |

**Tab. A4- 8 Energy Balance of liquid fuels 2011**

| 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 | 145 | 195 | 773 | 1 370 | 40 | 0 |
| Refinery Fuel | 128 | 0 | 0 | 0 | 0 | 0 |
| Total Imports (Balance) | 0 | 74 | 108 | 622 | 12 | 1 |
| Total Exports (Balance) | 0 | 109 | 19 | 299 | 6 | 0 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 | 0 |
| Stock Changes (National Territory) | 0 | -4 | -18 | 56 | 3 | 0 |
| Gross Inland Deliveries (Calculated) | 17 | 188 | 844 | 1 794 | 94 | 1 |
| Statistical Differences | 0 | 0 | 0 | 3 | 0 | 0 |
| Gross Inland Deliveries (Observed) | 17 | 188 | 844 | 1 791 | 94 | 1 |
| Refinery Intake (Observed) | 0 | 0 | 0 | 0 | 0 | 0 |
| Inland Demand (Total Consumption) | 17 | 188 | 844 | 1 791 | 94 | 1 |
| Transformation Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer CHP Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer CHP Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| For Blended Natural Gas | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Petrochemical Industry | 0 | 0 | 0 | 0 | 0 | 0 |
| Patent Fuel Plants (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal Mines | 0 | 0 | 0 | 0 | 0 | 0 |
| Oil and Gas Extraction | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Own Use in Electricity, CHP and Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Distribution Losses | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Final Consumption | 17 | 188 | 844 | 1 791 | 94 | 1 |
| Transport Sector | 0 | 74 | 0 | 1 791 | 94 | 1 |
| International Aviation | 0 | 0 | 0 | 0 | 0 | 0 |
| Domestic Aviation | 0 | 0 | 0 | 0 | 0 | 1 |
| Road | 0 | 74 | 0 | 1 791 | 94 | 0 |
| Rail | 0 | 0 | 0 | 0 | 0 | 0 |
| Domestic Navigation | 0 | 0 | 0 | 0 | 0 | 0 |
| Pipeline Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transport) | 0 | 0 | 0 | 0 | 0 | 0 |
| Industry Sector | 17 | 106 | 844 | 0 | 0 | 0 |
| Iron and Steel | 0 | 0 | 0 | 0 | 0 | 0 |
| Chemical (including Petrochemical) | 17 | 99 | 844 | 0 | 0 | 0 |
| Non-Ferrous Metals | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Metallic Minerals | 0 | 1 | 0 | 0 | 0 | 0 |
| Transport Equipment | 0 | 1 | 0 | 0 | 0 | 0 |
| Machinery | 0 | 1 | 0 | 0 | 0 | 0 |
| Mining and Quarrying | 0 | 0 | 0 | 0 | 0 | 0 |
| Food, Beverages and Tobacco | 0 | 1 | 0 | 0 | 0 | 0 |
| Paper, Pulp and Printing | 0 | 0 | 0 | 0 | 0 | 0 |
| Wood and Wood Products | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction | 0 | 2 | 0 | 0 | 0 | 0 |
| Textiles and Leather | 0 | 1 | 0 | 0 | 0 | 0 |
| Non-specified (Industry) | 0 | 0 | 0 | 0 | 0 | 0 |
| Other Sectors | 0 | 8 | 0 | 0 | 0 | 0 |
| Commercial and Public Services | 0 | 1 | 0 | 0 | 0 | 0 |
| Residential | 0 | 4 | 0 | 0 | 0 | 0 |
| Agriculture/Forestry | 0 | 3 | 0 | 0 | 0 | 0 |
| Fishing | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Other) | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Non-Energy Use | 17 | 99 | 844 | 0 | 0 | 0 |
| Non-Energy Use in Transformation Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Industry | 17 | 99 | 844 | 0 | 0 | 0 |
| *Of which: Non-Energy Use-Chemical/Petrochem* | 17 | 99 | 844 | 0 | 0 | 0 |
| Non-Energy Use in Other Sectors | 0 | 0 | 0 | 0 | 0 | 0 |

**Tab. A4- 9 Energy Balance of liquid fuels 2011 – continue**

| 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 | 134 | 0 | 3 067 | 115 | 59 | 195 |
| Refinery Fuel | 0 | 0 | 0 | 0 | 0 | 9 |
| Total Imports (Balance) | 181 | 3 | 1 625 | 43 | 21 | 29 |
| Total Exports (Balance) | 0 | 0 | 638 | 16 | 13 | 98 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 | 0 |
| Stock Changes (National Territory) | 56 | 0 | -74 | -1 | -1 | 21 |
| Gross Inland Deliveries (Calculated) | 358 | 3 | 4 100 | 271 | 76 | 151 |
| Statistical Differences | 16 | 0 | 25 | 0 | 0 | -11 |
| Gross Inland Deliveries (Observed) | 342 | 3 | 4 075 | 271 | 76 | 162 |
| Refinery Intake (Observed) | 0 | 0 | 0 | 0 | 0 | 0 |
| Inland Demand (Total Consumption) | 342 | 3 | 4 075 | 271 | 76 | 162 |
| Transformation Sector | 0 | 0 | 0 | 0 | 1 | 75 |
| Main Activity Producer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 5 |
| Autoproducer Electricity Plants | 0 | 0 | 0 | 0 | 1 | 0 |
| Main Activity Producer CHP Plants | 0 | 0 | 0 | 0 | 0 | 28 |
| Autoproducer CHP Plants | 0 | 0 | 0 | 0 | 0 | 29 |
| Main Activity Producer Heat Plants | 0 | 0 | 0 | 0 | 0 | 12 |
| Autoproducer Heat Plants | 0 | 0 | 0 | 0 | 0 | 1 |
| Gas Works (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| For Blended Natural Gas | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Petrochemical Industry | 0 | 0 | 0 | 0 | 0 | 0 |
| Patent Fuel Plants (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Energy Sector | 0 | 0 | 14 | 0 | 4 | 0 |
| Coal Mines | 0 | 0 | 14 | 0 | 0 | 0 |
| Oil and Gas Extraction | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Own Use in Electricity, CHP and Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Energy) | 0 | 0 | 0 | 0 | 4 | 0 |
| Distribution Losses | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Final Consumption | 342 | 3 | 4 061 | 271 | 71 | 87 |
| Transport Sector | 342 | 0 | 3 682 | 271 | 0 | 0 |
| International Aviation | 300 | 0 | 0 | 0 | 0 | 0 |
| Domestic Aviation | 42 | 0 | 0 | 0 | 0 | 0 |
| Road | 0 | 0 | 3 589 | 271 | 0 | 0 |
| Rail | 0 | 0 | 90 | 0 | 0 | 0 |
| Domestic Navigation | 0 | 0 | 3 | 0 | 0 | 0 |
| Pipeline Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transport) | 0 | 0 | 0 | 0 | 0 | 0 |
| Industry Sector | 0 | 0 | 49 | 0 | 59 | 81 |
| Iron and Steel | 0 | 0 | 0 | 0 | 0 | 15 |
| Chemical (including Petrochemical) | 0 | 0 | 0 | 0 | 9 | 13 |
| Non-Ferrous Metals | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Metallic Minerals | 0 | 0 | 0 | 0 | 1 | 8 |
| Transport Equipment | 0 | 0 | 0 | 0 | 1 | 0 |
| Machinery | 0 | 0 | 0 | 0 | 2 | 2 |
| Mining and Quarrying | 0 | 0 | 0 | 0 | 0 | 3 |
| Food, Beverages and Tobacco | 0 | 0 | 0 | 0 | 1 | 13 |
| Paper, Pulp and Printing | 0 | 0 | 0 | 0 | 0 | 7 |
| Wood and Wood Products | 0 | 0 | 0 | 0 | 1 | 4 |
| Construction | 0 | 0 | 47 | 0 | 3 | 3 |
| Textiles and Leather | 0 | 0 | 0 | 0 | 1 | 2 |
| Non-specified (Industry) | 0 | 0 | 2 | 0 | 40 | 11 |
| Other Sectors | 0 | 3 | 330 | 0 | 12 | 6 |
| Commercial and Public Services | 0 | 0 | 5 | 0 | 4 | 3 |
| Residential | 0 | 0 | 0 | 0 | 0 | 0 |
| Agriculture/Forestry | 0 | 0 | 316 | 0 | 5 | 3 |
| Fishing | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Other) | 0 | 3 | 9 | 0 | 3 | 0 |
| Total Non-Energy Use | 0 | 0 | 0 | 0 | 9 | 0 |
| Non-Energy Use in Transformation Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Industry | 0 | 0 | 0 | 0 | 9 | 0 |
| *Of which: Non-Energy Use-Chemical/Petrochem* | 0 | 0 | 0 | 0 | 9 | 0 |
| Non-Energy Use in Other Sectors | 0 | 0 | 0 | 0 | 0 | 0 |

**Tab. A4- 10 Energy Balance of liquid fuels 2011 – continue**

| 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 | 1 | 159 | 459 | 13 | 0 | 1 002 |
| Refinery Fuel | 0 | 0 | 0 | 0 | 0 | 86 |
| Total Imports (Balance) | 18 | 130 | 249 | 10 | 8 | 99 |
| Total Exports (Balance) | 1 | 81 | 291 | 10 | 3 | 11 |
| International Marine Bunkers | 0 | 0 | 0 | 0 | 0 | 0 |
| Stock Changes (National Territory) | 0 | -1 | -3 | 0 | 0 | 11 |
| Gross Inland Deliveries (Calculated) | 18 | 177 | 414 | 13 | 5 | 874 |
| Statistical Differences | 0 | 0 | 0 | 0 | 0 | 0 |
| Gross Inland Deliveries (Observed) | 18 | 177 | 414 | 13 | 5 | 874 |
| Refinery Intake (Observed) | 0 | 0 | 0 | 0 | 0 | 0 |
| Inland Demand (Total Consumption) | 18 | 177 | 414 | 13 | 5 | 874 |
| Transformation Sector | 0 | 0 | 0 | 0 | 0 | 63 |
| Main Activity Producer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Electricity Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer CHP Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer CHP Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Main Activity Producer Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Autoproducer Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| For Blended Natural Gas | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Petrochemical Industry | 0 | 0 | 0 | 0 | 0 | 63 |
| Patent Fuel Plants (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transformation) | 0 | 0 | 0 | 0 | 0 | 0 |
| Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Coal Mines | 0 | 0 | 0 | 0 | 0 | 0 |
| Oil and Gas Extraction | 0 | 0 | 0 | 0 | 0 | 0 |
| Coke Ovens (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Blast Furnaces (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Gas Works (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Own Use in Electricity, CHP and Heat Plants | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Energy) | 0 | 0 | 0 | 0 | 0 | 0 |
| Distribution Losses | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Final Consumption | 18 | 177 | 414 | 13 | 5 | 811 |
| Transport Sector | 0 | 155 | 0 | 0 | 0 | 0 |
| International Aviation | 0 | 0 | 0 | 0 | 0 | 0 |
| Domestic Aviation | 0 | 0 | 0 | 0 | 0 | 0 |
| Road | 0 | 145 | 0 | 0 | 0 | 0 |
| Rail | 0 | 10 | 0 | 0 | 0 | 0 |
| Domestic Navigation | 0 | 0 | 0 | 0 | 0 | 0 |
| Pipeline Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Transport) | 0 | 0 | 0 | 0 | 0 | 0 |
| Industry Sector | 18 | 22 | 411 | 13 | 5 | 811 |
| Iron and Steel | 0 | 0 | 0 | 0 | 0 | 1 |
| Chemical (including Petrochemical) | 1 | 0 | 0 | 0 | 0 | 566 |
| Non-Ferrous Metals | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Metallic Minerals | 0 | 0 | 0 | 0 | 0 | 11 |
| Transport Equipment | 0 | 0 | 0 | 0 | 0 | 0 |
| Machinery | 0 | 0 | 0 | 0 | 5 | 0 |
| Mining and Quarrying | 0 | 0 | 0 | 0 | 0 | 2 |
| Food, Beverages and Tobacco | 0 | 0 | 0 | 0 | 0 | 1 |
| Paper, Pulp and Printing | 0 | 0 | 0 | 0 | 0 | 0 |
| Wood and Wood Products | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction | 0 | 0 | 411 | 0 | 0 | 4 |
| Textiles and Leather | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Industry) | 17 | 22 | 0 | 13 | 0 | 226 |
| Other Sectors | 0 | 0 | 3 | 0 | 0 | 0 |
| Commercial and Public Services | 0 | 0 | 0 | 0 | 0 | 0 |
| Residential | 0 | 0 | 0 | 0 | 0 | 0 |
| Agriculture/Forestry | 0 | 0 | 0 | 0 | 0 | 0 |
| Fishing | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-specified (Other) | 0 | 0 | 3 | 0 | 0 | 0 |
| Total Non-Energy Use | 18 | 0 | 411 | 13 | 0 | 629 |
| Non-Energy Use in Transformation Sector | 0 | 0 | 0 | 0 | 0 | 63 |
| Non-Energy Use in Energy Sector | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Transport | 0 | 0 | 0 | 0 | 0 | 0 |
| Non-Energy Use in Industry | 18 | 0 | 411 | 13 | 0 | 566 |
| *Of which: Non-Energy Use-Chemical/Petrochem* | 0 | 0 | 0 | 0 | 0 | 566 |
| Non-Energy Use in Other Sectors | 0 | 0 | 0 | 0 | 0 | 0 |

**Tab. A4- 11 Energy Balance of Natural Gas – part Natural Gas Supply 2011 [TJ] in GCV**

| | |
|---|---|
| Indigenous Production | 7 109 |
| Associated Gas | 5 139 |
| Non-Associated Gas | 1 970 |
| Colliery Gas | 0 |
| From Other Sources | 0 |
| Total Imports (Balance) | 355 528 |
| Total Exports (Balance) | 6 378 |
| International Marine Bunkers | 0 |
| Stock Changes (National Territory) | -41 140 |
| Inland Consumption (Calculated) | 315 119 |
| Statistical Differences | -5 763 |
| Inland Consumption (Observed) | 320 882 |
| Recoverable Gas | |
| Opening Stock Level (National Territory) | 57 559 |
| Closing Stock Level (National Territory) | 98 699 |
| Memo: | |
| Gas Vented | 0 |
| Gas Flared | 0 |
| Memo: Cushion Gas | |
| Cushion Gas Closing Stock Level | 0 |
| Memo: From other sources | |
| From Other Sources - Oil | 0 |
| From Other Sources - Coal | 0 |
| From Other Sources - Renewables | 0 |

**Tab. A4- 12 Energy Balance of Natural Gas – part Consumption and Energy Use 2011 [TJ] in GCV**

| | |
|---|---|
| Transformation Sector | 46 146 |
| Main Activity Producer Electricity Plants | 634 |
| Autoproducer Electricity Plants | 0 |
| Main Activity Producer CHP Plants | 16 089 |
| Autoproducer CHP Plants | 4 950 |
| Main Activity Producer Heat Plants | 21 622 |
| Autoproducer Heat Plants | 2 851 |
| 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 | 4 622 |
| Coal Mines | 0 |
| Oil and Gas Extraction | 155 |
| Petroleum Refineries | 4 467 |
| 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 | 5 906 |
| Transport Sector | 3 397 |
| Road | 477 |
| of which Biogas | 0 |
| Pipeline Transport | 2 920 |
| Non-specified (Transport) | 0 |
| Industry Sector | 98 123 |
| Iron and Steel | 12 355 |
| Chemical (including Petrochemical) | 11 525 |
| Non-Ferrous Metals | 1 721 |
| Non-Metallic Minerals | 22 233 |
| Transport Equipment | 7 668 |
| Machinery | 12 080 |
| Mining and Quarrying | 1 880 |
| Food, Beverages and Tobacco | 14 020 |
| Paper, Pulp and Printing | 4 941 |
| Wood and Wood Products | 1 558 |
| Construction | 2 780 |
| Textiles and Leather | 2 190 |
| Non-specified (Industry) | 3 172 |
| Other Sectors | 158 045 |
| Commercial and Public Services | 59 850 |
| Residential | 93 152 |
| Agriculture/Forestry | 2 493 |
| Fishing | 0 |
| Non-specified (Other) | 2 550 |

# Annex 5: Assessment of completeness and potential sources and sinks of greenhouse gas emissions and removals excluded for the annual inventory submission and also for the KP-LULUCF inventory

The following table shows categories that are not estimated (NE) including relevant explanations of the reasons. Categories that are included elsewhere (IE) are shown in similar way. This table corresponds to the CRF Table 9(a).

| Sources and sinks not estimated (NE)[1] | | | | |
|---|---|---|---|---|
| GHG | Sector[2] | Source/sink category [2] | | Explanation |
| $CO_2$ | 1 Energy | 1.B.1.A.1.2 Post-Mining Activities | Relevant data for emission factors are not available. Emissions are expected to be very low. Relevant EF was not | |
| $CO_2$ | 1 Energy | 1.B.1.A.2.1 Mining Activities | Relevant data for emission factors are not available. | |
| $CO_2$ | 1 Energy | 1.B.1.A.2.2 Post-Mining Activities | Relevant data for emission factors are not available. | |
| $CO_2$ | 1 Energy | 1.B.1.B Solid Fuel Transformation | Relevant EF was not found in existing IPCC methodology. | |
| $CO_2$ | 1 Energy | 1.B.2.A.4 Refining / Storage | Emission factor is not available. Emissions are expected to be | |
| $CO_2$ | 1 Energy | B.2.A.5 Distribution of oil products | Emission factor is not available. Emissions are expected to be | |
| $CO_2$ | 2 Industrial Processes | 2.A.5 Asphalt Roofing | Relevant data are not available. Emissions are expected to be | |
| $CO_2$ | 2 Industrial Processes | 2.A.6 Road Paving with Asphalt | Relevant data are not available. Emissions are expected to be | |
| $CO_2$ | 5 LULUCF | 5.G Harvested Wood Products | This category is not mandatory for reporting (no default | |
| $CH_4$ | 1 Energy | B.2.A.5 Distribution of oil products | Emission factor is not available. Emissions are expected to be | |
| $CH_4$ | 4 Agriculture | 4.D.1 Direct Soil Emissions | Unavailable data | |
| $CH_4$ | 5 LULUCF | 5.G Harvested Wood Products | This category is not mandatory for reporting (no adopted | |
| $N_2O$ | 1 Energy | 1.B.2.A.4 Refining / Storage | Emission factor is not available. Emissions are expected to be | |
| $N_2O$ | 5 LULUCF | 5.G Harvested Wood Products | This category is not mandatory for reporting (no adopted | |
| $N_2O$ | 6 Waste | 6.B.1 6.B.1 Industrial Wastewater | There is no defined method for estimating N2O emissions in | |
| $N_2O$ | 6 Waste | 6.B.1 6.B.1 Industrial Wastewater | Unavailable data | |
| SF6 | 2 Industrial Processes | 2.F.8 2.F.8 Electrical Equipment | Unavailable data | |
| SF6 | 2 Industrial Processes | 2.F.8 2.F.8 Electrical Equipment | Unavailable data | |
| SF6 | 2 Industrial Processes | 2.F.P2.2 In products | not available data | |
| SF6 | 2 Industrial Processes | 2.F.P3.2 In products | not available data | |

| Sources and sinks reported elsewhere (IE)[3] | | | | |
|---|---|---|---|---|
| GHG | Source/sink category | Allocation as per IPCC Guidelines | Allocation used by the Party | Explanation |
| $CO_2$ | 2.B.5.2 Ethylene | 2B5/Ethylene | 1A2c | disaggregated data not available |
| $CO_2$ | 2.C.1.2 Pig Iron | 2C1 | 2C1/Steel | All $CO_2$ from 2C1 are calculated from coke consumptipon in the blast furnace |
| $CO_2$ | 2.C.1.3 Sinter | 2C1 | 2C1/Steel | All $CO_2$ from 2C1 are calculated from coke consumptipon in the blast furnace |
| $CO_2$ | 2.C.1.4 Coke | 2C1 | 2C1/Steel | All $CO_2$ from 2C1 are calculated from coke consumptipon in the blast furnace |
| $CO_2$ | 5.B.1 Cropland remaining Cropland | 5B1 (IV) Dolomite | V) Limestone | Reported as agregate estimates for total lime applications under limestone category. |
| $CO_2$ | 5.C.1 Grassland remaining Grassland | 5C1 (IV) Dolomite | V) Limestone | Reported as agregate estimates for total lime applications under limestone category. |
| $CH_4$ | 2.C.1.1 Steel | 2C1/Steel | 2C1/Coke | disaggregated data not available |
| $N_2O$ | 6.B.2.1 Domestic and Commercial (w/o human sewage) | 6B21 | 6B22 | disaggregation of data not available |
| $N_2O$ | 6.B.2.1 Domestic and Commercial (w/o human sewage) | 6B21 | 6.B.2.2 | disaggregation of data not available |
| $N_2O$ | Treatment on site (latrines) | 6B3 | 6B22 | disaggregation of data not available |

# Annex 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

**Table 1**

| | |
|---|---|
| Party | Czech Republic |
| Submission year | 2013 |
| Reported year | 2012 |
| 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 | ICERs |
| Party holding accounts | 4.53E+08 | NO | NO | NO | NO | NO |
| Entity holding accounts | 93513823 | 1058730 | NO | 2659101 | NO | NO |
| Article 3.3/3.4 net source cancellation accounts | NO | NO | NO | NO | | |
| Non-compliance cancellation accounts | NO | NO | NO | NO | | |
| Other cancellation accounts | NO | NO | NO | NO | NO | NO |
| Retirement account | 2.2E+08 | 754388 | NO | 9382544 | NO | NO |
| tCER replacement account for expiry | NO | NO | NO | NO | NO | |
| ICER replacement account for expiry | NO | NO | NO | NO | | |
| ICER replacement account for reversal of storage | NO | NO | NO | NO | | NO |
| ICER replacement account for non-submission of certification report | NO | NO | NO | NO | | NO |
| **Total** | 7.66E+08 | 1813118 | NO | 12041645 | NO | NO |

**Table 2(a)**

| | |
|---|---|
| Party | Czech Republic |
| Submission year | 2013 |
| Reported year | 2012 |
| Commitment period | 1 |

**Table 2 (a). Annual internal transactions**

| Transaction type | Additions | | | | | | Subtractions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unit type | | | | | | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | ICERs | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| **Article 6 issuance and conversion** | | | | | | | | | | | | |
| Party-verified projects | | 1640950 | | | | | 1640950 | | NO | | | |
| Independently verifed projects | | NO | | | | | NO | | NO | | | |
| **Article 3.3 and 3.4 issuance or cancellation** | | | | | | | | | | | | |
| 3.3 Afforestation and reforestation | | | NO | | | | NO | NO | NO | NO | | |
| 3.3 Deforestation | | | NO | | | | NO | NO | NO | NO | | |
| 3.4 Forest management | | | NO | | | | 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 | | |
| **Article 12 afforestation and reforestation** | | | | | | | | | | | | |
| Replacement of expired tCERs | | | | | | | NO | NO | NO | NO | NO | |
| Replacement of expired ICERs | | | | | | | 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 | NO | NO | NO |
| **Sub-total** | | 1640950 | NO | | | | 1640950 | NO | NO | NO | NO | NO |

| Transaction type | Retirement | | | | | |
|---|---|---|---|---|---|---|
| | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | ICERs |
| **Retirement** | 67795483 | 3085075 | NO | 3112580 | NO | NO |

**Table 2(b); Table 2(c)**

| | |
|---|---|
| Party | Czech Republic |
| Submission year | 2013 |
| Reported year | 2012 |
| Commitment period | 1 |

**Table 2 (b). Annual external transactions**

| | Additions | | | | | | Subtractions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unit type | | | | | | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | lCERs | AAUs | ERUs | RMUs | CERs | tCERs | lCERs |
| **Transfers and acquisitions** | | | | | | | | | | | | |
| FR | 242271 | 2000000 | NO | 655074 | NO | NO | 2850152 | NO | NO | NO | NO | NO |
| PL | 2785890 | NO | NO | NO | NO | NO | 812683 | 141406 | NO | 77046 | NO | NO |
| JP | NO | NO | NO | 42702 | NO | NO | 13655121 | 190437 | NO | NO | NO | NO |
| AT | 563 | 1610 | NO | 25762 | NO | NO | 14000 | 30344 | NO | NO | NO | NO |
| BG | 11689 | 15914 | NO | 30000 | NO | NO | 46914 | NO | NO | NO | NO | NO |
| GB | 535082 | 282159 | NO | 555950 | NO | NO | 1498671 | 412150 | NO | 5915 | NO | NO |
| NL | 7811 | 21247 | NO | 367400 | NO | NO | 303528 | 181535 | NO | 7811 | NO | NO |
| LI | 1 | NO | NO | NO | NO | NO | 355000 | NO | NO | NO | NO | NO |
| BE | 124150 | NO | NO | 19500 | NO | NO | 195269 | NO | NO | NO | NO | NO |
| DE | 593500 | NO | NO | 61358 | NO | NO | 559198 | NO | NO | 151356 | NO | NO |
| CH | NO | NO | NO | NO | NO | NO | 39150 | 94146 | NO | NO | NO | NO |
| IT | 6335 | NO | NO | NO | NO | NO | 1000 | NO | NO | 6335 | NO | NO |
| HU | 6555 | NO | NO | NO | NO | NO | NO | NO | NO | 6555 | NO | NO |
| EU | NO | 52585 | NO | 91335 | NO | NO | NO | 809880 | NO | 104266 | NO | NO |
| IE | NO | NO | NO | 7700 | NO | NO | 8200 | NO | NO | NO | NO | NO |
| SK | 1019009 | 168837 | NO | 110306 | NO | NO | 1910388 | 73444 | NO | 136625 | NO | NO |
| RO | NO | NO | NO | NO | NO | NO | NO | NO | NO | 29770 | NO | NO |
| EE | NO | NO | NO | NO | NO | NO | 32000 | NO | NO | NO | NO | NO |
| **Sub-total** | 5332856 | 2542352 | NO | 1967087 | NO | NO | 22281274 | 1933342 | NO | 525679 | NO | NO |

**Additional information**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Independently verified ERUs | | | | | | | | NO | | | | |

**Table 2 (c). Total annual transactions**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Total (Sum of tables 2a and 2b)** | 5332856 | 4183302 | NO | 1967087 | NO | NO | 23922224 | 1933342 | NO | 525679 | NO | NO |

**Table 3**

| | |
|---|---|
| Party | Czech Republic |
| Submission year | 2013 |
| Reported year | 2012 |
| Commitment period | 1 |

**Table 3. Expiry, cancellation and replacement**

| | Expiry, cancellation and requirement to replace | | Replacement | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Unit type | | Unit type | | | | | |
| **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 |

**Table 4**

| | |
|---|---|
| Party | Czech Republic |
| Submission year | 2013 |
| Reported year | 2012 |
| 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 | 4.6E+08 | NO | NO | NO | NO | NO |
| Entity holding accounts | NO | 223615 | NO | 987929 | NO | NO |
| Article 3.3/3.4 net source cancellation accounts | NO | NO | NO | NO | | |
| Non-compliance cancellation accounts | NO | NO | NO | NO | | |
| Other cancellation accounts | NO | NO | NO | NO | NO | NO |
| Retirement account | 2.88E+08 | 3839463 | NO | 12495124 | 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** | 7.48E+08 | 4063078 | NO | 13483053 | NO | NO |

**Table 5 (a), Table 5 (b), Table 5 (c)**

| | |
|---|---|
| Party | Czech Republic |
| Submission year | 2013 |
| Reported year | 2012 |
| Commitment period | 1 |

#### Table 5 (a). Summary information on additions and subtractions

| | Additions | | | | | | Subtractions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unit type | | | | | | Unit type | | | | | |
| **Starting values** | AAUs | ERUs | RMUs | CERs | tCERs | lCERs | AAUs | ERUs | RMUs | CERs | tCERs | lCERs |
| Issuance pursuant to Article 3.7 and 3.8 | 8.94E+08 | | | | | | | | | | | |
| Non-compliance cancellation | | | | | | | NO | NO | NO | NO | | |
| Carry-over | NO | NO | | NO | | | | | | | | |
| **Sub-total** | 8.94E+08 | 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) | 6423610 | NO | NO | 5052040 | NO | NO | 35377857 | NO | NO | 722906 | NO | NO |
| Year 2 (2009) | 59665197 | 428939 | NO | 7722832 | NO | NO | 1.09E+08 | 330302 | NO | 6123076 | NO | NO |
| Year 3 (2010) | 40059068 | 2539673 | NO | 6751365 | NO | NO | 75690649 | 2136642 | NO | 2853506 | NO | NO |
| Year 4 (2011) | 19017124 | 3617809 | NO | 6025303 | NO | NO | 32202279 | 2306359 | NO | 3810407 | NO | NO |
| Year 5 (2012) | 5332856 | 4183302 | NO | 1967087 | NO | NO | 23922224 | 1933342 | NO | 525679 | NO | NO |
| Year 6 (2013) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Year 7 (2014) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| Year 8 (2015) | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO |
| **Sub-total** | 1.3E+08 | 10769723 | NO | 27518627 | NO | NO | 2.76E+08 | 6706645 | NO | 14035574 | NO | NO |
| **Total** | 1.02E+09 | 10769723 | NO | 27518627 | NO | NO | 2.76E+08 | 6706645 | NO | 14035574 | NO | NO |

#### Table 5 (b). Summary information on replacement

| | Requirement for replacement | | Replacement | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Unit type | | Unit type | | | | | |
| | 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 5 (c). Summary information on retirement

| | Retirement | | | | | |
|---|---|---|---|---|---|---|
| | Unit type | | | | | |
| **Year** | 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) | 2.2E+08 | 754388 | NO | 9382544 | NO | NO |
| Year 5 (2012) | 67795483 | 3085075 | NO | 3112580 | NO | NO |
| Year 6 (2013) | NO | NO | NO | NO | NO | NO |
| Year 7 (2014) | NO | NO | NO | NO | NO | NO |
| Year 8 (2015) | NO | NO | NO | NO | NO | NO |
| **Total** | 2.88E+08 | 3839463 | NO | 12495124 | NO | NO |

**Table 6 (a); Table 6 (b); Table 6 (c)**

| | |
|---|---|
| Party | Czech Republic |
| Submission year | 2013 |
| Reported year | 2012 |
| Commitment period | 1 |

**Table 6 (a). Memo item: Corrective transactions relating to additions and subtractions**

| | Additions | | | | | | Subtractions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Unit type | | | | | | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | lCERs | AAUs | ERUs | RMUs | CERs | tCERs | lCERs |
| | | | | | | | | | | | | |

**Table 6 (b). Memo item: Corrective transactions relating to replacement**

| | Requirement for replacement | | Replacement | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Unit type | | Unit type | | | | | |
| | tCERs | lCERs | AAUs | ERUs | RMUs | CERs | tCERs | lCERs |
| | | | | | | | | |

**Table 6 (c). Memo item: Corrective transactions relating to retirement**

| | Retirement | | | | | |
|---|---|---|---|---|---|---|
| | Unit type | | | | | |
| | AAUs | ERUs | RMUs | CERs | tCERs | lCERs |
| | | | | | | |

# Annex 7: Table 6.1 of the IPCC Good Practice Guidance

### Tab. A7-0-1 Spreadsheet for Tier 1 Uncertainty Analysis, 2011

| Input DATA | | | | | | Uncertainty of Emissions | | Uncertainty of Trend | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IPCC Source Category | Gas | Base year emissions (1990) | Year t emissions (2011) | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combine uncertainty as % of total national emissions in year t | Type A sensitivity | Type B sensitivity | Uncertainty in trend in national emissions introduced by EF unc. | Uncertainty in trend in national emissions introduced by a.d. | Uncertainty introduced into the trend in total national emissions |
| | | Gg $CO_2$ ekv | | % | % | % | % | % | % | % | % | % |
| 1.A Stationary Combustion - Solid Fuels | $CO_2$ | 110 713 | 65 099 | 4.0 | 3.0 | 5.00 | 6.72 | 0.037 | 0.338 | 0.11 | 1.91 | 3.67 |
| 1.A Stationary Combustion - Gaseous Fuels | $CO_2$ | 12 165 | 15 181 | 3.0 | 2.5 | 3.91 | 0.22 | 0.038 | 0.079 | 0.09 | 0.33 | 0.12 |
| 1.A Stationary Combustion - Liquid Fuels | $CO_2$ | 13 518 | 4 965 | 5.0 | 3.0 | 5.83 | 0.05 | 0.020 | 0.026 | 0.06 | 0.18 | 0.04 |
| 1.A Stationary Combustion - Other fuels - MSW | $CO_2$ | 37 | 326 | 20.0 | 20.0 | 28.28 | 0.01 | 0.002 | 0.002 | 0.03 | 0.05 | 0.00 |
| 1.A Stationary Combustion - Other fuels - 1A2 | $CO_2$ | 0 | 377 | 10.0 | 15.0 | 18.03 | 0.00 | 0.002 | 0.002 | 0.03 | 0.03 | 0.00 |
| 1.A.3.a Transport - Civil Aviation | $CO_2$ | 146 | 5 | 4.0 | 3.7 | 5.47 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.b Transport - Road Transportation | $CO_2$ | 6 239 | 16 124 | 3.0 | 2.4 | 3.82 | 0.24 | 0.063 | 0.084 | 0.15 | 0.36 | 0.15 |
| 1.A.3.c Transport - Railways | $CO_2$ | 651 | 282 | 5.0 | 1.5 | 5.21 | 0.00 | 0.001 | 0.001 | 0.00 | 0.01 | 0.00 |
| 1.A.3.d Transport - Navigation | $CO_2$ | 56 | 9 | 5.0 | 1.5 | 5.22 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.e Transport - Other Transportation | $CO_2$ | 484 | 144 | 4.0 | 3.0 | 5.00 | 0.00 | 0.001 | 0.001 | 0.00 | 0.00 | 0.00 |
| 1.A.5.b Mobile sources in Agriculture and Forestry | $CO_2$ | 1 601 | 1 091 | 7.0 | 3.0 | 7.62 | 0.00 | 0.000 | 0.006 | 0.00 | 0.06 | 0.00 |
| 1.B.1.a Coal Mining and Handling | $CO_2$ | 456 | 255 | 4.0 | 25.0 | 25.32 | 0.00 | 0.000 | 0.001 | 0.01 | 0.01 | 0.00 |
| 1.B.1.b Fugitive Emission from Oil, Natural Gas and Othe | $CO_2$ | 4 | 13 | 7.0 | 75.0 | 75.33 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 2.A.1 Cement Production | $CO_2$ | 2 489 | 1 665 | 2.0 | 2.0 | 2.83 | 0.00 | 0.000 | 0.009 | 0.00 | 0.02 | 0.00 |
| 2.A.2 Lime Production | $CO_2$ | 1 337 | 691 | 2.0 | 2.0 | 2.83 | 0.00 | 0.001 | 0.004 | 0.00 | 0.01 | 0.00 |
| 2.A.3 Limestone and Dolomite Use | $CO_2$ | 678 | 1 151 | 5.0 | 4.0 | 6.40 | 0.00 | 0.004 | 0.006 | 0.01 | 0.04 | 0.00 |
| 2.A.4 Soda Ash Use | $CO_2$ | 0 | 1 | 5.0 | 10.0 | 11.18 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 2.A.7 Glass, Bricks and Ceramics | $CO_2$ | 326 | 315 | 5.0 | 10.0 | 11.18 | 0.00 | 0.001 | 0.002 | 0.01 | 0.01 | 0.00 |
| 2.B.1 Ammonia Production | $CO_2$ | 807 | 553 | 5.0 | 7.0 | 8.60 | 0.00 | 0.000 | 0.003 | 0.00 | 0.02 | 0.00 |
| 2.C.1 Iron and Steel Production | $CO_2$ | 12 533 | 5 623 | 7.0 | 10.0 | 12.21 | 0.30 | 0.013 | 0.029 | 0.13 | 0.29 | 0.10 |
| 3 Solvents and Other Product Use | $CO_2$ | 550 | 237 | 5.0 | 5.0 | 7.07 | 0.00 | 0.000 | 0.001 | 0.00 | 0.01 | 0.00 |
| 6.C Waste Incineration | $CO_2$ | 23 | 187 | 20.0 | 5.0 | 20.62 | 0.00 | 0.001 | 0.001 | 0.00 | 0.03 | 0.00 |
| 1.A Stationary Combustion - Solid Fuels | $CH_4$ | 1 335 | 159 | 4.0 | 50.0 | 50.16 | 0.00 | 0.004 | 0.001 | 0.19 | 0.00 | 0.03 |
| 1.A Stationary Combustion - Gaseous Fuels | $CH_4$ | 21 | 26 | 3.0 | 50.0 | 50.09 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A Stationary Combustion - Liquid Fuels | $CH_4$ | 14 | 3 | 5.0 | 50.0 | 50.25 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A Stationary Combustion - Biomass | $CH_4$ | 56 | 343 | 8.0 | 50.0 | 50.64 | 0.02 | 0.002 | 0.002 | 0.08 | 0.02 | 0.01 |
| 1.A Stationary Combustion - Other fuels - MSW | $CH_4$ | 0 | 0 | 20.0 | 50.0 | 53.85 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A Stationary Combustion - Other fuels - 1A2 | $CH_4$ | 0 | 1 | 10.0 | 50.0 | 50.99 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.a Transport - Civil Aviation | $CH_4$ | 1 | 0 | 4.0 | 21.0 | 21.38 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.b Transport - Road Transportation | $CH_4$ | 26 | 25 | 3.0 | 100.0 | 100.04 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.c Transport - Railways | $CH_4$ | 1 | 0 | 5.0 | 100.0 | 100.12 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.d Transport - Navigation | $CH_4$ | 0 | 0 | 5.0 | 50.0 | 50.25 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.e Transport - Other Transportation | $CH_4$ | 1 | 0 | 4.0 | 50.0 | 50.16 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.5.b Mobile sources in Agriculture and Forestry | $CH_4$ | 7 | 2 | 7.0 | 50.0 | 50.49 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.B.1.a Coal Mining and Handling | $CH_4$ | 7 601 | 3 283 | 4.0 | 13.0 | 13.60 | 0.13 | 0.009 | 0.017 | 0.11 | 0.10 | 0.02 |
| 1.B.1.b Fugitive Emission from Oil, Natural Gas and C | $CH_4$ | 897 | 666 | 7.0 | 75.0 | 75.33 | 0.16 | 0.000 | 0.003 | 0.03 | 0.03 | 0.00 |
| 2.A.7 Glass, Bricks and Ceramics | $CH_4$ | 3 | 3 | 5.0 | 50.0 | 50.25 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 2.B.5 Other | $CH_4$ | 15 | 24 | 5.0 | 40.0 | 40.31 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 2.C.1 Iron and Steel Production | $CH_4$ | 127 | 56 | 7.0 | 30.0 | 30.81 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 4.A Enteric Fermentation | $CH_4$ | 4 219 | 2 003 | 5.0 | 20.0 | 20.62 | 0.11 | 0.004 | 0.010 | 0.08 | 0.07 | 0.01 |
| 4.B Manure Management | $CH_4$ | 1 001 | 379 | 5.0 | 30.0 | 30.41 | 0.01 | 0.001 | 0.002 | 0.04 | 0.01 | 0.00 |
| 6.A Solid Waste Disposal on Land | $CH_4$ | 1 663 | 2 745 | 30.0 | 40.0 | 50.00 | 1.19 | 0.009 | 0.014 | 0.34 | 0.61 | 0.49 |
| 6.B Wastewater Handling | $CH_4$ | 825 | 516 | 21.0 | 50.0 | 54.23 | 0.05 | 0.000 | 0.003 | 0.01 | 0.08 | 0.01 |
| 1.A Stationary Combustion - Solid Fuels | $N_2O$ | 495 | 299 | 4.0 | 60.0 | 60.13 | 0.02 | 0.000 | 0.002 | 0.01 | 0.01 | 0.00 |
| 1.A Stationary Combustion - Gaseous Fuels | $N_2O$ | 7 | 9 | 3.0 | 60.0 | 60.07 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A Stationary Combustion - Liquid Fuels | $N_2O$ | 34 | 13 | 5.0 | 60.0 | 60.21 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A Stationary Combustion - Biomass | $N_2O$ | 27 | 120 | 8.0 | 60.0 | 60.53 | 0.00 | 0.001 | 0.001 | 0.03 | 0.01 | 0.00 |
| 1.A Stationary Combustion - Other fuels - MSW | $N_2O$ | 0 | 4 | 20.0 | 70.0 | 72.80 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A Stationary Combustion - Other fuels - 1A2 | $N_2O$ | 0 | 2 | 10.0 | 60.0 | 60.83 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.a Transport - Civil Aviation | $N_2O$ | 6 | 0 | 4.0 | 40.0 | 40.20 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.b Transport - Road Transportation | $N_2O$ | 132 | 660 | 3.0 | 100.0 | 100.04 | 0.28 | 0.003 | 0.003 | 0.30 | 0.01 | 0.09 |
| 1.A.3.c Transport - Railways | $N_2O$ | 12 | 5 | 5.0 | 100.0 | 100.12 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.d Transport - Navigation | $N_2O$ | 1 | 0 | 5.0 | 90.0 | 90.14 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.3.e Transport - Other Transportation | $N_2O$ | 0 | 0 | 4.0 | 60.0 | 60.13 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 1.A.5.b Mobile sources in Agriculture and Forestry | $N_2O$ | 20 | 23 | 7.0 | 60.0 | 60.41 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 2.B.2 Nitric Acid Production | $N_2O$ | 1 127 | 418 | 4.0 | 15.0 | 15.52 | 0.00 | 0.002 | 0.002 | 0.02 | 0.01 | 0.00 |
| 2.B.5 Other | $N_2O$ | 84 | 94 | 20.0 | 40.0 | 44.72 | 0.00 | 0.000 | 0.000 | 0.01 | 0.01 | 0.00 |
| 3 Solvents and Other Product Use | $N_2O$ | 215 | 233 | 50.0 | 0.0 | 50.00 | 0.01 | 0.000 | 0.001 | 0.00 | 0.09 | 0.01 |
| 4.B Manure Management | $N_2O$ | 1 708 | 664 | 5.0 | 30.0 | 30.41 | 0.03 | 0.002 | 0.003 | 0.07 | 0.02 | 0.01 |
| 4.D.1 Agricultural Soils, Direct Emissions | $N_2O$ | 5 484 | 2 989 | 15.0 | 50.0 | 52.20 | 1.54 | 0.003 | 0.016 | 0.15 | 0.33 | 0.13 |
| 4.D.2 Pasture, Range and Padock Manure | $N_2O$ | 317 | 254 | 10.0 | 100.0 | 100.50 | 0.04 | 0.000 | 0.001 | 0.02 | 0.02 | 0.00 |
| 4.D.3 Agricultural Soils, Indirect Emissions | $N_2O$ | 3 503 | 1 776 | 20.0 | 50.0 | 53.85 | 0.58 | 0.003 | 0.009 | 0.13 | 0.26 | 0.09 |
| 6.B Wastewater Handling | $N_2O$ | 162 | 205 | 26.0 | 50.0 | 56.36 | 0.01 | 0.001 | 0.001 | 0.03 | 0.04 | 0.00 |
| 6.C Waste Incineration | $N_2O$ | 0 | 4 | 20.0 | 70.0 | 72.80 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 2.F.1-6 F-gases Use - ODS substitutes | F-gas | 0 | 1 130 | 37.0 | 23.0 | 43.57 | 0.15 | 0.006 | 0.006 | 0.14 | 0.31 | 0.11 |
| 2.F.7 F-gases Use - Semiconductore Manufacture | F-gas | 0 | 29 | 15.0 | 15.0 | 21.21 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 2.F.8 F-gases Use - Electrical Equipment | SF6 | 78 | 31 | 5.0 | 15.0 | 15.81 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 2.F.9 F-gases Use - Other SF6 | SF6 | 0 | 3 | 10.0 | 20.0 | 22.36 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 5.A.1 Forest Land remaining Forest Land | $CO_2$ | -4 777 | -7 635 | | 18.1 | 18.10 | 1.21 | 0.023 | 0.040 | 0.43 | 0.00 | 0.18 |
| 5.A.1 Forest Land remaining Forest Land | $CH_4$ | 100 | 55 | | 50.0 | 50.00 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 5.A.1 Forest Land remaining Forest Land | $N_2O$ | 10 | 6 | | 50.0 | 50.00 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 5.B.1 Cropland remaining Cropland | $CO_2$ | 1 089 | 61 | | 12.5 | 12.47 | 0.00 | 0.003 | 0.000 | 0.04 | 0.00 | 0.00 |
| 5.C.1 Grassland remaining Grassland | $CO_2$ | 59 | 2 | | 9.4 | 9.39 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 5.D.1 Wetlands remaining Wetlands | $CO_2$ | 0 | 0 | | 50.0 | 50.00 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 5.E.1 Settlements remaining Settlements | $CO_2$ | 0 | 0 | | 50.0 | 50.00 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 5.F.1 Other Land remaining Other Land | $CO_2$ | 0 | 0 | | 50.0 | 50.00 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 5.A.2 Land converted to Forest Land | $CO_2$ | -280 | -329 | | 38.8 | 38.78 | 0.01 | 0.001 | 0.002 | 0.03 | 0.00 | 0.00 |
| 5.B.2 Land converted to Cropland | $CO_2$ | 226 | 86 | | 38.5 | 38.54 | 0.00 | 0.000 | 0.000 | 0.01 | 0.00 | 0.00 |
| 5.C.2 Land converted to Grassland | $CO_2$ | -187 | -331 | | 18.6 | 18.64 | 0.00 | 0.001 | 0.002 | 0.02 | 0.00 | 0.00 |
| 5.D.2. Land converted to Wetlands | $CO_2$ | 23 | 32 | | 73.6 | 73.58 | 0.00 | 0.000 | 0.000 | 0.01 | 0.00 | 0.00 |
| 5.E.2 Land converted to Settlements | $CO_2$ | 86 | 87 | | 101.8 | 101.80 | 0.01 | 0.000 | 0.000 | 0.02 | 0.00 | 0.00 |
| 5G Other - Liming of Forest Land | $CO_2$ | 12 | 0 | | 15.0 | 15.00 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| 5.B.2. Land converted to Cropland | $N_2O$ | 21 | 6 | | 2.8 | 2.83 | 0.00 | 0.000 | 0.000 | 0.00 | 0.00 | 0.00 |
| | Total | 192 421 | 125 536 | | | Level uncertainty = | 3.62 | % | | | Trend uncertainty = | 2.30 |

# Annex 8: (Optional)

This Annex provides general QC form, which is used for QC procedures in each specific sector.

**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 fulfilled for each source category or removals and provides the record of controls 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.

First part of the form summarizes results of the control and highlights all significant findings. Second part should be fulfilled according to each listed item. For particular categories are usually not applicable all these items - these items are then noted as not relevant (n.r.). On other hand in the form can be added additional issues which are characteristic for the relevant category.

**Summary of control results**

Overview of findings and corrections:

*description of findings*

Suggested corrections, which should be realised 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)**

| | Auto-control / control realisation | | | Correction realisation | |
|---|---|---|---|---|---|
| **Description of controls** | **Date year 12/13** | **Controlled by** | **Finding YES- NO** | **Date year 12/13** | **Corrected by** |
| **Qualitative check of input data** | | | | | |
| 1. Check for transcription errors in data input (mistakes made on the way from input data to the computational spreadsheet) | | | | | |
| 2. Check of the computational spreadsheets and comparison of data recorded in them and in the CRF (and if needed in NIR) | | | | | |
| 3. Identification of possible changes in input documents and check of their relevance and correctness | | | | | |
| 4. Another check of input data (specification needed) | | | | | |
| **Quantitative check of data documentation (Data + NIR)** | | | | | |
| 5. Check of data file from the view of completeness | | | | | |
| 6. Check of the references on sources of input data in the spreadsheets | | | | | |
| 7. Check that all references in spreadsheets are documented | | | | | |
| 8. Check of completeness of references on the sources of input data in the computational spreadsheets | | | | | |
| 9. Random check of correctness of references on the data sources (NIR) | | | | | |
| 10. Check, that new references (in this submission) are in line with the list of references (NIR) | | | | | |
| 11. Random check of referred materials, if they really contains referred data | | | | | |
| 12.Check that assumptions and criteria for the selection of activity data, emission factors and other parameters are documented (data + NIR) | | | | | |
| 13. Check, that the changes in data or methodology (i.e. recalculations) are documented (data + NIR) | | | | | |
| 14. Check, that quotes are realised uniformly (NIR) | | | | | |
| 15a. Another check of data documentation (specification needed) – e.g. data archiving | | | | | |
| 15b. Another check of data documentation (specification needed) – e.g. transparency of sectoral chapter in NIR | | | | | |
| **Check of correctness of computations of emissions and removals** | | | | | |
| 16. Check, that all realised computations are included | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 17. Check of the units, parameters and conversion factors | | | | | |
| 18. Check of correct significations and units used during the whole computation | | | | | |
| 19. Check of correct use of conversion factors | | | | | |
| 20. Check of correct use of factors describing seasonal fluctuations and spatial orientation | | | | | |
| 21. Check of correctness of relationships and equations used in computations | | | | | |
| 22. Check that in the spreadsheet is apparent which data are input data and which are calculated (i.e. output data) | | | | | |
| 23. On the representative sample confirm the way of computation by independent calculation (i.e. out of the particular computational spreadsheet) | | | | | |
| 24. Comparison of some computations with the simplified approaches | | | | | |
| 25. Check of correctness of data aggregation in terms of relevant category | | | | | |
| 26. Check of time-series consistency in case of methodology changes or data changes (corrections) | | | | | |
| 27. Comparison of results of actual year with the previous year and check of unexpected differences | | | | | |
| 28. Check of implied emission factors, check possible outliers and explanations | | | | | |
| 29. Check of every unexpected and unexplainable trends of input data and computational sources | | | | | |
| 30. Check of methodology in terms of consistency with IPCC methodology and its Good Practice Guidance (data + NIR) | | | | | |

**General notes to controls**

*description*

**Notes for each parts and founded issues**

*notes which are needed to add in order to finish adequate control*