REPUBLIC OF BULGARIA
MINISTRY OF ENVIRONMENT AND WATER

EXECUTIVE ENVIRONMENT AGENCY

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NATIONAL INVENTORY REPORT 2016

GREENHOUSE GAS EMISSIONS IN BULGARIA

1988-2014

Submission under the UNFCCC and the Kyoto Protocol

May, 2016

PREFACE

According to Decision 13/CP.20 of the Conference of the Parties to the UNFCCC, the CRF Reporter version 5.0.0 was not functioning in order to enable Annex I Parties to submit their CRF tables. In the same Decision, the Conference of the Parties reiterated that Annex I Parties may submit their CRF tables after April 15 2015, but no longer than the corresponding delay in the CRF Reporter availability. Decisions 20/CP.21 and 10/CMP.11 further noted that the CRF reporter was still not functioning.

"Functioning" software means that the data on the greenhouse emissions/removals are reported accurately both in terms of reporting format tables and XML format. The CRF reporter version 5.12.0, released on 27th November 2015, as well as its subsequent hotfixes, still contain issues in the reporting format tables and XML formats, in particular in relation to Kyoto Protocol requirements.

Recalling the invitation of the Conference of Parties for Parties to submit as soon as practically possible, and considering that CRF reporter 5.14.0 released on May 3rd, 2016 allows sufficiently accurate reporting under the UNFCCC Convention and the Kyoto Protocol. The present report is the official inventory submission of Bulgaria for the year 2016 under the UNFCCC and for the years 2015 and 2016 under the Kyoto Protocol

The submission contains the following parts:

Part 1: Bulgaria's national greenhouse gas emission inventory report (NIR) prepared using the UNFCCC reporting guidelines (UNFCCC 2013) and the relevant decisions under the Kyoto Protocol as well as the EU monitoring mechanism for monitoring and reporting greenhouse gas emissions (EU 525/2013).

Part 2: CRF (Common Reporting Format) data tables for the years 1988 – 2014 including KP-LULUCF data tables for the years 2013 and 2014. The CFR tables were compiled using the CRF Reporter Inventory software (version 5.14.0).

Part 3: SEF (Standard Electronic Tables) for the reporting of Kyoto units. SEF tables are provided separately for units relevant to the first commitment period (SEF tables for 2015) and for units relevant to the second commitment period (SEF tables for 2014 and 2015).

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EXECUTIVE SUMMARY

ES 1 Background information on greenhouse gas inventories and climate change

Over the past century, 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 to space and cause warming of the climate. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (AR4) (IPCC 2007)[1], the atmospheric concentrations of CO_2 have increased by 35%, CH_4 concentrations have more than doubled and N_2O concentration has risen by 18%, compared with the pre-industrial era.

Changing climate has effects on both human and natural systems (e.g. human settlements, human health, water and food resources, ecosystem and biodiversity). Some of the effects on environmental and socio-economic systems will be beneficial, some damaging. The larger changes and the rate of changes in climate, the more adverse effects will predominate. In Bulgaria the adverse impacts are related, for example, the winter tourism, increased floodings and droughts and the prevalence of pests and diseases. Positive impacts could be possible growth of productivity in agriculture and forestry and decreased need for heating energy. According to the “Fifth National Communication of Bulgaria on Climate Change”[2] from the year 2010 the average temperature in the country could rise. Extreme weather events, such as storms, droughts and heavy rains, are likely to increase.

According to the HadCM3[3] model significant summer warming in the Western Balkan countries were projected for 2080. Air temperatures during this time of the year are expected to increase between 5°C and 8°C over most of the countries in the peninsula. Summer precipitation is projected to decrease in the region.

Acknowledging the importance of the climate change issue and the need for international cooperation to address this problem, Bulgaria signed the UNFCCC in Rio de Janeiro in June 1992 and the Parliament ratified it in March 1995. In compliance with Article 4.6 and 4.2(b) of the UNFCCC, Bulgaria as a country in transition has adopted 1988[4] as a base year for the implementation of the Convention instead of 1990. As an Annex I Party of the UNFCCC the Republic of Bulgaria adopted the target to stabilize emissions of greenhouse gases by 2000 at a level not exceeded that in 1988. The same year was used when comparing, evaluating and projecting greenhouse gas emissions. The 2000 target was successfully achieved.

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[1] Fourth Assessment Report of the Intergovernmental Panel on Climate Change (AR4) (IPCC 2007): Working Group I Report "The Physical Science Basis"; Working Group II Report "Impacts, Adaptation and Vulnerability"; Working Group III Report "Mitigation of Climate Change";

http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm

[2] http://unfccc.int/resource/docs/natc/bgr_nc5.pdf

[3] http://www.ipcc-data.org/sres/hadcm3_info.html

[4] FCCC/CP/1996/15/Add.1/Corr.17 June 1999 http://unfccc.int/resource/docs/cop2/15a01c01.pdf#page=1

The Kyoto Protocol (KP) is adopted at the III-rd Session of the Conference of the Parties (COP) to the Convention (December 1997, Kyoto). The KP is ratified by Bulgaria in August 2002. After Russia ratified the KP in November 2004, it entered into force on 16 February 2005.

With the KP, the Parties to the Convention took the commitment not only to stabilize the GHG emissions, but also to reduce them by percentage, defined with respect to the base year of each Party.

Bulgaria ratified the the KP in August 2002 taking the commitment to reduce its national GHG emissions for the first commitment period (2008-2012) by 8% compared to 1988 (base year). Under these international agreements Bulgaria is committed to provide annually information on its national anthropogenic greenhouse gas emissions by sources and removals by sinks for all greenhouse gases not controlled by the Montreal Protocol.

The inventories started with the country base year – 1988. The first inventories covered the period 1988-1994 as a part of the international project "Country Study to Address Climate Change[5]".

ES 2 Summary of national emission and removal-related trends

The annual inventory and reporting of greenhouse gas emissions and removals provide an information base for the planning and monitoring of climate policy. The Kyoto Protocol obliges its parties to establish a national greenhouse gas inventory system by the end of 2006. Bulgaria's National Greenhouse Gas Inventory System was set up at the beginning of 2007.

The national system produces data and background information on emissions and removals for the UNFCCC, the Kyoto Protocol and the EU Commission. In addition, the scope of the system covers the archiving of the data used in emission estimations, the publishing of the results, participation in inventory reviews and the quality management of the inventory.

The Regulation[6] of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol obliges the Member States (MS) of the European Union (EU) to participate in the compilation of the EU's common greenhouse gas inventory and other climate policy, as well as in the monitoring and evaluation of its detailed measures. This procedure causes a two-phased submission of MS inventory reporting to the Commission with annual deadlines for submission 15 January and 15 March.

This National Inventory Report (NIR) of Bulgaria for the 2016 submission to the EU, the UNFCCC and the Kyoto Protocol includes data of the anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHG_S) not controlled by the Montreal Protocol, i.e. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC_S), hydrofluorocarbons (HFC_S), nitrogen trifluoride (NF_3) and sulphur hexafluoride (SF_6).

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[5] http://www.gcrio.org/CSP/pdf/bulgaria_snap.pdf

[6] Regulation No 525/2013

Each of these gases has a different warming effect. As an example, the gases HFCs, PFCs and SF_6 (so called F-gases) have much greater warming effect, in some cases over one hundred times, compared to methane (25), nitrous oxide (298) and carbon dioxide (1).[7]

Because of that, a common assessment criterion for the effect of each GHG on the atmosphere warming should be introduced. This criterion is the so-called Global Warming Potential (GWP), representing GHG emissions as CO_2-eq. emissions. It allows totalling the effect of all GHGs, adjusted to a common base.

For defining of GWP, the Parties to the Convention and Kyoto Protocol accept values, over a time horizon of 100 years, as mentioned in the IPCC Fourth Assessment Report of 2007[8].

Indirect CO_2 emissions resulting from atmospheric oxidation of CH_4 and NMVOC emissions from non-biogenic sources are also included in the inventory. These have been separately estimated for fugitive emissions in the Energy sector and sources in the Industrial Processes and Product Use sectors using the methodology given in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006, see Section 7.2.1.5). For fossil fuel combustion, indirect emissions are included in the methodology to estimate CO_2 emissions.

The NIR includes also estimates of so-called indirect greenhouse gases carbon monoxide (CO), nitrogen oxides (NO_X) and non-methane volatile organic compounds ($NMVOC_S$) and sulphur dioxide (SO_2) meaning sulphur oxides and other sulphur emissions calculated as SO_2. Indirect greenhouse gases and sulphur dioxide do not have a direct warming effect, but influence on the formation or destruction of direct greenhouse gases, such as troposheric ozone. These gases are not included in Annex A of the Kyoto Protocol.

Other gases have indirect warming effect to the atmosphere (as NO_X, CO and NMVOCs), or cooling effect as SO_X. These gases are precursors of the greenhouse gas – troposphere ozone, and are subject of regional control protocols. They do not have global effect on the climate changes as the main GHG. That is why in the NIR only the total GHG emissions – precursors, as well as the total SO_X emissions were reported.

The emission estimates and removals are presented by gas and by source category and refer to the year 2014. Full time series of the emissions and removals (with exception of F-gases) from 1988 to 2014 are included in the submission.

The structure of this NIR was reelaborated in order to follow the Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention (Decision 15/CP.17). The annotated outline of the NIR'[9], and the guidance contained therein, developed by the UNFCCC secretariat in 2011, has been followed. Chapter 1 provides an introduction to the background of greenhouse gas inventories and the inventory preparation

[7] Global Warming Potential referenced to the updated decay response for the Bern carbon cycle model and future CO_2 atmospheric concentrations held constant at current levels. http://unfccc.int/ghg_data/items/3825.php

[8] http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14

[9] http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/application/pdf/annotated_nir_outline.pdf

process and Chapter 2 presents the overall emission trend in Bulgaria from the year 1988 to the year 2014. In Chapters 3 to 9 more detailed information of GHG emission estimates are given for the seven sectors:

- CRF 1: Energy
- CRF 2: Industrial processes and product use
- CRF 3: Agriculture
- CRF 4: Land use, land-use change and forestry
- CRF 5: Waste
- CRF 6: Other
- CRF 7: Indirect CO_2 and nitrous oxide emissions

In Chapter 10 improvements and recalculations since the previous submission are summarised. Chapter 11 provides description of KP-LULUCF, Chapter 12 information on accounting of KYOTO units, Chapter 13 information on changes in national system and Chapter 14 information on changes in national registry. Chapter 15 gives information on minimisation of adverse impacts in accordance with Article 3, paragraph 14.

Annex 1 contains the mandatory key category reporting tables. A national reference calculation for CO_2 emissions from energy combustion can be found in Annex 4 (Comparison of CO_2 emissions calculated from the Energy balance with fuel combustion emissions as reported in the CRF tables). Annex 2 contains the mandatory uncertainty reporting table. Annex 6 includes 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.

As an Annex I Party to the UNFCCC Bulgaria reports annually its GHG inventory from the base year to the year proceeding the year of reporting.

Annex I Parties to the KP should report also additional elements as assigned amount information, changes in national system, changes in national registry and submission of information relating to activities under Articles 3, paragraphs 3, of the Kyoto Protocol.

The inventories are prepared according to the UNFCCC Guidelines[10] and establishing the NIR structure in compliance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.[11]

The general objective regarding the preparation of the annual GHG inventories is to improve „TACCC" in emission estimates. The Report presents the National GHG inventory for 2014. The following are described as well:

- Methods and indices for uncertainty assessment of the annual GHG emissions and trends;
- Key GHG emission sources according to Approach 1 and Approach 2, specified in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;

[10] http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf

[11] http://unfccc.int/files/national_reports/annex_i_ghg_inventories/reporting_requirements/items/2759.php

- Assessment of the quality assurance and control system.
- Activity data and emission tables for 1988-2014 in the Common Reporting Format (CRF) for annual GHG inventories are submitted together with the Report and are uploaded on:

http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php

http://cdr.eionet.europa.eu/bg/un/unfccc

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

In 2014 Bulgaria's greenhouse gas emissions totalled 57 197,22 Gg CO2 without reporting of sequestration from LULUCF sector. The emissions decreased by 50,08 % compared with the base year. Emissions in 2014 were 4.09 % decrease in comparison with the emissions of the previous year.

The net emissions including reporting of sequestration from LULUCF sector were 45 933,50 Gg CO2 eq. The emissions decreased by 53.74 % compared with the base year.

The main reasons for the declining GHG emission trend in Bulgaria are the structural economic changes due to the radical transition process from a centrally-planned economy to a market-based economy. This led to a decrease of power production from thermal power stations (and an increase of the shares of hydropower and nuclear power), structural changes in industry (including a decline in production by energy-intensive enterprises and energy-efficiency improvements), introduction of energy efficiency measures in the residential sector and a shift form solid and liquid fuels to natural gas in energy consumption. This also led to a decrease in GHG emissions from the agricultural sector stemming from the decline in the cattle and sheep populations and the use of fertilizers.

Bulgaria experienced a steady declining population trend during the period 1988-2014, which resulted in the reduction of population by 20%.

ES 4 Background information of the Kyoto Protocol

Bulgaria has made a commitment to follow the UNFCCC that entered into force on 21 March 1994. The Kyoto Protocol negotiated in 1997 under the UN Framework. The Kyoto protocol took effect on 16 February 2005 and became legally binding.

The Kyoto Protocol (Article 5.1) requires that the parties have in place a National System by the end of 2006 at the latest for estimating anthropogenic greenhouse gas emissions by sources and removals by sinks not controlled by the Montreal Protocol. The guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol (Decision 19/CMP.1[12]) provide the requirements for the general and specific functions of the national systems. Bulgaria’s inventory system was reviewed as part of the review of the Bulgaria’s initial report under Convention in 2007 (FCCC/IRR/2007/BGR)[13].

[12] http://www.ciesin.columbia.edu/repository/entri/docs/cop/Kyoto_COP001_019.pdf

[13] Report of the review of the initial report of Bulgaria: http://unfccc.int/resource/docs/2008/irr/bgr.pdf

Under the UNFCCC and the Kyoto Protocol, Bulgaria is required to submit annually to secretariat of the Convention a national greenhouse gas inventory covering emissions and removals of direct greenhouse gases from the five sectors (Energy, Industrial processes and product use, Agriculture, Land Use, Land-Use change and Forestry and Waste) and for all years from the base year or period to the most recent year. The preparation and reporting of the inventories are guided by the UNFCCC guidelines (UNFCCC 2014) and are based on the following IPCC methodologies to ensure the transparency, accuracy, comparability, consistency and completeness of the inventories;

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006 GL)[14]
- 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP supplement)
- 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement)
- EMEP/EEA air pollutant emission inventory guidebook – 2013.

The national greenhouse gas inventory for 2014 is submitted to the European Commission by Bulgarian Ministry of Environment and Water in fulfillment of Bulgaria's obligation under Article 7 of Regulation 525/2013[15] of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC. The purpose of Regulation 525/213 is to monitor all anthropogenic greenhouse gas emissions not controlled by the Montreal Protocol and to evaluate the progress towards meeting the commitments under the UNFCCC and the Kyoto Protocol.

[14] http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

[15] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:165:0013:0040:EN:PDF

PART 1: ANNUAL INVENTORY SUBMISSION

1 INTRODUCTION

1.1 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES, AND CLIMATE CHANGE

1.1.1 BACKGROUND INFORMATION ON CLIMATE CHANGE

Over the past century, 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 to 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 concentration has risen by 18%, compared with the pre-industrial era.

Changing climate has effects on both human and natural systems (e.g. human settlements, human health, water and food resources, ecosystem and biodiversity). Some of the effects on environmental and socio-economic systems will be beneficial, some damaging. The larger changes and the rate of changes in climate, the more adverse effects will predominate. In Bulgaria the adverse impacts are related, for example, to the winter tourism, increased floodings and droughts and the prevalence of pests and diseases. Positive impacts could be possible growth of productivity in agriculture and forestry and decreased need for heating energy. According to the Fifth National Communication of Bulgaria on Climate Change from the year 2010 the average temperature in the country could rise. Extreme weather events, such as storms, droughts and heavy rains, are likely to increase.

Significant summer warming in the western Balkan countries, were projected by the HadCM3 model for 2080. Air temperatures during this time of the year are expected to increase between 5ºC and 8ºC over most of the countries in the peninsula. Summer precipitation is projected to decrease in the region.

Acknowledging the importance of the climate change issue and the need for international cooperation to address this problem, Bulgaria signed the UNFCCC in Rio de Janeiro in June 1992 and the Parliament ratified it in March 1995. In compliance with Article 4.6 and 4.2(b) of the FCCC, Bulgaria as a country in transition has adopted 1988 as a base year for the implementation of the Convention instead of 1990. As an Annex I Party of the UNFCCC the Republic of Bulgaria adopted the target to stabilize emissions of greenhouse gases by 2000 at a level not exceeded that in 1988. The same year was used when comparing, evaluating and projecting greenhouse gas emissions. The 2000 target was successfully achieved.

The Kyoto Protocol (KP) is adopted at the III-rd Session of the Conference of the Parties to the Convention (December 1997, Kyoto). KP is ratified by Bulgaria in August 2002. After Russia ratified the KP in November 2004, it entered into force on 16 February 2005.

With the KP, the Parties to the Convention took the commitment not only to stabilize the GHG emissions, but also to reduce them by percentage, defined with respect to the base year of each Party.

Bulgaria ratified the KP in August 2002 taking the commitment to reduce its national GHG emissions for the first commitment period (2008-2012) by 8% compared to 1988 (base year). Under these international agreements Bulgaria is committed to provide annually information on its national anthropogenic greenhouse gas emissions by sources and removals by sinks for all greenhouse gases not controlled by the Montreal Protocol.

The inventories started with the country base year – 1988. The first inventories covered the period 1988-1994 as a part of the international project "Country Study to Address Climate Change".

1.1.2 BACKGROUND INFORMATION ON GREENHOUSE GAS INVENTORIES

The annual inventory and reporting of greenhouse gas emissions and removals provide an information base for the planning and monitoring of climate policy. The Kyoto Protocol obliges its parties to establish a national greenhouse gas inventory system by the end of 2006. Bulgaria's National Greenhouse Gas Inventory System was set up at the beginning of 2007.

The national system produces data and background information on emissions and removals for the UNFCCC, the Kyoto Protocol and the EU Commission. In addition, the scope of the system covers the archiving of the data used in emission estimations, the publishing of the results, participation in inventory reviews and the quality management of the inventory.

The Regulation of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol obliges the Member States (MS) of the European Union (EU) to participate in the compilation of the EU's common greenhouse gas inventory and other climate policy, as well as in the monitoring and evaluation of its detailed measures. This procedure causes a two-phased submission of MS inventory reporting to the Commission with annual deadlines for submission 15 January and 15 March.

This National Inventory Report (NIR) of Bulgaria for the 2016 submission to the EU, the UNFCCC and the Kyoto Protocol includes data of the anthropogenic emissions by sources and removals by sinks of all greenhouse gases (GHGs) not controlled by the Montreal Protocol, i.e. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), nitrogen trifluoride (NF_3) and sulphur hexafluoride (SF_6).

Indirect CO_2 emissions resulting from atmospheric oxidation of CH_4 and NMVOC emissions from non-biogenic sources are also included in the inventory. These have been separately estimated for fugitive emissions in the Energy sector and sources in the Industrial Processes and Product Use sectors using the methodology given in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006, see Section 7.2.1.5). For fossil fuel combustion, indirect emissions are included in the methodology to estimate CO_2 emissions.

The NIR includes also estimates of so-called indirect greenhouse gases carbon monoxide (CO), nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2) meaning sulphur oxides and other sulphur emissions calculated as SO_2. Indirect greenhouse gases and sulphur dioxide do not have a direct warming effect, but influence on the formation or destruction of direct greenhouse gases, such as troposheric ozone. These gases are not included in Annex A of the Kyoto Protocol.

The emission estimates and removals are presented by gas and by source category and refer to the year 2014. Full time series of the emissions and removals (with exception of F-gases) from 1988 to 2014 are included in the submission.

The structure of this NIR was reelaborated in order to follow the Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention (Decision 24/CP.19). The annotated outline of the NIR, and the guidance contained therein, developed by the UNFCCC secretariat in 2014, has been followed. Chapter 1 provides an introduction to the background of greenhouse gas inventories and the inventory preparation process and Chapter 2 presents the overall emission trend in Bulgaria from the year 1988 to the year 2014. In Chapters 3 to 9 more detailed information of GHG emission estimates are given for the seven sectors: (i) energy, (ii) industrial processes and product use, (iii) agriculture, (iv) land use, land-use change and forestry, (v) waste, (vi) other and (vii) indirect CO_2 and nitrous oxide emissions. In Chapter 10 improvements and recalculations since the previous submission are summarised. Chapter 11 provides description of KP-LULUCF, Chapter 12 information on accounting of KYOTO units, Chapter 13 information on changes in national system and Chapter 14 information on changes in national registry. Chapter 15 gives information on minimisation of adverse impacts in accordance with Article 3, paragraph 14.

Annex 1 contains the mandatory key category reporting tables. A national reference calculation for CO_2 emissions from energy combustion can be found in Annex 4 (Comparison of CO_2 emissions calculated from the Energy balance with fuel combustion emissions as reported in the CRF tables). Annex 2 contains the mandatory uncertainty reporting table (table 3.3 of 2006 IPCC GLs). Annex 6 includes 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.

As an Annex I Party to the Convention Bulgaria reports annually its GHG inventory/emissions from the base year to the year proceeding the year of reporting.

Annex I Parties to the KP should report also additional elements as assigned amount information, changes in national system, changes in national registry and voluntary submission of information relating to activities under Articles 3, paragraphs 3 and 4, of the Kyoto Protocol.

The main greenhouse gases to be reported pursuant to UNFCCC are as follows:

- Carbon dioxide - CO_2;
- Methane - CH_4;
- Nitrous oxide - N_2O;
- Hydrofluorocarbons – HFCs;
- Perfluorocarbons – PFCs;
- Sulphur hexafluoride - SF_6;
- Nitrogen trifluoride - NF_3.

Each of these gases has a different warming effect. As an example, the gases HFCs, PFCs, NF_3 and SF_6 (so called F-gases) have much greater warming effect, in some cases over one hundred times, compared to methane (25), nitrous oxide (298) and carbon dioxide (1).

Because of that, a common assessment criterion for the effect of each GHG on the atmosphere warming should be introduced. This criterion is the so-called Global Warming Potential (GWP), representing GHG emissions as CO_2-eq. emissions. It allows totalling the effect of all GHGs, adjusted to a common base.

For defining of GWP, the Parties to the Convention and Kyoto Protocol accept values, over a time horizon of 100 years, as mentioned in the IPCC Fourth Assessment Report of 2007.

Other gases have indirect warming effect to the atmosphere (as NOx, CO and NMVOCs), or cooling effect as SOx. These gases are precursors of the greenhouse gas – troposphere ozone, and are subject of regional control protocols. They do not have global effect on the climate changes as the main GHG. That is why in the NIR only the total GHG emissions – precursors, as well as the total SOx emissions were reported.

The inventories are prepared according to the UNFCCC Guidelines and establishing the NIR structure in compliance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The general objective regarding the preparation of the annual GHG inventories is to improve „TACCC" in emission estimates. The Report presents the National GHG inventory for 2014. The following are described as well:

- Methods and indices for uncertainty assessment of the annual GHG emissions and trends;
- Key GHG emission sources according to Approach 1 and Approach 2, specified in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;
- Assessment of the quality assurance, control system and verification.
- Activity data and emission tables for 1988-2014 in the Common Reporting Format (CRF) for annual GHG inventories are submitted together with the Report and are uploaded on:

http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8812.php

http://cdr.eionet.europa.eu/bg/un/unfccc

1.1.3 BACKGROUND INFORMATION ON SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1, OF THE KYOTO PROTOCOL AND INTERNATIONAL AGREEMENTS

Bulgaria has made a commitment to follow the United Nations Framework Convention on Climate Change that entered into force on 21 March 1994. The Kyoto Protocol negotiated in 1997 under the UN Framework. The Kyoto protocol took effect on 16 February 2005 and became legally binding.

The Kyoto Protocol (Article 5.1) requires that the parties have in place a National System by the end of 2006 at the latest for estimating anthropogenic greenhouse gas emissions by sources and removals by sinks not controlled by the Montreal Protocol. The guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol (Decision 19/CMP.1) provide the requirements for the general and specific functions of the national systems.

Bulgaria's inventory system was reviewed successfully as part of the review of the Bulgaria's initial report under Protocol in 2007.

Under the UNFCCC and the Kyoto Protocol, Bulgaria is required to submit annually to secretariat of the Convention a national greenhouse gas inventory covering emissions and removals of direct greenhouse gases from the five sectors (Energy, Industrial processes and product use, Agriculture, Land use, Land use change and Forestry and Waste) and for all years from the base year or period to the most recent year. The preparation and reporting of the inventories are guided by the UNFCCC guidelines (UNFCCC, 2014) and are based on the following IPCC methodologies to ensure the transparency, accuracy, consistency, comparability and completeness of the inventories:

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC GL)
- 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol (KP supplement)
- 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement)
- EMEP/EEA air pollutant emission inventory guidebook – 2013[15]

The national greenhouse gas inventory for 2014 is submitted to the European Commission by Bulgarian Ministry of Environment and Water in fulfilment of Bulgaria's obligation under Article 7 of Regulation 525/201315 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC. The purpose of Regulation 525/213 is to monitor all anthropogenic greenhouse gas emissions not controlled by the Montreal Protocol and to evaluate the progress towards meeting the commitments under the UNFCCC and the Kyoto Protocol.

The quantified emission limitation and reduction commitments for the members of the European Union (including Bulgaria) listed in the third column of Annex B to the Doha Amendment to the Kyoto Protocol are 80%. The joint assigned amount of the members for the second commitment period will be determined pursuant to Article 3(7 bis), (8) and (8 bis) of the Kyoto Protocol, and its calculation will be facilitated by the report submitted by the European Union pursuant to paragraph 2 of Decision 2/CMP.8.

The assigned amounts of the members shall be equal to their respective emission levels.

In accordance with Annex 2, Table 1 of the Agreement concerning emission levels of the Member States and Iceland (before application of Article 3(7bis)) in terms of tonnes of carbon dioxide equivalent for the second commitment period of the Kyoto Protocol the prescribed amount for Bulgaria should be equal to 222 945 983.

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[15] In the following referred as EMEP/EEA Guidebook (2013)

1.2 DESCRIPTION OF THE NATIONAL INVENTORY ARRANGEMENTS

1.2.1 INSTITUTIONAL, LEGAL AND PROCEDURAL ARRANGEMENTS

REQUIREMENTS FOR NATIONAL SYSTEMS FOR GREENHOUSE GAS INVENTORIES AS SPECIFIED IN THE GUIDELINES FOR ARTICLE 5.1 OF THE KYOTO PROTOCOL

The Bulgarian National Inventory System (BGNIS) is developed following the requirements of the provisions of Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol.

In order to reinstate the eligibility under Kyoto Protocol a Compliance Action Plan for ensuring the effective and timely functioning of BGNIS in accordance with the requirements of Article 5.1 of the Kyoto Protocol and Decision 19/CMP.1 was developed and implemented in 2010.

The conclusions and recommendations of ERT set out in the Report of the individual review of the 2010 annual submission of Bulgaria (FCCC/ARR/2010/BGR) indicate that all activities for improvements of institutional, legal and procedural arrangements within the National Inventory System as well as for improvement of quality of inventory are adequately planned and implemented by the Bulgarian government in 2010.

The main results are written in the paragraph §203 from the annual review report FCCC/ARR/2010/BGR - “The ERT concludes that the national system of Bulgaria is performing its required general and specific functions, as set out in the annex to decision 19/CMP.1 with respect to the institutional, legal and procedural arrangements to perform these functions; that the institutional, legal and procedural arrangements established and formalized by the “Ordinance on the way and order of organization of the national inventories of hazardous substances from greenhouse gases in the ambient air” (Ordinance No. 215) that entered into force on 21 September 2010 are fully operational; and that Bulgaria has in place the institutional arrangements and the capacity, including the arrangements for the technical competence of staff involved in the national system, to plan, prepare and manage inventories on an annual basis”. As a result from implemented activities for improvements “No questions of implementation were identified by the ERT during the review” (FCCC/ARR/2010/BGR § 207).

In accordance with Decision of Enforcement Branch CC-2010-1-17/Bulgaria/EB from 4 February 2011 Bulgaria is now fully eligible to participate in the mechanisms under Articles 6, 12, and 17 of the Kyoto Protocol.

The activities for improvement of quality of GHGs inventory are planned in order to implement the recommendations of the Expert Review Team set out in the annual review report FCCC/ARR/2014/BGR.

HISTORY OF GHG INVENTORY PREPARATION

The Bulgarian National Inventory System changed over time two times because of decisions of the particular government. In the following table the national circumstances are outlined:

BGNIS until 2007 (submission 2007)	Present BGNIS (submission 2008-2016)	Prospected BGNIS
←	Centralized inventory	→
Single institute	Single agency	→
Out-sourced inventory	In-sourced inventory	→
Private consultants	**Public/Governmental** (submission with cooperation of consultants)	→
National Inventory Focal Point: Private consultants	National Inventory Focal Point: ExEA	→
←	National Focal Point: MoEW	→

Until 2007 the national emissions inventory as well as the relevant NIR under UNFCCC was prepared by an external company through an open tender procedure under the rules of the Public Procurement Law.

Since 2008 the Executive Environment Agency (ExEA) is responsible for the whole process of inventory planning, preparation and management.

The national system defines the "road map" in which Bulgaria prepares its inventory. This is outlined in the national inventory preparation cycle (see below part Fulfilment of paragraph 10(a) from Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol).

As it is illustrated in figure 1 and outlined in the following chapters the preparation of the inventory has an institutional "home" that is ultimately responsible for managing the process and has a legal authority to collect data and submit it on behalf of the Bulgaria.

Bulgaria's reporting obligations to the UNFCCC, UNECE and EC are being administered by the MoEW. All activities on preparation of GHG inventory in Bulgaria are coordinated and managed on the state level by MoEW.

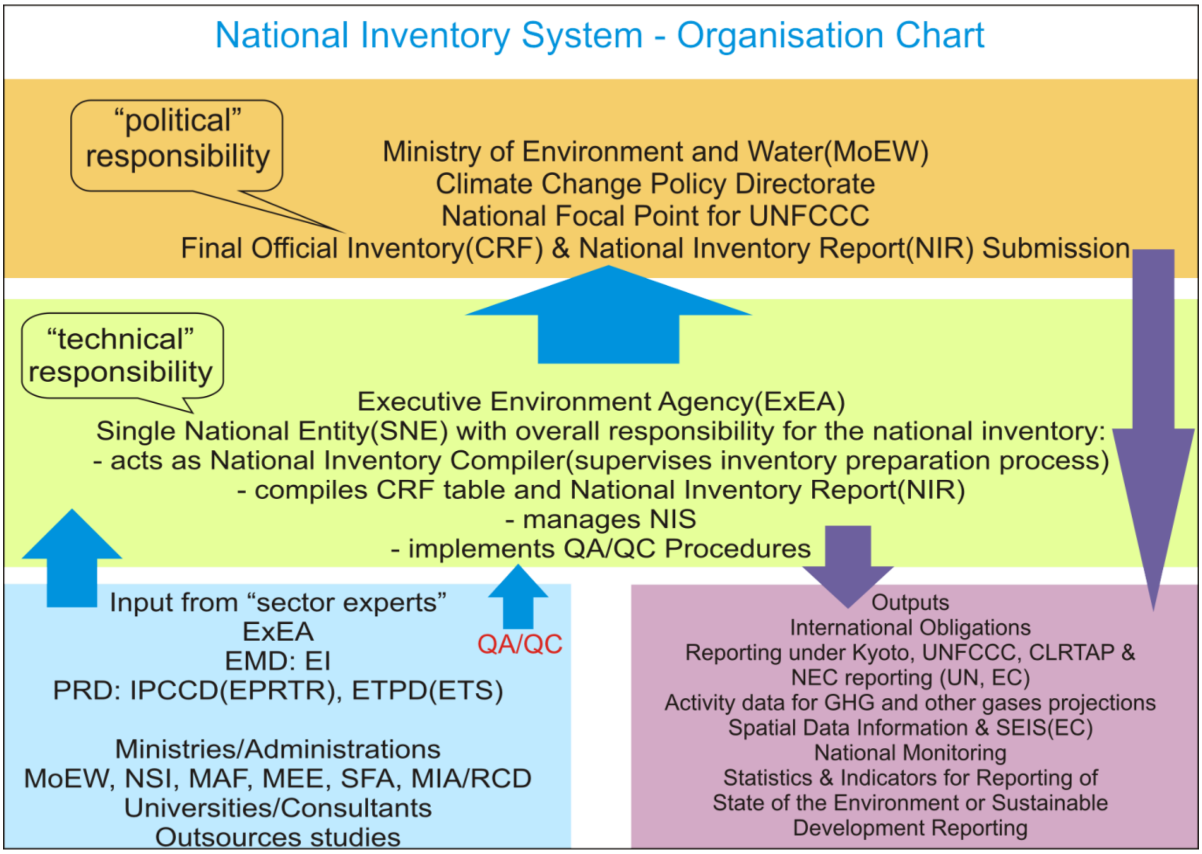

Figure 1 Organizational Chart of the Bulgarian National Inventory System

The Bulgarian Government by MoEW (Climate Change Policy Directorate) has the political responsibility for compliance with commitments under the UNFCCC and the Kyoto Protocol, including for functioning of BGNIS in accordance with the requirements of Decision 19/CMP.1 under Article 5, paragraph 1, of the Kyoto Protocol. In order to meet all challenges in this sphere, the Climate Change Policy has been transformed in a separate directorate and its staff has been increased with 6 experts. Now, it consists of 13 persons in total.

The following strategic goals in climate change area were achieved by the Ministry of Environment and Water in 2014:

Climate Change Mitigation Act

The Climate Change Mitigation Act was adopted on first reading by National Assembly on 23.10.2013, and entered into force on March 11, 2014. In pursuance of the international commitments of Bulgaria and in order to synchronise the Bulgarian legislation with the European law, the Climate Change Mitigation Act outlines the overall policy to be followed in order to mitigate and adapt to climate change and its impacts and fulfil international obligations of Bulgaria within the UNFCCC and Kyoto Protocol, as well as the EU legal framework. The Act integrates the already existing climate change mitigation related articles of the Environmental Protection Act, namely provisions on:

• the National Environmental Monitoring System (including the National GHG Inventory System), directed by the Minister of Environment and Water through the Executive Environment Agency, originally established by the EPA and related Regulation (Decision of Council of Ministers 162/03.08.2010);

• the Greenhouse Gas Emissions Allowances Trading Scheme, for which the Minister of Environment and Water (acting jointly with other ministers) elaborates a National Allocation Plan every five years;

• the National Trust Eco Fund that manages Bulgaria's Green Investment Scheme, originally established in 2010 as independent legal entity to manage the funds received by Bulgaria within the "Debt for Environment" swap deal between Bulgaria, Switzerland and other donors.

The Act further regulates instruments available under the Kyoto Protocol (Joint Implementation, CDM – Chapter 3, Section III.), administration of the national GHG trading register, reduction of GHG emissions from fuels used for transport and energy, and the voluntary emissions reduction scheme.

The Act also reaffirms the National Action Plan on Climate Change as the "instrument which determines the framework of state policy in the field of climate change for each separate period of action under the policies of the European Union and international treaties to which Bulgaria is a party".

The Act further establishes the National Expert Council on Climate Change as an advisory body to the Minister of Environment and Water.

The Act also mandates the Minister of Environment and Water and other competent ministers to draft, after consultation with the National Council of Experts on Climate Change, a national strategy on climate change adaptation.

National Green Investment Scheme

As our country significantly overachieved the emissions reduction target, Bulgaria concluded two Assigned Amount Units (AAUs) Purchase Agreements with the Republic of Austria. The proceeds from the sale of AAUs are being spent through the National Green Investment Scheme, supporting projects on energy efficiency. The projects financed the improvement of 77 public buildings at the total amount of 27 million BGN. The program itself is socially focused due to the nature of buildings included 32 educational institutions, of which 30 schools and 2 universities, 28 kindergartens, 9 cultural institutions (cultural community centers, a theater and sport halls), 5 medical centers and just 3 administrative buildings

National Adaptation Strategy

In order to reduce the country's vulnerability to the effects of climate change and improve the capacity to adapt of the natural, social and economic systems to the inevitable negative impacts of climate change, the Ministry of Environment and Water initiated a process towards development of a National Adaptation Strategy.

Taking into account that developing of such strategic document is subject to substantial expertise and significant data collection, we adopted a stepwise approach.

As a first step was prepared a Framework document "National climate change risk and vulnerability assessment for the sectors of the Bulgarian economy". The document was finalized in early June 2014.

The main objective of the „National climate change risk and vulnerability assessment for the sectors of the Bulgarian economy" is to assess the risk of climate change related natural disasters which are most typical for Bulgaria on the basis of climate models and scenarios.

The Framework document covers the following sectors: agriculture, water, urban environment, energy, transport, construction and infrastructure, ecosystems and biodiversity, human health and tourism. A separate chapter on cross-border cooperation on issues related to the impacts of climate change is included in the document.

The Framework document should serve as a basis for the further development of a National Adaptation Strategy.

Another very important part to be integrated in the National Adaptation Strategy is insurance. The Ministry of Environment and Water already has developed an analytical document "Financial disaster risk management and insurance options for climate change adaptation in Bulgaria". The document was prepared in 2014 with the financial and technical support of the World Bank and its purpose is to analyze the role and importance of the insurance business for the prevention of risks that occur as a result of climate change and for the development of adaptation measures.

The analysis will be included in the National Adaptation Strategy.

The ExEA has been identified as the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Kyoto Protocol and designated as single national entity (see below Legal bases; Chapter 1.2.11).

The ExEA is represented and managed by an Executive Director. The organizational chart of the ExEA is presented in Figure 2.

The ExEA's directorates and departments, which are directly involved in operation of the BGNIS are:

Environmental Monitoring and Assessment Directorate with the Emission Inventory Department (EID) and Waste Department (WD) and

Permit Regime Directorate with the **Integrated Pollution Prevention and Control Department** (IPPCD) and **Emission Trading Permit Department** (ETPD).

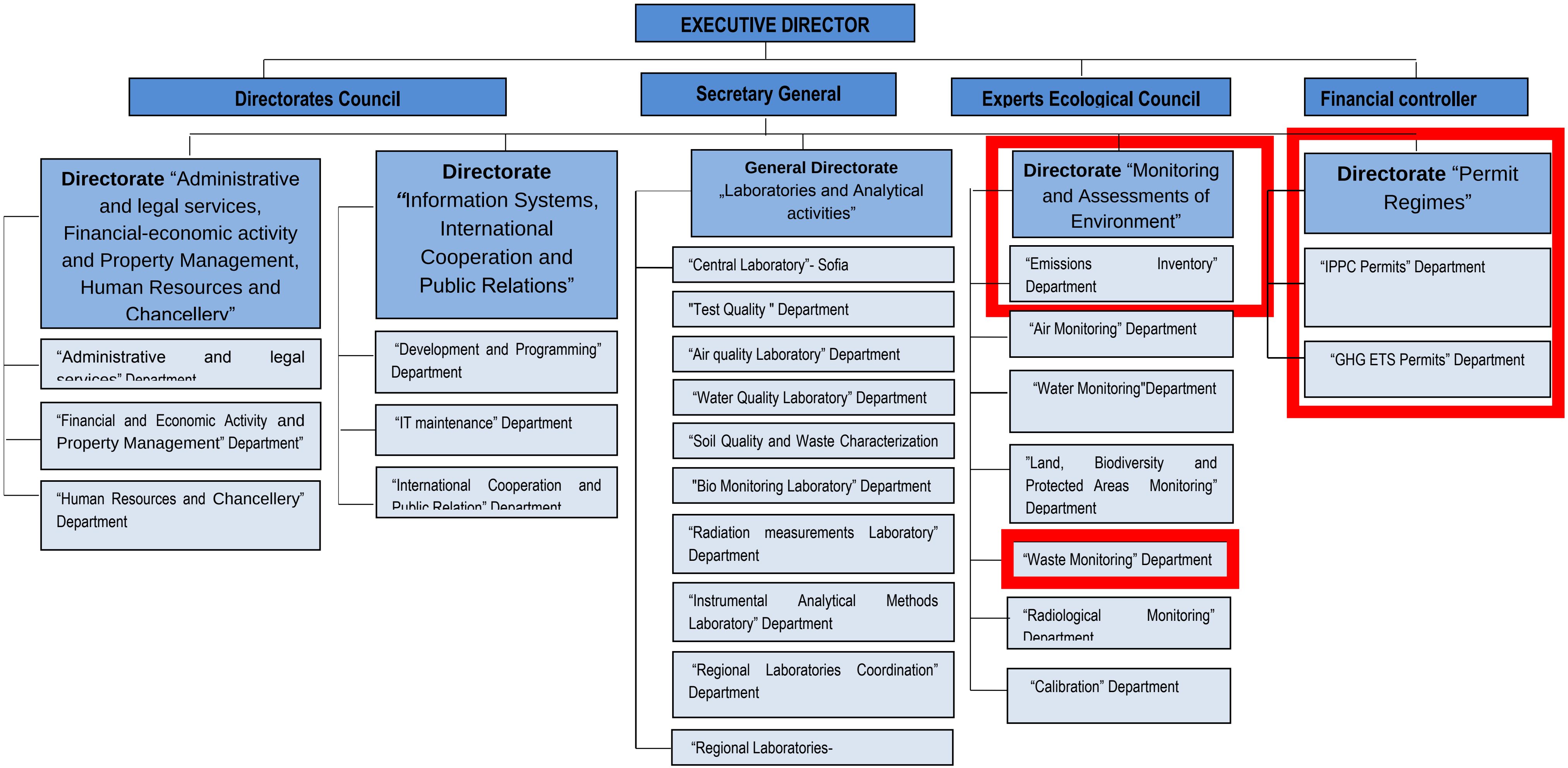

Figure 2 Organizational Chart of the Executive Environmental Agency (ExEA)

Since 1 January 2012, the Emissions Inventory Unit, responsible for preparation of the GHG Inventory, has been promoted as Emissions Inventory Department (see Figure 2).

The specific responsibilities of the different departments are presented below in part Legal arrangements of the Bulgarian National Inventory System (Figure 4: Bulgarian National Inventory System – Responsibilities).

The definitions provisions of Decision 19/CMP.1 Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol, are incorporated in BGNIS which is outlined below.

The overall objective of the BGNIS is annually to produce a high quality inventory (National CRF, Kyoto and SEF tables and NIR) for compliance with its Kyoto commitment and to submit it by the required deadline.

The objective of a BGNIS is annually to produce a high quality inventory, with "quality" being defined by the TCCCA criteria. (see also chapter 1.2.12)

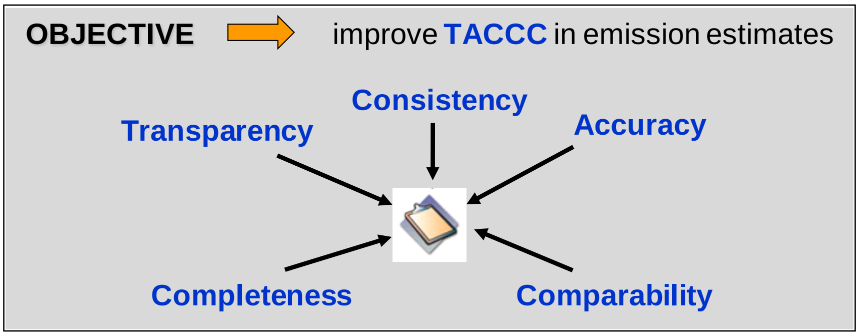

Figure 3 Objectives of the Bulgarian National Inventory System

1.2.2 OVERVIEW OF INVENTORY PLANNING, PREPARATION AND MANAGEMENT

Legal basis of the Bulgarian NIS – General functions

Fulfillment of paragraph 10(a)

The Republic of Bulgaria joined the UNFCCC in 1992 and the Parliament ratified it in March 1995. As an Annex I Party to the Convention, Bulgaria is committed to conduct annual inventories on greenhouse gas (GHG) emissions by sources and removals by sinks, using the GHG inventory methodology, approved by the UNFCCC. The inventories started with the country base year – 1988. The first inventories covered the period 1988-1994 as a part of the international project "Country Study to Address Climate Change".

Legal basis of the BGNIS

As illustrated in Figure 1 and outlined shortly the Bulgaria's reporting obligations to the UNFCCC, UNECE and EC are being administered by the MoEW. All activities on preparation of GHG inventory in Bulgaria are coordinated and managed on the state level by MoEW. The Bulgarian Government by MoEW has the political responsibility for compliance with commitments under the Kyoto Protocol, including for functioning of BGNIS in accordance with the requirements of Decision 19/CMP.1 under Article 5, paragraph 1, of the Kyoto Protocol:

National Focal Point;

QA experts from Climate Change Policy Directorate;

Approval of inventory;

Submission of CRF / NIR / Kyoto Tables / SEF.

The ExEA has been identified as the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Kyoto Protocol and designated as single national entity. ExEA has the technical responsibility for the national inventory:

- acts as National Inventory Compiler (supervises inventory preparation process);
- manages BGNIS;
- compiles CRF tables and NIR;
- coordinates the work of engaged consultants for supporting inventory;
- coordinates and implements the activity of National QA/QC Plan;
- National Inventory Focal Point.

The bases for BGNIS are:

Environmental Protection Act (EPA, State Gazette No. 91/25.09.2002; corrected, SG No. 96/2002; last amendment August 2015);

Statute on the organization and structure of ExEA (Decision of Council of ministers 162/03.08.2012 – final update 30.10.2015);

Order № 296/04.12.2015 by the Executive Director of ExEA (Sector experts/QC experts);

Order № RD-218/05.03.2010 by the Minister of Environment and Water (QA experts).

Regulation of the Council of Ministers 216/05.09.2014 SG 76/2014 on the way and order of organization of the National Inventories of hazardous substances and greenhouse gases in the ambient air.

Add 1.

EPA (State Gazette No. 91/25.09.2002; corrected, SG No. 96/2002; last amendment August 2015), which establishes the National Environmental Monitoring System, make clear the responsibility for preparation inventories under both conventions and lists of its tasks:

Chapter One: GENERAL DISPOSITIONS

Article 11: The Minister of Environment and Water shall perform the following functions:

direct the National Environmental Monitoring System through the **Executive Environment Agency;**

Article 13:

The Executive Environment Agency with the Minister of Environment and Water shall direct the National Environmental Monitoring System.

The Executive Environment Agency shall be a legal person.

The Executive Environment Agency shall be managed and represented by an Executive Director.

The operation, the structure, the organization of work and the staffing of the Executive Environment Agency shall be determined by Rules of Organization adopted by the Council of Ministers.

Chapter Eight: NATIONAL ENVIRONMENTAL MONITORING SYSTEM

Article 144:

The National Environmental Monitoring System shall comprehend:

1. the national networks for:

2. a system for information on, and control of, air emissions and the state of waste waters;

Add 2.

EPA establishes the national Executive Environment Agency (ExEA) according to **Regulation on the organization and structure of ExEA** (Decision of Council of ministers 162/03.08.2012 - last update 30.10.2015), which regulate it's responsibilities for monitoring of environment as well as the responsibility for preparation of emission inventories.

The Emissions Inventory Department of ExEA prepares and annually updates the air emissions inventories [according to article 14 (12) of the above Regulation].

Add 3.

To increase the capacity in ExEA for adequate planning, preparation and management of emissions inventory an Order № 296/04.12.2015 by the Executive Director of ExEA has been issued. The order regulates the name and responsibilities of experts from different departments within the ExEA, which are engaged in preparation of National GHGs emission inventory (Sector experts/QC experts).

Add 4.

To assure the quality of information reported to UNFCCC and UNECE and to support the single national entity, the Minister of Environment and Water has issued an order № RD-218/05.03.2010. The order regulates the names and responsibilities of the MoEW and ExEA QA experts for implementation of the requirements of National QA/QC Plan in emission inventory of sectors Energy, Industry, Solvents, Agriculture, LULUCF and Waste.

Add 5.

The BGNIS has been enshrined in law through a special Regulation of the Council of Ministers 261/05.09.2014 SG 76/2014. The regulation establishes and maintain the institutional, legal and procedural arrangements necessary to perform the general and specific functions of BGNIS, defined in Decision 19/CMP.1 for national systems. The regulation reinforces the existing institutional agreements by specifying the roles of all data providers.

INSTITUTIONAL ARRANGEMENTS

In order to strengthen the institutional arrangements and to fulfil the required general and specific functions of BGNIS an official agreements between MoEW and the main data providers were signed in 2010:

- National Statistical Institute (RD21-35/12.02.2010);
- Ministry of Agriculture and Food and its body Executive Forest Agency (04-00-517/26.02.2010 and RD 50-47/15.03.2010);
- Ministry of Economy, Energy and Tourism (14/06/2010);
- Ministry of Interior (MI) (08/06/2010).

The agreements ensure the support from these organisations regarding the choice of the activity data and EFs and methods, in the compilation of emission estimates and QA/QC of these estimates.

The ExEA as Single National Entity coordinates all activities, related to collecting inventory data and aggregates the data relevant for GHG emissions on a national level by the following state authorities:

- National Statistics Institute (NSI);
- Ministry of Agriculture and Food (MAF) and their relevant services (Agrostatistic Directorate and Executive Forest Agency);
- Ministry of Energy (ME);
- Ministry of Interior (MI);
- Ministry of Environment and Water (MoEW);
- Ministry of Transport, Information Technologies and Communications (MTITC).

OTHER ARRANGEMENTS OF THE BULGARIAN NATIONAL INVENTORY SYSTEM

The Executive Environment Agency (ExEA) coordinates all activities, related to the large industrial plants and Branch Business Associations:

- Large industrial plants – official letters (questionnaire);
- Branch Business Associations – official letters (questionnaire).

For validation of the activity data we gather reliable country specific data from Branch Business Associations in Bulgaria and aggregate the data relevant for GHG emissions on a national level. Please see the list of all branch business associations in Bulgaria: http://www.bia-bg.com/memberCategory/278. The data must be representative for the whole period since 1988 (base year for Bulgaria).

EXPERT CAPACITY

Expert capacity in ExEA - Emission Inventory Department

The EID has the main role in BGNIS as National Inventory Compiler (supervises inventory preparation process, compiles CRF tables and NIR, manages BGNIS implements QA/QC procedures on a national level)

The responsibilities of the Sector experts

Within the inventory system specific responsibilities for the different emission source categories are defined ("sector experts"), as well as for all activities related to the preparation of the inventory, including QA/QC, data management and reporting.

The sector experts are in charge of specific responsibilities related to choice of methods, data collection, processing and archiving. Sector experts are also responsible for performing Quality Control (QC) activities that are incorporated in the Quality Management System (QMS) (see below).

Engaged departments within ExEA

In order to improve the capacity of the BGNIS in planning, preparation and managing its annual submissions the extension of the ExEA staff has been realised in the beginning of 2010.

Additionally to the existing experts in Emissions Inventory Department, there are one expert from Waste Monitoring Department and two sector experts for "Energy" and "Industrial Processes" (from IPPCD and ETPD) available in the ExEA. Figure 5 presents the available staff/experts in ExEA, engaged in planning, preparation and management of emission inventory.

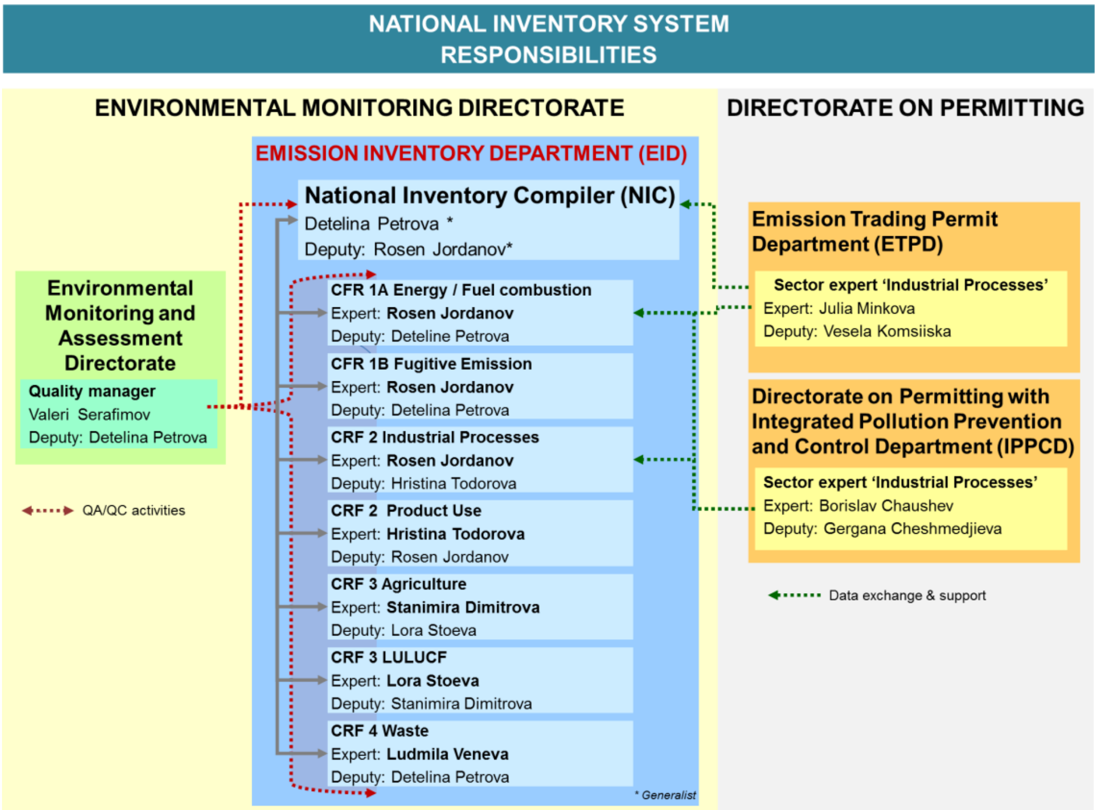

Figure 4 ExEA capacity for ensuring the function of BGNIS

As it is written above the distribution of responsibilities of different departments within the ExEA for inventory planning, preparation and management is according to Order № 296/04.12.2015 by the Executive Director of ExEA.

TECHNICAL CAPACITY

Training of Bulgarian experts

Workshops and Training on the job

To raise the technical competence of staff involved in the inventory development process, a training programme for Bulgarian inventory experts was updated within the Twinning project with the Federal Environment Agency of Austria[16]. The program covered all inventory sectors in a series of workshops realised in the period December 2009 to September 2010.

Further collaboration with Austrian Environment Agency for training of Bulgarian staff is envisaged for the next submissions.

[16] The Twinning Partner "Austrian Federal Environment Agency" has already experience as supporting role / expert in preparing GHG and air emission inventory and reporting (UNFCCC, UNECE/LRTAP and NEC); FCCC/ARR/2008/LUX para 8: "…. The ERT noted that three relevant studies have been outsourced to external experts and that the improvements are mainly the result of research activities and intensive cooperation with the Austrian Federal Environment Agency."

Online training

To raise the technical competence of staff involved in the inventory development and review process, sector experts from ExEA applied for having an access to the Online training by the UNFCCC and GHG Management Institute (GHGMI)[17].

Basic Course[18]

This course covers technical aspects of the review of GHG inventories of Annex I Parties. It consists of seven modules: one general module, "Overview of UNFCCC Review Process and General IPCC Inventory Guidance" and individual modules on the review of individual IPCC sectors: Energy (Fuel Combustion and Fugitive Emissions), Industrial Processes, Agriculture, LULUCF and Waste. Each of the modules provides important background information and references for the sector, instruction on general procedures for review, exercises on key topics and specific emission categories, and practical case studies that simulate an actual review.

The courses are also available to trainees all year round, without instructor.

Fulfilment of paragraph 10(c)

See above and below

UNFCCC reporting guidelines

Fulfilment of paragraph 10(d);

Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention following incorporation of the provisions of decision 24/CP.19"

Fulfilment of paragraph 10(c)

See below

LEGAL BASIS OF THE BULGARIAN NIS – SPECIFIC FUNCTIONS

SINGLE NATIONAL ENTITY

Fulfilment of paragraph 12(a)

An overview of the general responsibilities in the inventory development and reporting process is given in Fulfilment of paragraph 10a.

Bulgaria's reporting obligations to the UNFCCC, UNECE and EC are being administered by the Ministry of Environment and Water (MoEW). All activities on preparation of GHG

[17] http://ghginstitute.org/2010/03/03/the-unfccc-expert-reviewer-training-programme-is-ongoing
[18] http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_training/items/2763.php
http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_training/items/2764.php

inventories in Bulgaria are coordinated and managed on the state level by MoEW. The MoEW (Climate Change Policy Directorate) has the political responsibility for compliance with commitments under the Kyoto Protocol, including for functioning of BGNIS in accordance with the requirements of Decision 19/CMP.1 under Article 5, paragraph 1, of the Kyoto Protocol.

The Executive Environment Agency (ExEA) has been identified as the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Kyoto Protocol and designated as single national entity. ExEA has the technical responsibility for the national inventory:

- acts as National Inventory Compiler (supervises inventory preparation process);
- compiles CRF tables and NIR;
- manages BGNIS;
- implements QA/QC procedures.

Fulfilment of paragraph 12(b)

The postal and electronic addresses of the single national entity are:

Executive Environment Agency at the Ministry of Environment and Water

136 "Tzar Boris III" Blvd

Sofia 1618, Bulgaria

P.O.Box 251

Tel.:+359 2 9559011

Fax: +359 2 9559015

E-Mail: vgrigorova@eea.government.bg

E-mail: ncesd@eea.government.bg

http://eea.government.bg/eng

National Focal Point (NFP): Diana Todorova

Organization: Ministry of Environment and Water

Address: 22 "Maria Luiza" blvd., 1202 Sofia, Bulgaria

E-mail: dtodorova@moew.government.bg

Tel.: +359 2 940 62 85

National Inventory Focal Point (NIFP) & National Inventory Compiler (NIC):

Detelina Petrova

Organization: Executive Environment Agency, Emissions Inventory Department

Address: 136, "Tsar Boris III" blvd., 1618 Sofia, Bulgaria

e-mail: climatechange@eea.government.bg

Tel.: +359 2 940 64 88

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Head of Emission Inventory Department: Rosen Yordanov

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Name of Quality Manager: Valeri Serafimov

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Tel.: +359 2 940 64 87

Fax: +359 2 955 90 15

Fulfilment of 12(c)

An overview of the general responsibilities in the inventory development and reporting process is given in Fulfilment of paragraph 10a. As mentioned before, the ExEA has the overall responsibility for the national inventory, comprising greenhouse gases as well as other air pollutants. Within the inventory system specific responsibilities for the different emission source categories are defined ("sector experts"), as well as for all activities related to the preparation of the inventory, including QA/QC, data management and reporting.

The sector experts are in charge of specific responsibilities related to choice of methods, data collection, processing and archiving. Sector experts are also responsible for performing Quality Control (QC) activities that are incorporated in the Quality Management System (QMS) (see below).

1.3 INVENTORY PREPARATION, DATA COLLECTION, PROCESSING AND STORAGE

Collection of activity data by ExEA

The information is collected on the annual basis.

The ExEA sends every year letters with request for provision of the necessary activity data to every one of the information sources, including the deadline for response.

For NSI, MAF, MI and ME the type of the necessary data, as well as the deadlines for submissions to ExEA are regulated by the official agreements mentioned above as well as by the Regulation of the Council of Ministers 216/05.09.2014 (SG 76/2014).

The annual national energy and material balances as well as the data related to the solid waste generation and the wastewater treatment are prepared by NSI. NSI uses up-to-date statistical methods and procedures for data collection, summarizing and structuring that are harmonized with EUROSTAT.

The GHG inventory use data, received directly from large point sources in the energy sector and in the industry and these data are summarized by ExEA.

Table 1 Sources of activity data for preparation of national GHGs emission inventory

Sectors	Data Source of Activity Data	Activity Data supplier	
1. Energy			
1.A Fuel Combustion	Energy balance (IEA - EUROSTAT – UNECE Energy Questionnaire)	NSI	National Statistical Institute
1.A.3 Transport	Energy balance (IEA - EUROSTAT – UNECE Energy Questionnaire)	NSI	National Statistical Institute
	Statistics vehicle fleet	MI/RCD	Ministry of Interior/ Road Control Department
	Country specific parameters used in the COPERT IV related to car fleet and vehicle split	MTITC	Ministry of Transport, Information Technologies and Communications
1.B Fugitive emissions	Energy balance (IEA - EUROSTAT – UNECE Energy Questionnaire)	NSI	National Statistical Institute
	National statistics	ME	Ministry of Energy
2. Industrial processes and product use	National production statistics	NSI	National Statistical Institute
	National registers (EPRTR and ETS)	ExEA	Executive Environment Agency
	National studies	MoEW /ExEA	Ministry of Environment and Water/ Executive Environment Agency
	National VOC register	ExEA	Executive Environment Agency
4. Agriculture	National agriculture statistics	MAF	Ministry of Agriculture and Food/Statistics Department
	Synthetic fertilizers	NSPP	National service for Plant Protection
5. LULUCF	National Forest Inventory	EFA	Executive Forest Agency
	National statistics of the balance of territory of Bulgaria	MAF	Ministry of Agriculture and Food
6. Waste	National statistics	NSI	National Statistical Institute
	National database	ExEA	Executive Environment Agency/ Waste Monitoring Department

Inventory preparation

The inventory preparation process covers:

- Identification key source categories[19];
- Prepare estimates[20] and ensure that appropriate methods are used to estimate emissions from key source categories;
- Collect sufficient activity data, process information, and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks;
- Make a quantitative estimate of inventory uncertainty[21] for each source category and for the inventory in total recalculations[22] of previously submitted estimates of anthropogenic GHG emissions by sources and removals by sinks;
- Compile the national inventory in accordance with Article 7, paragraph 1, and relevant decisions of the COP and/or COP/MOP;
- Implement general inventory QC procedures (tier 1) in accordance with its QA/QC plan following the 2006 IPCC GL;
- Apply source category specific QC procedures[23] (tier 2) for key source categories and for those individual source categories in which significant methodological and/or data revisions have occurred;
- Collection of all data collected together with emission estimates in a database (see below), where data sources are well documented for future reconstruction of the inventory.

The Figure 4 presents the general responsibilities of all engaged institutions in functioning of Bulgarian National Inventory System.

The ExEA coordinates all activities on preparation of inventory under UNFCCC.

The Executive director of the ExEA through internal administrative order and based on the Regulation on the organization and structure of ExEA appoints sector experts for preparation of emission inventory in Energy, Industrial processes and products use, Agriculture, LULUCF and Waste.

The ExEA, agreed with the MoEW engages external consultants for preparation of tasks, which are out of competence of the Agency and are related with improvement of the inventory.

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[19] following the methods described in the 2006 IPCC GL (chapter 4, section 4.2);

[20] in accordance with the methods described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

[21] following the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

[22] prepared in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and relevant decisions of the COP and/or COP/MOP;

[23] in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

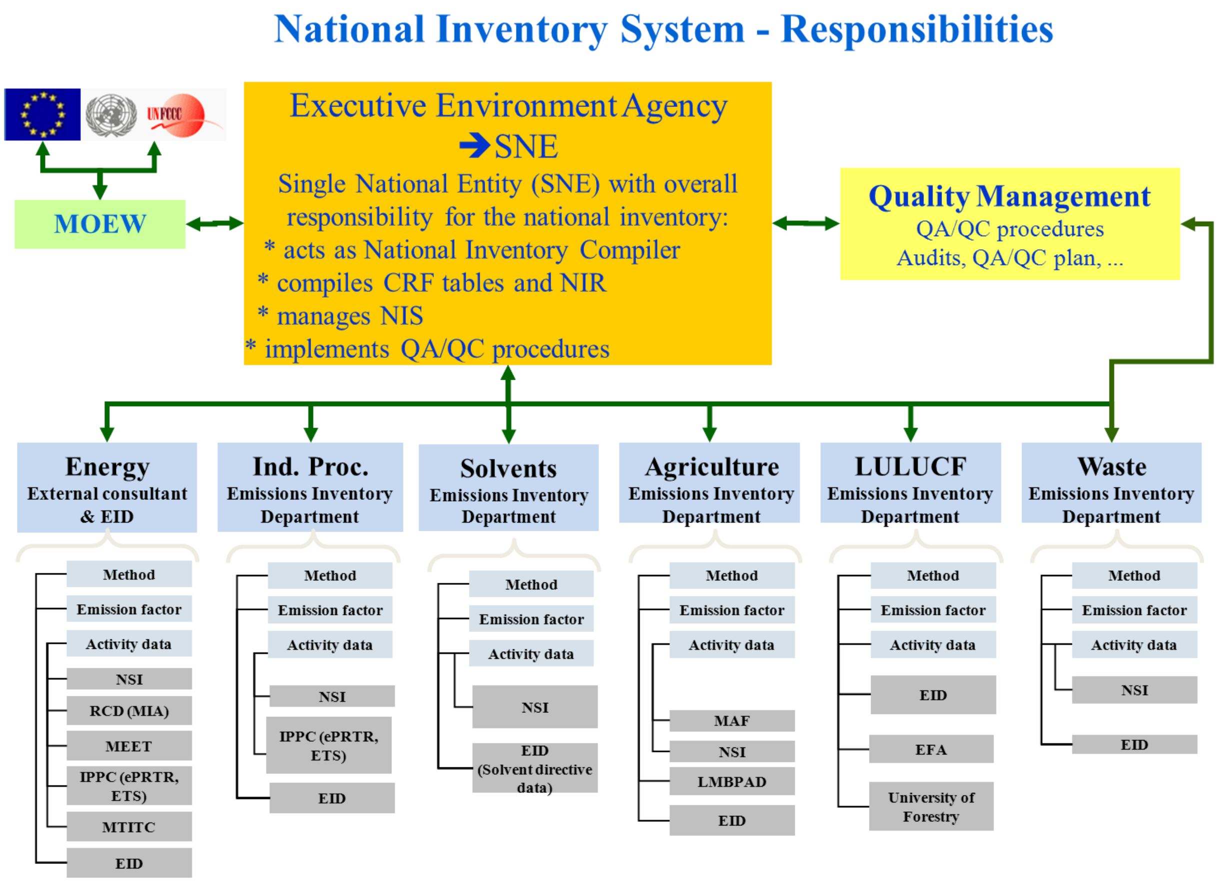

Figure 5 Bulgarian National Inventory System – Responsibilities

The following table presents the responsibilities of all engaged institutions for preparation of GHGs emission inventory for 2016 submission.

Table 2 Preparation of GHGs emission inventory for 2016 submission

Sector CRF	Activity data	Methodology and selection of emission factors	Preparation of Sector inventories
Energy CRF1A1 CRF1A2 CRF1A4	NSI	ExEA, NSI	Sector expert ExEA External consultants
Energy/Transport CRF1A3	NSI MI MTITC	ExEA, NSI MI, MTITC	Sector expert ExEA External consultants
Energy CRF1B	NSI ME	ExEA, NSI, ME	Sector expert ExEA External consultants
Industry processes and product use CRF2	NSI ExEA MOEW NSI ExEA	ExEA, NSI, Installations operators	Sector expert ExEA
Agriculture CRF3	MAF NSPP	ExEA, MAF	Sector expert ExEA
LULUCF CRF3	EAF MAF	ExEA, EAF	Sector expert ExEA
Waste CRF4	NSI ExEA	ExEA, NSI	Sector expert ExEA

The National Inventory Compiler compiles the national GHGs inventory (CRF-tables and NIR) for submission under UNFCCC.

Documentation and data archiving

In August 2010 a new system for sector expert workflow organization, inventory documentation and data archiving has been implemented in the ExEA.

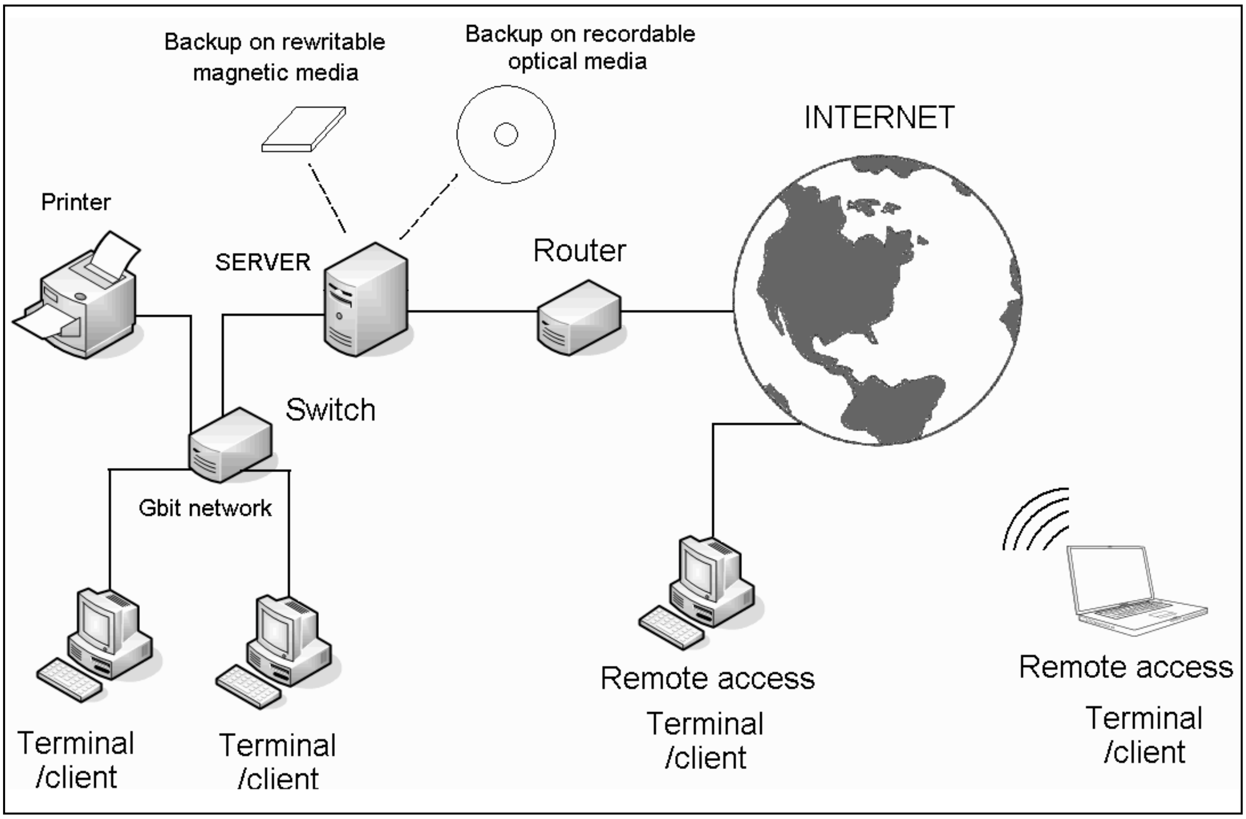

Figure 6 Documentation and data archiving in ExEA

1.3.1 QUALITY ASSURANCE, QUALITY CONTROL AND VERIFICATION

Fulfilment of paragraph 12(d)

As it is written above the Executive Environment Agency is responsible for the preparation of the GHGs Emission Inventory and the relevant National Inventory Reports under UNFCCC.

The ExEA is also responsible for coordination and implementation of QA/QC activities for the national inventory. A quality manger is in place.

The Bulgarian Quality Management System was established in the frame of project with Bulgarian Academy of Science, Geophysical Institute. The project was carried out and finished in 2008.

The QA/QC plan is an internal document to organise, plan and implement QA/QC activities. Once developed for the next submission, it is referenced and used in subsequent inventory preparation, or modified as appropriate.

The QA/QC plan has been updated in 2014 in order to implement the new established legal, institutional and procedural arrangements within the BGNIS. The updated National QA/QC Plan was approved by the Ministry of Environment and Water in December 2014.

National QA/QC Plan includes following elements:

- Responsible institutions;
- Data collection;
- Preparation of inventory;
- Category-specific QC procedures;
- QA and review procedures;
- Uncertainty analyses;
- Organisation of the activities in quality management system;
- Verification activities;
- Reporting, documentation and archiving.

does NOT require knowledge of the emission source category	requires knowledge of the emission source category
general	source specific
QC procedures sector experts (1st party) performed throughout preparation of inventory	
TIER 1	**TIER 2**
data validation, calculation sheet (check of formal aspects)	preparation of NIR, comparison with Guidelines (check of applicability, comparisons)
QA procedures quality manager (2nd or 3rd party; staff not directly involved, preferably independent) performed after inventory work has finished	
TIER 1 basic, before submission	
	MOEW experts **Internal audit / EU 'Initial check'** **(Expert Peer Review)**
	evaluate if TIER2 QC is effectively performed (check if methodologies are applicable)
TIER 2 extensive	
System audit (Audit)	**ICR by UNFCCC (Expert Peer Review)**
evaluate if TIER 2 QC is effectively performed	evaluate if TIER 2 QC is effectively performed (Check if methodologies are applicable)

must

Figure 7 National quality assurance and quality control program

The legal and institutional arrangements within the BGNIS regulate the responsibilities of all engaged institutions for implementation of the requirements of the National QA/QC Plan.

The QC procedures are performed by the sectors, who are directly involved in the process of preparation of inventory with their specific responsibilities.

The QC procedures are implemented by all activity data provider and ExEA's sector experts (Order № 296/04.12.2015 by the Executive Director of ExEA) and/or external consultants.

Table 3 QC experts within the BGNIS

Responsibility	QC experts
Activity data	MAF, MI, MTITC, ME, NSI, EAF, ExEA, MOEW
Methodology and selection of emission factors	ExEA, MAF, MI, MTITC, ME, NSI, EAF, MOEW
Sector inventories preparation	Sector experts ExEA and/or external consultants

The QC experts are:

- experts, responsible for activity data provision;
- experts, involved in the choice of method and selection of emission factors;
- sector experts and/or consultants, who prepare the sector inventories, including preparation of reporting tables and respective chapters from the national reports;

All institutions, engaged in the functioning of BGNIS are responsible for quality of information, which are provided by their competence to the ExEA for preparation of national emission inventories. The institutions are obligated to implement all requirements of the international and national standards for collection, processing and provision of activity data from them competence.

Quality Assurance (QA) is a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. The quality assurance process includes expert review was conducted in two stages: a review of the initial set of emission estimates and, a review of the estimates and text of the Inventory Report.

QA experts could be:

- Sector experts from the MoEW, which are engaged through internal administrative order by the minister of environment and water ;
- Experts from research institutes in accordance with them competence;
- Other external reviewer (national and/or international).

The QA procedures include the following checks in accordance with FCCC/SBSTA/2006/9:

Transparency means that the data sources, assumptions and methodologies used for an inventory should be clearly explained, in order to facilitate the replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of the information. The use of the common reporting format (CRF) tables and the preparation of a structured national inventory report (NIR) contribute to the transparency of the information and facilitate national and international reviews;

Accuracy means that emission and removal estimates should be accurate in the sense that they are systematically neither over nor under true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable. Appropriate methodologies should be used, in accordance with the 2006 IPCC Guidelines, to promote accuracy in inventories;

Consistency means that an annual GHG inventory should be internally consistent for all reported years in all its elements across sectors, categories and gases. An inventory is consistent if the same methodologies are used for the base and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. Under certain circumstances referred to in paragraphs 16 to 18 below, an inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, in accordance with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;

Comparability means that estimates of emissions and removals reported by Annex I Parties in their inventories should be comparable among Annex I Parties. For that purpose, Annex I Parties should use the methodologies and formats agreed by the COP for making estimations and reporting their inventories. The allocation of different source/sink categories should follow the CRF tables provided in annex II to decision 24/CP.19 at the level of the summary and sectoral tables;

Completeness means that an annual GHG inventory covers at least all sources and sinks, as well as all gases, for which methodologies are provided in the 2006 IPCC Guidelines or for which supplementary methodologies have been agreed by the COP. Completeness also means the full geographical coverage of the sources and sinks of an Annex I Party.

For 2016 submission the QA procedures are implemented by sector experts within the MoEW and experts from the ExEA, who are not directly involved in the preparation of inventory (Order № RD-218/05.03.2010 by the minister) or external reviewers.

The expert peer review present opportunity to uncover technical issues related to the application of methodologies, selection of activity data, or the development and choice of emission factors. The comments received during these processes are reviewed and, as appropriate, incorporated into the National Inventory Report or reflected in the inventory estimates.

The project for "Improvement of National Quality Management System for GHG Inventories in 2011-2012 can be seen as expert peer review.

Information of the QA/QC activities

According to the 2006 IPCC Guidelines the QA/QC system, that should be implemented for GHG Inventories consists of an inventory agency responsible for coordinating QA/QC activities, a QA/QC plan, general QC procedures (Tier 1), source category-specific QC procedures (Tier 2), QA review procedures and verifications as well as procedures regarding reporting, documentation and archiving.

The QA/QC plan is a basic element of the QA/QC system. The plan outlines QA/QC activities that are implemented and includes the scheduled time frame for inventory preparation from its initial development through the final reporting in any year. It contains an outline of the processes and schedule to review of all source categories.

The QA/QC plan is an internal document to organise, plan and implement QA/QC activities. Once developed for the next submission, it is referenced and used in subsequent inventory preparation, or modified as appropriate.

The main parts of the National QA/QC Plan for emissions inventories are presented in the next table:

Table 4 Comparison of 2006 IPCC GL and ISO 9001

	2006 IPCC GL	ISO 9001
1. Scope	✓	✓
2. Definitions	✓	✓
3. Administrative requirements	✓	✓
4. Organisation and management	✓	✓
5. Quality system	✓	✓
6. Personnel	✓	✓
7. Facilities and equipment	✓	✓
8. Handling of inspection samples and items	✓	✓
9. Records	✓	✓
10. Reports	✓	✓
11. Sub-contracting	✓	✓
12. Complaints and appeals	✓	✓

The cycle of QA/QC activity for inventory consists of the following steps:

The QA/QC Manager prepares a Plan for implementation of QA/QC activities for the current submission. The check list with all specific QA/QC procedures are part of the plan;

The plan for QA/QC is sent to all engaged QC and QA experts for implementation;

In the process of preparation of inventory the QC experts (activity data provider and ExEA's sector experts) apply each of the specific procedures set in the check list for each of the sources categories they are responsible for.

The QA/QC Manager coordinate the exchange of the check lists between the QC experts for correction of the findings with input data for calculation of emissions (activity data and EF).

The QA/QC Manager send to the QA experts the prepared by ExEA's sector expert and/or external consultants CRF tables and respective chapters from NIR;

The QA/QC Manager coordinate the exchange of the check lists between the QA experts and ExEA's sector expert and/or external consultants for correction of the findings with quality of the inventory (CRF and NIR);

The QA/QC Manager prepares a summary of the results from implemented QA/QC checks.

The QA/QC Manager prepares an attendant file for implemented procedures;

The QA/QC Manager prepares a report to the executive director of the ExEA for results of the performed QA/QC procedures and improvement plan for the next reporting round;

The QA/QC Manager is responsible for documentation and archiving of all documents, related to performed QA/QC procedures in the national System for documentation and archiving of inventory in ExEA.

QA/QC activities of data provider

The QA/QC Plan is provided for implementation to all institutions, which are engaged in the process of preparation of emissions inventories under UNFCCC as provision of the relevant activity data.

Based on the National QA/QC Plan each of the institutions has nominated experts, responsible for preparation of the required information as well as for implementation of QA/QC procedures.

The QC experts are all experts from the institutions, who are engaged to participate in the activity of BGNIS and to implement the requirements of National QA/QC Plan.

All institutions, engaged in the functioning of BGNIS are responsible for quality of information, which are provided by their competence to the ExEA for preparation of national emission inventories. The institutions are obligated to implement all requirements of the international and national standards for collection, processing and provision of activity data from their competence.

The QC experts fill in a check-list, which is an annex to the National QA/QC plan. The QC experts fill the check-list for the sector they are responsible for and in the part "Review of input data for calculation of emissions", "Activity data" and/or "Method and EF".

The check list contains all general and specific procedures for QC. It consist information for carried out review by the QC experts, including findings and corrections made.

The check lists are filled in by QC experts in accordance with them responsibilities and for each category (CRF).

The check lists are exchange between QC experts for correction of the findings with input data for calculation of emissions in the respective sectors.

Table 5 Responsibilities in the exchange of check lists between QC experts for 2016 submission

Sector CRF	Activity data		Methodology/ emission factors		Emission calculations	
	Check	Correction	Check	Correction	Check	Correction
Energy CRF1	ExEA NSI ME	NSI ME	ExEA NSI ME	ExEA	ExEA NSI ME	ExEA
Transport CRF1A3	ExEA NSI MI MTITC	MTITC MI NSI	ExEA NSI MI MTITC	ExEA	ExEA NSI MI MTITC	Sector expert ExEA
Industry processes and product use CRF2	NSI ExEA	NSI ExEA	NSI ExEA	ExEA	NSI ExEA	Sector expert ExEA

Agriculture CRF3	ExEA MAF	MAF	ExEA MAF	ExEA	ExEA MAF	Sector expert ExEA
LULUCF CRF3	ExEA EAF	EAF	ExEA EAF	ExEA	ExEA EAF	Sector expert ExEA
Waste CRF4	NSI ExEA	NSI ExEA	NSI ExEA	ExEA	NSI ExEA	Sector expert ExEA

General (QC) procedures are described in Checklists that is part of QA/QC Plan.

As it is written above for 2016 submission the QA procedures are implemented by sector experts within the MoEW and experts from the ExEA, who are not directly involved in the preparation of inventory (Order № RD-218/05.03.2010 by the minister) or external reviewers

The QA experts fill a check list in the part "Review of reporting tables and National report" in the sector of them competence.

The check list contains all general and specific procedures for QA. It consist information for carried out review by the QA experts, including findings and corrections made.

The check lists are filled out by QA experts in accordance with their responsibilities for each category (CRF).

The check lists are exchanged between QA experts and sector expert in ExEA and/or external consultant for correction of the findings with reporting tables and respective chapters from national reports.

Table 6 Responsibilities in exchange of the check lists between QA experts and sector experts for 2016 submission

Sector - CRF	Reporting Tables - CRF		National Report - NIR	
	Check	**Correction**	**Check**	**Correction**
Energy CRF1	MOEW ExEA	Sector expert ExEA	MOEW ExEA	Sector expert ExEA
Industry processes and product use CRF2	Rview expert ExEA	Sector expert ExEA	Review expert ExEA	Sector expert ExEA
Agriculture CRF3	ExEA and/or external auditor	Sector expert ExEA	ExEA and/or external consultant	Sector expert ExEA
LULUCF CRF3	Review expert ExEA	Sector expert ExEA	Review expert ExEA	Sector expert ExEA
Waste CRF4	Review expert ExEA	Sector expert ExEA	Review expert ExEA	Sector expert ExEA

Quality management of the sources of initial data

Each organization – data source, solves the quality management issues in accordance with its internal rules and provisions. With some of the sources as NSI, MAF, etc., those rules follow strictly the international practices. For example, quality assessment/quality control procedures with NSI have been harmonized with the relevant instructions and provisions of EUROSTAT. Strict rules on data processing and storage, harmonized with international organizations. Some of the large enterprises – GHG emission sources, have well arranged and effective quality management systems. Most of them have introduced quality management systems on the basis of ISO 9001:2000 standard.

Fulfilment of paragraph 12(e)

Official consideration and approval of the inventory

Bulgaria's reporting obligations to the UNFCCC, UNECE and EC are being administered by the MoEW. All activities on preparation of GHG inventory in Bulgaria are coordinated and managed on the state level by MoEW. The ExEA is the responsible organization for preparation of Bulgaria's National GHG Inventory under the UNFCCC and the Kyoto Protocol and designated as single national entity (see Figure 1 Organizational Chart of the Bulgarian National Inventory System).

Quality improvement

Fulfilment of paragraph 13

Since November 2011, a project for **"Improvement of National Quality Management System for GHG Inventories"** had been started together with the Austrian Environmental Agency. The project is funded by the **German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety** and **German Federal Environment Agency** with means of the Advisory Assistance Programme for Environmental Protection in the Countries of Central and Eastern Europe, the Caucasus and Central Asia.

The objectives of the project are:

Third-party audit[24] of the current QMS according to ISO 19011 Guidelines for quality and/or environmental management system auditing (and ISO 17020 General criteria for the operation of various types of bodies performing inspection):

- To analyze/review the current QMS (in accordance with the IPCC GPG)
    1. system audit
    2. procedures audit

[24] Audits are used to determine the extent to which the quality management system requirements are fulfilled. Audit findings are used to assess the effectiveness of the quality management system and to identify opportunities for improvement.

- First-party audits are conducted by, or on behalf of, the organization itself for internal purposes and can form the basis for an organization's self-declaration of conformity.
- Second-party audits are conducted by customers of the organization or by other persons on behalf of the customer.
- Third-party audits are conducted by external independent organizations.

Such organizations, usually accredited, provide certification or registration of conformity with requirements such as those of ISO 9001.

ISO 19011 provides guidance on auditing.

- Identification of improvements
    1. QMS Manual
    2. Quality Policy
    3. Roles and responsibilities
    4. QC activities
    5. Quality assurance (QA) activities
    6. Documentation and archiving System within NIS.
    7. Development of Procedures and Checklists
    8. Improvement plan for the QMS and GHG Inventory
- Proposal on implementation of the improvements
- Training of the quality manager and the sectoral experts (within the QMS) according to 2006 IPCC GL Chapter 6 and following the ISO 9000 standards

The outcome of the project is development of an efficient and optimal aligned QMS, that fulfils every quality requirement of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Chap. 6).

WORK PLAN FOR SUBMISSION 2017

Fulfilment of Para 16(a) (b) (c) and 17 Inventory management

The next table presents the responsibilities of all engaged institutions for preparation of GHGs emission inventory for 2017 submission.

Table 7   Preparation of GHGs emission inventory for 2017 submission

Sector CRF	Activity data	Methodology and selection of emission factors	Preparation of Sector inventories
Energy CRF1A1 CRF1A2 CRF1A4	NSI	ExEA, NSI	Sector expert ExEA
Energy/Transport CRF1A3	NSI MI MTITC	ExEA, NSI MI, MTITC	Sector expert ExEA
Energy CRF1B	NSI MEE	ExEA, NSI, ME	Sector expert ExEA
Industry processes and product use CRF2	NSI ExEA MOEW ExEA	ExEA, NSI, Installations operators	Sector expert ExEA
Agriculture CRF3	MAF NSPP	ExEA, MAF	Sector expert ExEA
LULUCF CRF3	EAF MAF	ExEA, EAF	Sector expert ExEA
Waste CRF4	NSI ExEA	ExEA, NSI	Sector expert ExEA

The Work plan for preparation and submission of National GHGs inventory in 2017 is presented in the next table.

Table 8   Work plan for GHGs inventory preparation and submission 2017

Action	Responsible organization	Initial Deadline	Final Deadline	Comment
Sending of statistic questionnaire to all enterprises in the country	NSI with its regional inspectorates	31.03.16	15.06.16	NSI uses statistical methods and procedures for data collection, sum-marizing and structuring that are harmonized with EUROSTAT
Sending of letters to the responsible organizations for provision of necessary activity data.	ExEA	31.03.16	15.06.16	
QA/QC Procedures -	NSI MAF, ME,	15.06.16	30.09.16	National QA/QC Plan

Action	Responsible organization	Initial Deadline	Final Deadline	Comment
Implementation of the requirements of National QA/QC Plan.	MEW, SFA, RCD			
Provision of all collected activity data by questionnaires and other sources of information to ExEA	NSI MAF, ME, MEW, EFA, MIA	30.09.16	30.10.16	
QA/QC Procedures - Implementation of the requirements of National QA/QC Plan	ExEA	30.10.16	15.11.16	QA/QC expert, responsible for implementation of all procedures laid down in the National QA/QC Plan
Provision of annual national energy and material balances to ExEA	NSI		30.11.16	
Preliminary estimation of emissions	ExEA, external consultants		15.12.16	
Provision of corrected activity data as a result of QA/QC procedures to ExEA	NSI MAF, ME, MEW, EFA, MIA		20.12.16	
Recalculation of emissions, based on the corrected activity data of inventory in the required format for reporting	ExEA and external consultant		31.12.16	
Preparation of Preliminary national inventory report (NIR) to the EC.	ExEA		10.01.17	
Submission of national GHG inventory under the RMM with the short NIR.	ExEA		15.01.17	Delivered to Eionet Central Data Repository
Submission of final national GHG inventory and NIR.	ExEA		15.03.17	Delivered to Eionet Central Data Repository
Submission of the final GHG inventory and NIR after the European Commission comments	MEW ExEA		15.04.17	Official submission to UNFCCC Delivered to Eionet Central Data Repository
Documentation and archiving of inventory. Preparation of inventory management report	ExEA		15.05.17	
Preparation of QA/QC plan for the next inventory.	ExEA		15.06.17	

Fulfilment of Para 14(d) Make a quantitative estimate of inventory uncertainty for each source category and for the inventory in total, following the 2006 IPCC Guidelines

As a whole, the uncertainty assessment of the GHG inventories follows the methodology of the 2006 IPCC Guidelines . The overall uncertainty is closely related to the GHG emission sources data uncertainty (fuels, activities, processes, etc.) and to the emission factor uncertainty.

The uncertainties for all the emission sources (key and non-key) and emission factors are presented in Chapter 1.3.

Fulfilment of Para 15. As part of its inventory preparation, each Party included in Annex I should:

(a) Apply source-category-specific QC procedures (tier 2) for key source categories and for those individual source categories in which significant methodological and/or data revisions have occurred, in accordance with the IPCC good practice guidance;

(b) Provide for a basic review of the inventory by personnel that have not been involved in the inventory development, preferably an independent third party, before the submission of the inventory, in accordance with the planned QA procedures referred to in paragraph 12 (d) above;

(c) Provide for a more extensive review of the inventory for key source categories, as well as source categories where significant changes in methods or data have been made;

(d) Based on the reviews described in paragraph 15 (b) and (c) above and periodic internal evaluations of the inventory preparation process, re-evaluate the inventory planning process in order to meet the established quality objectives referred to in paragraph 12 (d).

VERIFICATION ACTIVITIES

Emission and activity data are verified by comparing them with other available data compiled independently of the GHG inventory system. These include data from research projects and other obligations for other purposes but producing information relevant to the inventory preparation. Verification activities that have been undertaken are described in the category-specific chapters.

TREATMENT OF CONFIDENTIALITY ISSUES

ExEA ensures confidentiality of sensitive information that is data declared as confidential obtained in the course of preparing the national GHG inventory. ExEA is a member of the National Statistics Institute (NSI).

Confidentiality of statistics: The strict confidentiality provisions concerning handling of sensitive data relating to individuals and organisations are regulated by the Statistics Law.

Security of data: Confidentiality of sensitive data used to calculate the emissions is a legal obligation.

Furthermore a checklist with the following items is elaborated:

Outlines what information is to be treated as confidential;

Identify sectoral expert who is dealing with the information;

Identify the use to which the information can be put;

Specify the publishment of confidentiality data on an aggregated level.

1.4 BRIEF GENERAL DESCRIPTION OF METHODOLOGIES (INCLUDING TIERS USED) AND DATA SOURCES USED

Fulfilment of Para 14(b) (c) (e) (f)

The most recent greenhouse gas inventory for the period 1988 to 2014 (NIR 2016) was compiled according to the recommendations for inventories set out in the UNFCCC reporting guidelines according to Decision 24/CP.19, the Common Reporting Format (CRF) and the 2006 IPCC Guidelines.

The GHG inventory represents a process, covering the following main activities:

- Collecting, processing and assessment of input data on used fuels, produced output, materials and other GHG emission sources;
- Selection and application of emission factors for estimating the emissions;
- Determination of the basic (key) GHG emission sources and assessment of the results uncertainty.

Each year during inventory, some changes occur that affect directly the activities above enlisted. Important inventory stage is the process of data transformation into a form, suitable for CRF Tables format. During this process, aggregation of the fuels by type is made (solid, liquid and gaseous), and further data is added, regarding parameters and indices, specifying the systems for transportation and distribution of oil and natural gas, the systems for fertilizer processing, etc. These activities are just a part of additional data, filled in the CRF Tables.

National Inventory Methodology

According to Clean Air Act, article 25 (6) The Minister of Environment and Water in co-ordination with the interested ministers issues an order for the approval of a Methodology for the calculation, with balance methods, of the emissions of harmful substances (pollutants), emitted in the ambient air. The national Methodology (approved with Order RD 77 from 03.02.2006 of MEW) is harmonized with CORINAIR methodology for calculation of the emissions according to the UNECE/LRTAP Convention.

During 2007, MEW/ExEA had a project for development of Common methodology for emissions inventory under UNECE/LRTAP Convention and UNFCCC, i.e. to update the present Methodology under article 25 (6) CAA. (Approved with Order RD 40 from 22.01.2008 of MEW). The aim of the project was harmonization of the national Methodology with IPCC, including the three main greenhouse gases – CO_2, CH_4 and N_2O (plus relevant ODS and SF_6).

The Bulgarian national GHGs inventory and NIR are compiled according to requirements of the following documents:

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC GL)
- EMEP/EEA air pollutant emission inventory guidebook – 2013

The emission factors are mainly from:

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC GL)
- EMEP/EEA air pollutant emission inventory guidebook – 2013

- Country-specific

The following tables summarise the 'Applied method' and 'Emission factor' of the inventory 2014, submission 2016.

Table 9 Methods and the emission factors applied (CO_2, CH_4, N_2O)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
1. Energy	T1,T2	CR,CS,D	T1,T2	CR,D	NA,T1,T2	CR,D,NA
A. Fuel combustion	T1,T2	CR,CS,D	T1,T2	CR,D	NA,T1,T2	CR,D,NA
1. Energy industries	T1,T2	CS,D	T1	D	NA,T1	D,NA
2. Manufacturing industries and construction	T1,T2	CS,D	T1	D	T1	D
3. Transport	T1,T2	CR,CS,D	T1,T2	CR,D	T1,T2	CR,D
4. Other sectors	T1,T2	CS,D	T1	D	T1	D
5. Other	T1,T2	CS,D	T1	D	T1	D
B. Fugitive emissions from fuels	T1	D	T1	D	T1	D
1. Solid fuels	NA	NA	T1	D	NA	NA
2. Oil and natural gas	T1	D	T1	D	T1	D
C. CO_2 transport and storage	NA	NA				
2. Industrial Processes	D,T1,T2	CR,CS,D,PS	D,NA	D,NA	T1,T3	CS,D,PS
A. Mineral industry	T1,T2	CS,D,PS				
B. Chemical industry	T2	CS,PS	D	D	T3	PS
C. Metal industry	T1,T2	CS,D	NA	NA		
D. Non-energy products from fuels and solvent use	T1, T2	CR,D				
E. Electronic industry						
F. Product uses as ODS substitutes						
G. Other product manufacture and use	T1	D			T1	CS,D
H. Other	D	D			NA	NA
2. Agriculture			D,T1,T2	CS,D	D,T1	D
A. Enteric fermentation			T1,T2	CS,D		
B. Manure management			T1,T2	CS,D	T1	D
C. Rice cultivation			T1	D		
D. Agricultural soils(3)					T1	D
E. Prescribed burning of savannas						
F. Field burning of agricultural residues			D	D	D	D
G. Liming						
H. Urea application	T1	D				
I. Other carbon-containing fertilizers	NA	NA				
J. Other						
4. LULUCF	D,T1,T2,T3	CS,D	T1	D	T1	D
A. Forest land	T1,T3	CS,D	T1	D	T1	D
B. Cropland	T1,T3	CS,D				
C. Grassland	T1,T3	CS			NA	NA
D. Wetlands					NA	NA
E. Settlements						
F. Other land	T2	CS				
G. Harvested wood products	T1, T2	D				
H. Other	T1,T2	CS,D	T1	D	T1	D

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
5. Waste	NO,T1	D,NO	NO,T1,T2	CS,D,NO	NO,T1	D,NO
A. Solid waste disposal	NA	NA	T2	CS,D		
B. Biological treatment of solid waste			NO,T1	D,NO	NO,T1	D,NO
C. Incineration and open burning of waste	NO,T1	D,NO	NO,T1	D,NO	NO,T1	D,NO
D. Waste water treatment and discharge			NO,T2	D,NO	NO,T1	D,NO
E. Other	NO	NO	NO	NO	NO	NO
7. Other (specified in Summary 1.A)	NO	NO	NO	NO	NO	NO

Table 10 Methods and the emission factors applied: HFCs, PFCs, SF_6

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFCs		PFCs		SF_6		NF_3	
	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor	Method applied	Emission factor
2. Industrial processes	T2	D	T2	D	T2	D	NO	NO
A. Mineral industry								
B. Chemical industry								
C. Metal industry								
D. Non-energy products from fuels and solvent use								
E. Electronic industry								
F. Product uses as ODS substitutes	T2	D	T2	D	T2	D	NO	NO
G. Other product manufacture and use								
H. Other								

The following notation keys were used to specify the method applied:		
D (IPCC default)	**T1a, T1b, T1c** (IPCC Tier 1a, Tier 1b and Tier 1c, respectively)	**CR** (CORINAIR)
RA (Reference Approach)	**T2** (IPCC Tier 2)	**CS** (Country Specific)
T1 (IPCC Tier 1)	**T3** (IPCC Tier 3)	**OTH** (Other)
If using more than one method within one source category, list all the relevant methods. Explanations regarding country-specific methods, other methods or any modifications to the default IPCC methods, as well as information regarding the use of different methods per source category where more than one method is indicated, should be provided in the documentation box. Also use the documentation box to explain the use of notation OTH.		
Use the following notation keys to specify the emission factor used:		
D (IPCC default)	**CS** (Country Specific)	**OTH** (Other)
CR (CORINAIR)	**PS** (Plant Specific)	

1.5 BRIEF DESCRIPTION OF KEY CATEGORIES

Fulfilment of paragraph 14(a)

The key category analysis follows the Approach 1 and Approach 2 is performed according to the 2006 IPCC Guidelines (IPCC 2006, chapter 4) .

According to method of the Approach 2 assessment of the key sources is made by identifying the uncertainty of each source. The uncertainty is the combined uncertainty of the assessment, which is a mean quadratic assessment of the uncertainty of the data and of the emission factors.

The key source identification of the Bulgarian inventory includes all reported greenhouse gases CO_2, CH_4, N_2O, HFC, PFC, NF_3 and SF_6, and all IPCC source categories, including LULUCF. The key source analysis is performed by the ExEA with data for greenhouse gas emissions of the corresponding current submission and comprises a level assessment for all years between 1988 and the last reported year and trend assessments for the trend of the latest reported years with respect to base year emissions.

Emissions and removals from LULUCF are included in the key category analysis which is performed according to the 2006 IPCC Guidelines.

The key category analysis is used to prioritize improvements that should be taken into account for the next inventory submissions. First of all, it is important that emissions of key categories, being the most significant in terms of absolute weight and/or combined uncertainty, are estimated with a high level of accuracy.

The Key Category analysis Approach 1 and Approach 2 method including and excluding LULUCF is provided in Annex 1.

1.6 GENERAL UNCERTAINTY EVALUATION, INCLUDING DATA ON THE OVERALL UNCERTAINTY FOR THE INVENTORY TOTALS

This section provides an overview of the approach to uncertainty analysis adopted for the Bulgarian inventory. The mandatory, detailed reporting table of the analysis for all the emission sources (key and non-key) and emission factors is provided in as Approach 1 Uncertainty calculation and reporting'.

The present approach consists of two levels: screening and detailed analysis. Screening is done with Approach 1 uncertainty analysis. The key categories are discussed with the sectoral experts during the annual quality meetings.

Separate uncertainty calculation was performed using a spreadsheet prepared specifically according to the Approach 1 (2006 IPCC GL).

GHG INVENTORY

As a whole, the uncertainty assessment of the GHG inventories follows the methodology of the 2006 IPCC GL.

The overall uncertainty is closely related to the GHG emission sources data uncertainty (fuels, activities, processes, etc.) and to the emission factor uncertainty.

The uncertainty of the GHG emission sources can be defined during data collection and processing and it is a part of procedures, applied by the statistical authorities, differences between the production, import, export and consumption of fuels, expert assessment, etc.

The uncertainty of emission factors depends on the origin of the factors applied. In case the emission factors result from direct periodical measurements, the uncertainty is determined by the relevant methodology, related to the measuring methods and apparatuses.

The overall uncertainty of the GHG inventory is determined by combining the emission sources uncertainty and the emission factors uncertainty.

Two rules are applied in this process:

Rule A - combination of the uncertainty by summing;

Rule B - combination of the uncertainty by multiplying.

Since the GHG inventories are sums of the products of emission sources, multiplied by emission factors, the two rules above can be used for determining the overall uncertainty of the inventory.

Rules A and B represent the foundation of the Approach 1 method, recommended in the Good Practice Guidance.

The uncertainties for all the emission sources (key and non-key) and emission factors are presented in Table 12.

Combined uncertainty as a part of overall emissions for 2014 for every source has been calculated as following equation:

$$MCU_i = (EM_i/EM_{total}) x\ CU_i$$

where MCUi – measured combined uncertainty,

EM_i - source emissions for 2014,

EM_{total} – total country emissions for 2014,

CN_i – combined uncertainty of the i-th source.

Uncertainty of the overall emissions trend for 2014 for every source has been calculated as HTi – overall emissions trend uncertainty brought in by the i-th source. This uncertainty calculates in column M of Table 3.2 of p.3.31 of the 2006 IPCC GL.

The calculated uncertainties, in %, of the overall national GHG emissions for the year 2014 (column H in Table 3.2 of the 2006 IPCC GL), and the overall emission trend related to the base inventory year until 2014 (column M in Table 3.2) are given in Table 11. The relevant data for the previous inventory for 2013 are given for comparison (NIR 2015 and NIR 2016).

Table 11 Uncertainty in total GHG emissions, %

Uncertainty	Uncertainty NIR 2015	Uncertainty NIR 2016
Uncertainty in total GHG emissions	14.09 %	12.48 %
Overall uncertainty into the trend in total GHG emissions	1.29	1.99

The respective sectoral uncertainties are documented in detail in the sectoral chapters of this report. The complete uncertainty information and other background information are presented in Annex 2.

1.7 GENERAL ASSESSMENT OF THE COMPLETENESS

GHG INVENTORY

Completeness by source and sink categories and gases

Bulgaria has provided estimates for all significant IPCC source and sink categories according to the detailed CRF classification. Estimates are provided for the following gases: CO_2, N_2O CH_4, F-gases (HFC, PFC, NF_3 and SF_6), NMVOC, NOx, CO and SO_2. In accordance with the IPCC Guidelines, international aviation and marine bunker fuel emissions are not included in national totals. However, CO_2, CH_4 and N_2O emissions from lubricants from International bunkers are included in emissions from feedstock and non-energy use of the fuels. Lubricants are not split between domestic and international, as only information on total sales of lubricants is available in fuel statistics.

CRF - Table 9 (Completeness) has been used to give information regarding completeness. An assessment of completeness for each sector is given in the Sector Overview part of the corresponding subchapters.

All sources and sinks included in the IPCC Guidelines are addressed. No additional sources and sinks specific to Bulgaria have been identified.

Completeness by geographical coverage

The geographic coverage is complete. There is no part of the Bulgarian territory not covered by the national inventory.

Completeness by timely coverage

A complete set of CRF tables are provided for all years and the estimates are calculated in a consistent manner.

Notation keys

The sources and sinks not considered in the inventory but included in the IPCC Guidelines are indicated, the reasons for such exclusion are explained. In addition, the notation keys presented below are used to fill in the blanks in all the tables in the CRF. Notation keys used in the NIR are consistent with those reported in the CRF. Notation keys are used according to the UNFCCC guidelines (UNFCCC 2014).

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

IE (included elsewhere):

"IE" for emissions by sources and removals by sinks of GHGs estimated but included elsewhere in the inventory instead of under the expected source/sink category. Where "IE" is used in an inventory, the Annex I Party should indicate, in the CRF completeness table (Table 9), where in the inventory the emissions or removals for the displaced source/sink category have been included, and the Annex I Party should explain such a deviation from the inclusion under the expected category, especially if it is due to confidentiality. .

NE (not estimated):

"NE" for AD and/or emissions by sources and removals by sinks of GHGs which have not been estimated but for which a corresponding activity may occur within a Party.6 Where "NE" is used in an inventory to report emissions or removals of CO_2, N_2O, CH_4, HFCs, PFCs, SF_6 and NF_3, the Annex I Party shall indicate in both the NIR and the CRF completeness table why such emissions or removals have not been estimated. Furthermore, a Party may consider that a disproportionate amount of effort would be required to collect data for a gas from a specific category that would be insignificant in terms of the overall level and trend in national emissions and in such cases use the notation key "NE". The Party should in the NIR provide justifications for exclusion in terms of the likely level of emissions. An emission should only be considered insignificant if the likely level of emissions is below 0.05 per cent of the national total GHG emissions and does not exceed 500 kt CO_2 eq. The total national aggregate of estimated emissions for all gases and categories considered insignificant shall remain below 0.1 per cent of the national total GHG emissions.9 Parties should use approximated AD and default IPCC EFs to derive a likely level of emissions for the respective category. Once emissions from a specific category have been reported in a previous submission, emissions from this specific category shall be reported in subsequent GHG inventory submissions. .

NA (not applicable):

"NA" for activities under a given source/sink category that do occur within the Party but do not result in emissions or removals of a specific gas. If the cells for categories in the CRF tables for which "NA" is applicable are shaded, they do not need to be filled in. .

"NO" (not occurring):

"NO" for categories or processes, including recovery, under a particular source or sink category that do not occur within an Annex I Party;

C (confidential):

"C" is used for emissions which could lead to the disclosure of confidential information if reported at the most disaggregated level. In this case a minimum of aggregation is required to protect business information.

KP-LULUCF INVENTORY

All activities according to Article 3.3 and 3.4 of the Kyoto Protocol are described in Chapter 11.

2 TRENDS IN GREENHOUSE GAS EMISSIONS

Description and interpretation of emission trends for aggregated greenhouse gas emissions

In 2014 Bulgaria's greenhouse gas emissions totalled 57 197,22 Gg CO_2 without reporting of sequestration from LULUCF sector. The emissions decreased by 50,08 % compared with the base year. Emissions in 2014 were 4.10 % increase in comparison with the emissions of the previous year.

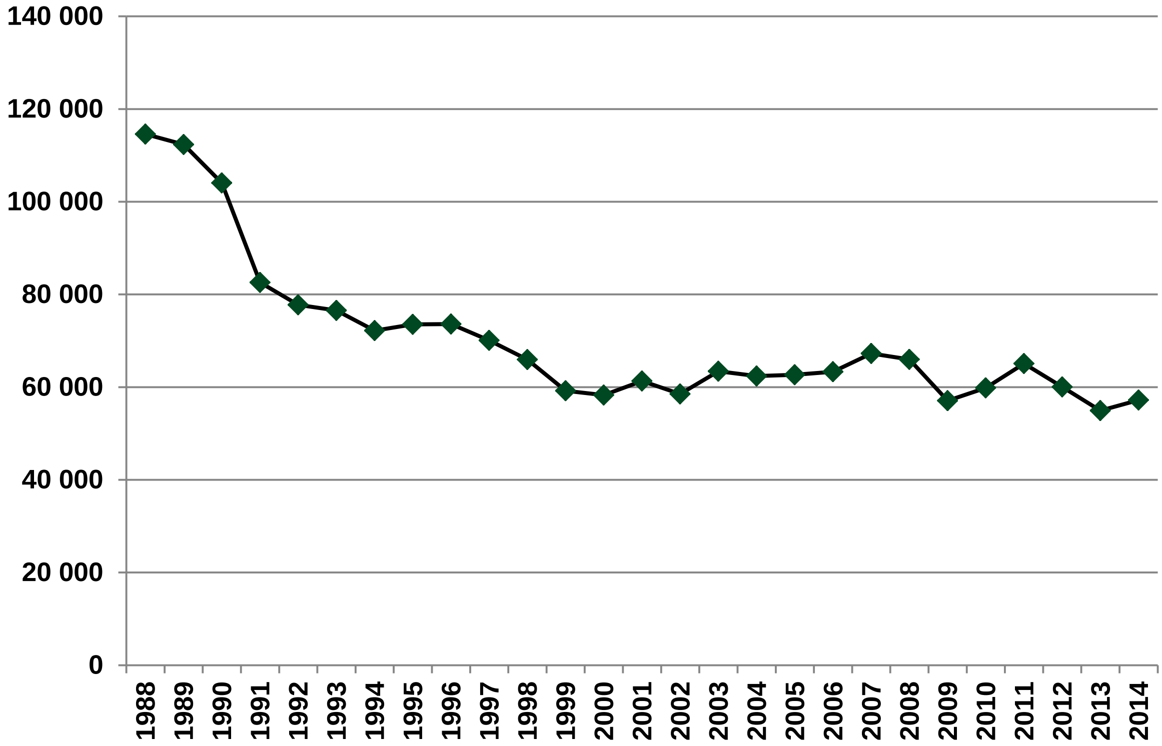

Figure 8 Total GHG emissions (without LULUCF) for 1988 – 2014, Gg CO_2 eq.

The net emissions including reporting of sequestration from LULUCF sector were 45 933,50 Gg CO_2 eq. The emissions decreased by 53.74 % compared with the base year.

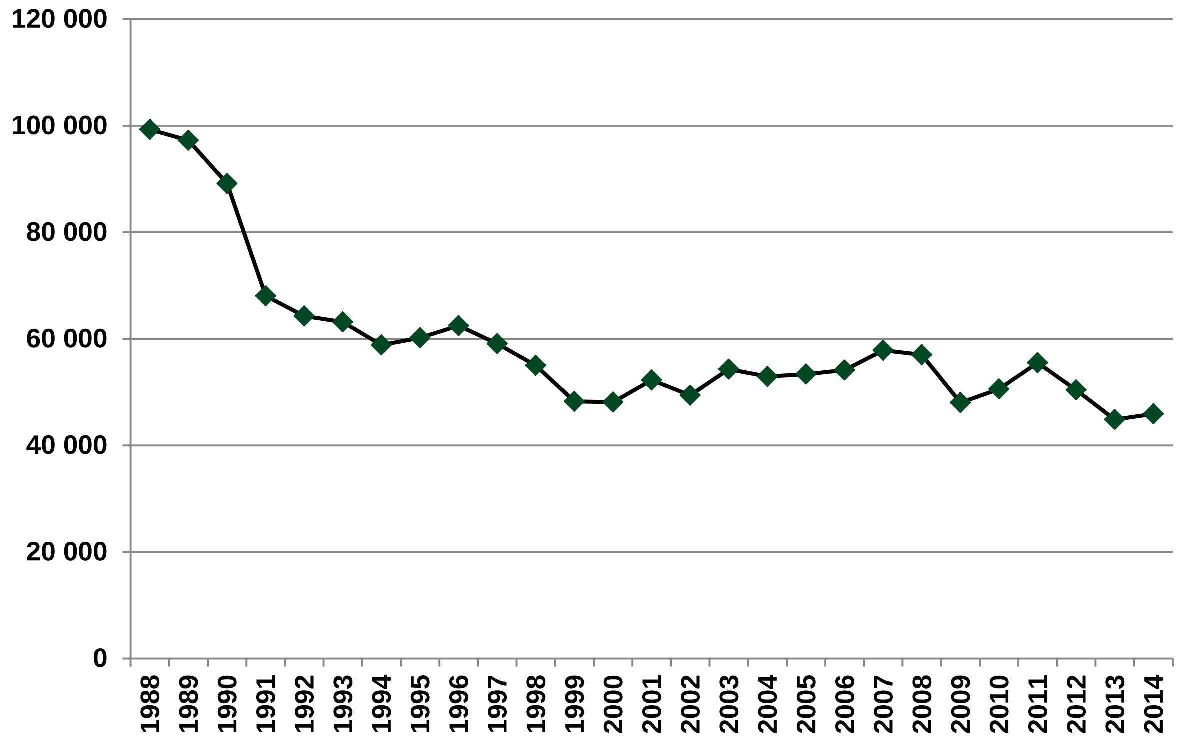

Figure 9 Total GHG emissions (with LULUCF) for 1988 – 2014, Gg CO_2 eq.

The main reasons for the declining GHG emission trend in Bulgaria are the structural economic changes due to the radical transition process from a centrally-planned economy to a market-based economy. This led to a decrease of power production from thermal power stations (and an increase of the shares of hydropower and nuclear power), structural changes in industry (including a decline in production by energy-intensive enterprises and energy - efficiency improvements), introduction of energy efficiency measures in the residential sector and a shift form solid and liquid fuels to natural gas in energy consumption. This also led to a decrease in GHG emissions from the agricultural sector stemming from the decline in the cattle and sheep populations and the use of fertilizers.

Bulgaria experienced a steady declining population trend during the period 1988-2014, which resulted in the reduction of population by 20%.

2.1 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS FOR AGGREGATED GHG EMISSIONS

The most important greenhouse gas in Bulgaria is carbon dioxide. The share of CO_2 emissions from the total greenhouse gas emissions varies around 79% excluding LULUCF and 59% including LULUCF. In absolute terms CO_2 emissions have decreased 49% since 1988. Around 75% of total CO_2 eq emissions originate from the Energy sector. The amount of energy-related CO_2 emissions has fluctuated much according to the economic trend, the energy supply structure (including electricity exports) and climate conditions.

Methane emissions (CH_4) have decreased by 56% from the 1988 level. This is mainly due to the improvements in waste collection and treatment and a reduction in animal husbandry in the Agriculture sector. Correspondingly, emissions of nitrous oxide (N_2O) have also decreased by 62% which has been occasioned mostly by the reduced nitrogen fertilisation of agricultural fields, the biggest decline was in the beginning of time series.

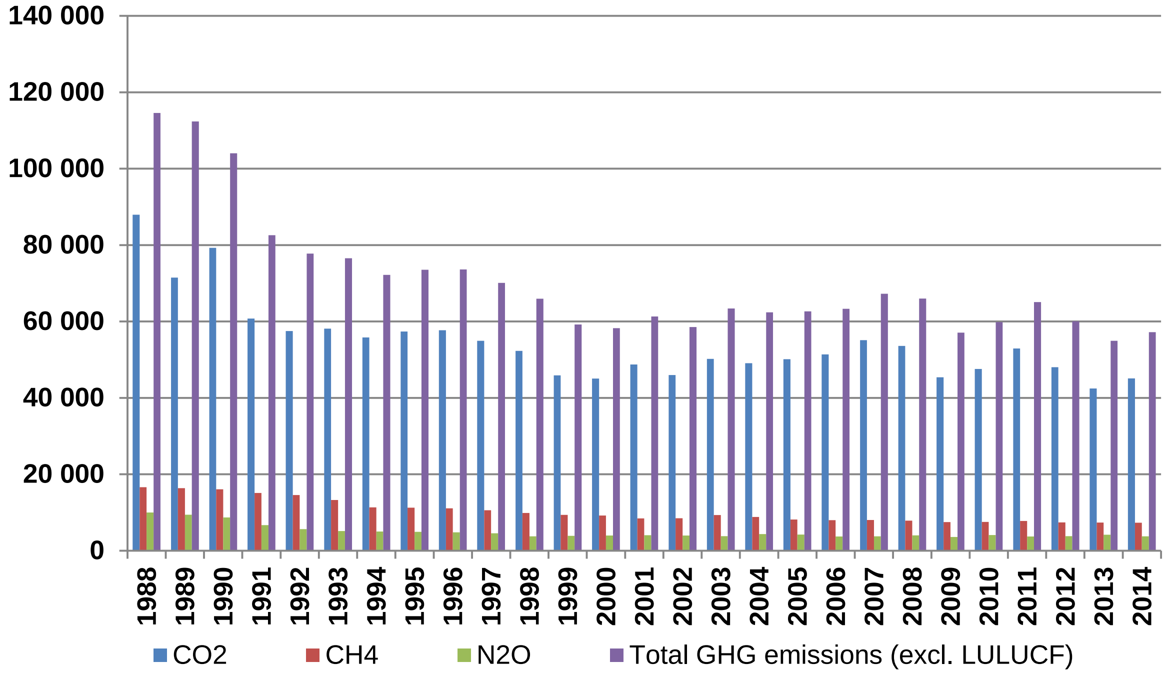

Figure 10 Total GHG emissions in Gg CO_2 eq. for 1988 – 2014

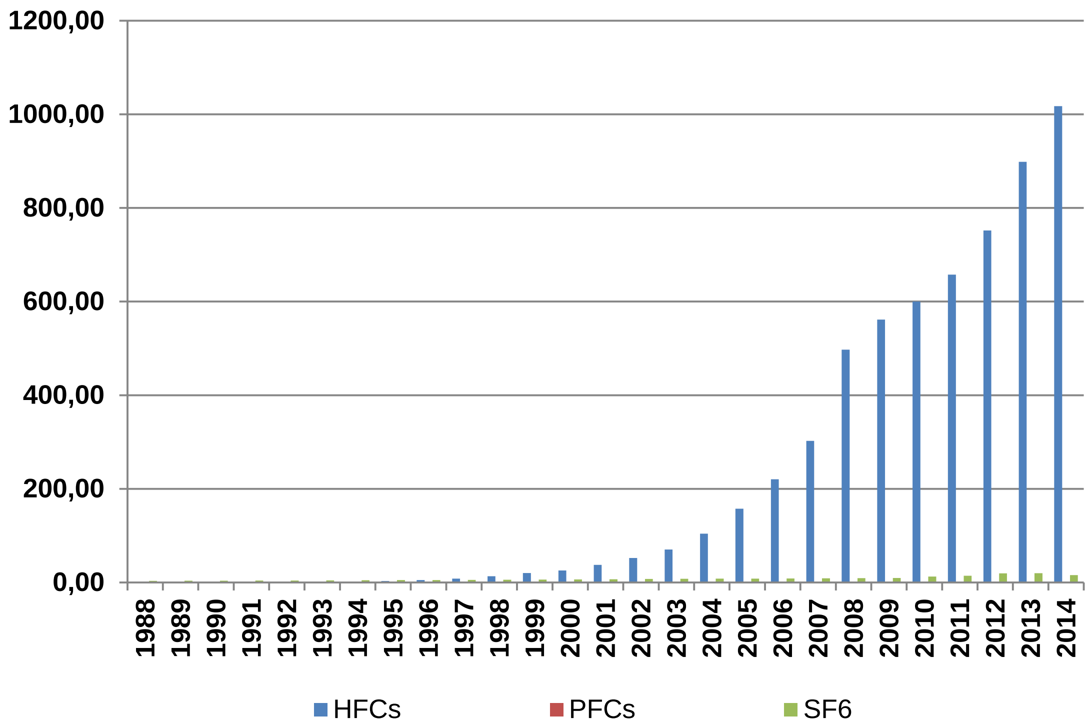

Figure 11 Actual emissins of HFCs, PFCs and SF_6 for 1988 – 2014, Gg CO_2 eq.

The emissions of F-gases have increased over tenfold during 1995-2014. A key driver behind the trend has been the substitution of ozone depleting substances (ODS) by F-gases in many applications.

2.2 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS BY SECTOR

Figure 12 below shows the GHG aggregated emission trends by IPCC sectors. The Energy sector, where GHG emissions come from fuel combustion, headed the list in 2014 with the biggest share – 73.6%. Sector Agriculture ranked the second place with 10.6% and sectors Waste ranked the third place with 8% and IP with 7.7 %.

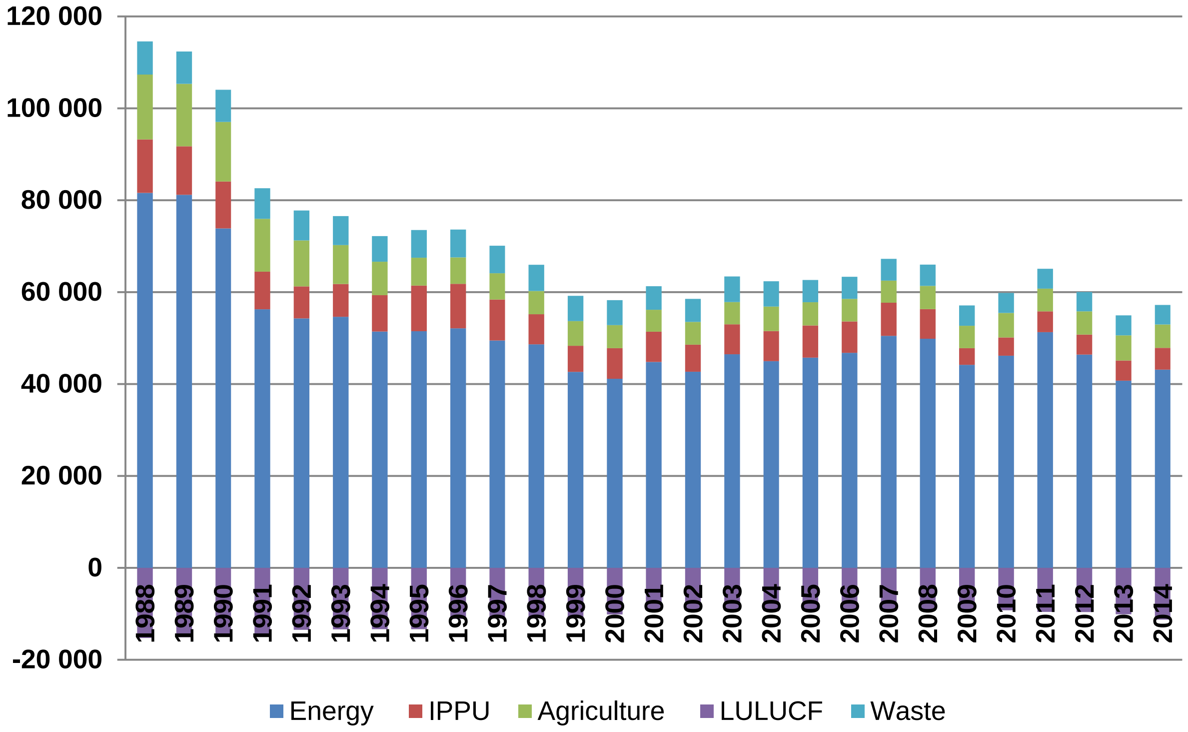

Figure 12 Total greenhouse gas emissions in CO_2-eq. per IPCC sector 1988-2014

Table 12 The reductions of GHG emissions by sectors by base year

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Change from base to latest reported year
1. Energy	-47,12
2. Industrial Processes and product use	-59,55
4. Agriculture	-63,96
5. Land Use, Land-Use Change and Forestry(5)	-26,26
6. Waste	-41,11
7. Other	0.00
Total (including LULUCF)	-53,74

Energy

Emissions from the energy sector in 2014 decreased by 47% compared to the base year (43 149 Gg CO_2e in 2014 compared to 81 593 Gg CO_2e in 1988). Compared to previous year, the emissions in 2014 increased with 6.0% mostly due to the increase of electricity production from fossil fuels in the energy industries sector and increase of fossil fuel use in the transport sector.

Main source of emissions in the energy sector is fuel combustion of solid fuels, which is responsible for 62.9% of the emissions from fuel combustion in 2014, followed by liquid fuels with 25.3% and gaseous fuels with 11.0%.

The main reasons for the decrease of the GHG emission trend in energy sector are the transition from a centrally-planned economy to a market-based economy, reconstructing of the economy and subsequent economic slowdown. This led to a sharp drop in demand for electricity production from thermal power production.

The trend of GHG emissions between 1988 and 2014 was defined by a substantial decrease of emissions from fuel combustion in energy industries (35%) and energy use in manufacturing industry and construction (83%) and in other sectors (70%), as well as a clear increase in GHG emissions from transport (0.9%).

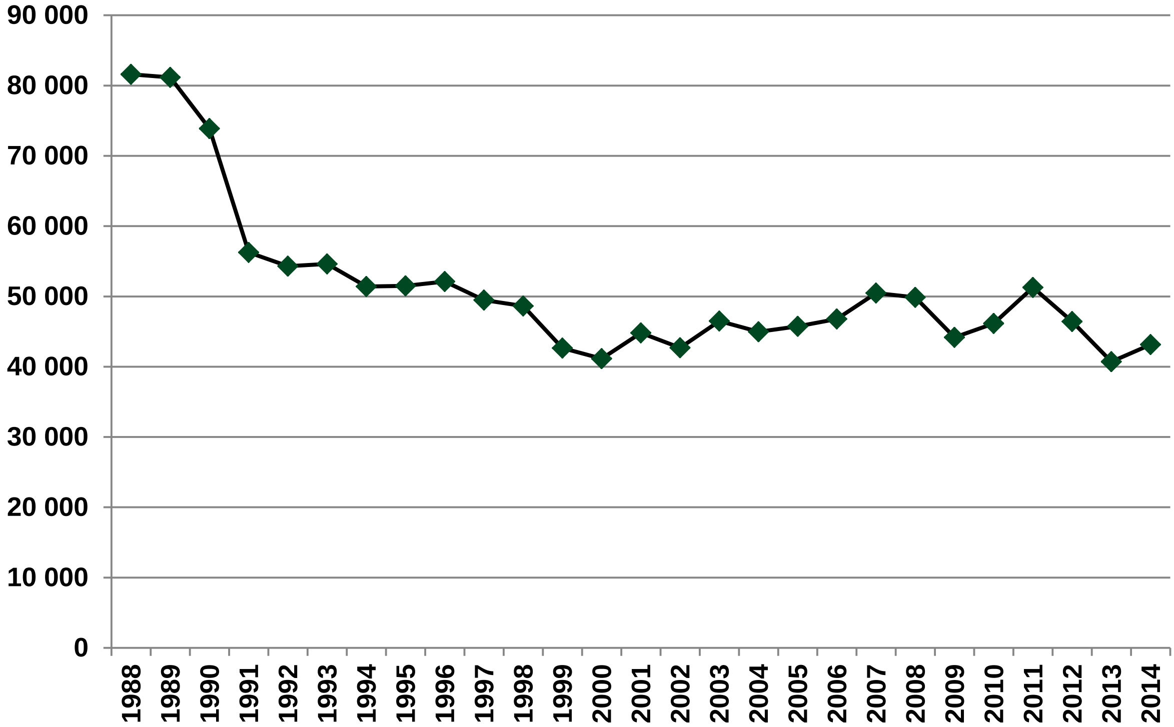

Figure 13 GHG emissions from Energy sector for 1988 – 2014, Gg CO_2 eq.

Chapter 3 of this Report contains a more detailed analysis of GHG emissions in the sector.

Industrial Processes and Product use

A steady trend towards emission reduction in this sector is observed since 1988. The emissions in 2014 decreased with 60% compared to the base year.

In the year 2014, 8.2% of national total greenhouse gas emissions (without LULUCF) originated from industrial processes and product use, compared to 10% in the base year 1988. In 2014, greenhouse gas emissions from Industrial Processes and Product use are 4 710 CO_2 equivalent compared to 11 644 Gg CO_2 in the base year.

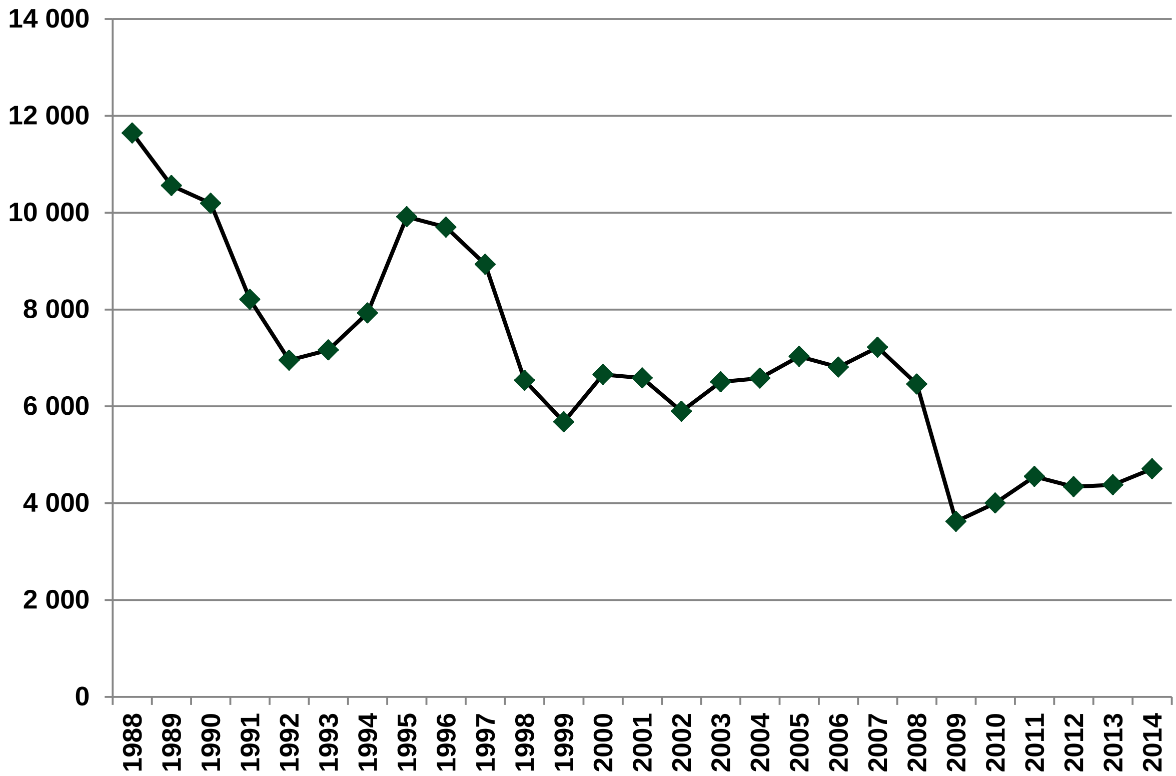

Figure 14 GHG emissions from Industrial processes sector for 1988 – 2014, Gg CO_2 eq.

In 2014 the most important emitting category is Mineral products (mainly production of clinker and quick lime), which share in the total Industrial processes and product use emissions is 42%. The second category by share is Chemical Industry (ammonia and nitric acid production) with 34%, followed by Consumption of Halocarbons and SF_6 with 21.6% share and finally Metal Production (steel) with 0.8%.

Greenhouse gas emissions from the Industrial Processes and product use sector fluctuate during the period and reach a minimum in 2009. The reduction in 2014 for the whole sector is 60% while the biggest reduction (compared to the base year) can be seen in Metal Production category – 99%.

This is mainly due to economic crisis and in particular the world economic crisis in 2009. The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

The general reduction in the emissions in the later years of the time period is influenced also by the starting introduction of better technologies on plant level.

Agriculture

The overall emission reduction in the sector has amounted to 64% since 1988. In the year 2014 the sector agriculture contributed 8.9% to the total of Bulgaria's greenhouse gas emissions (without LULUCF).

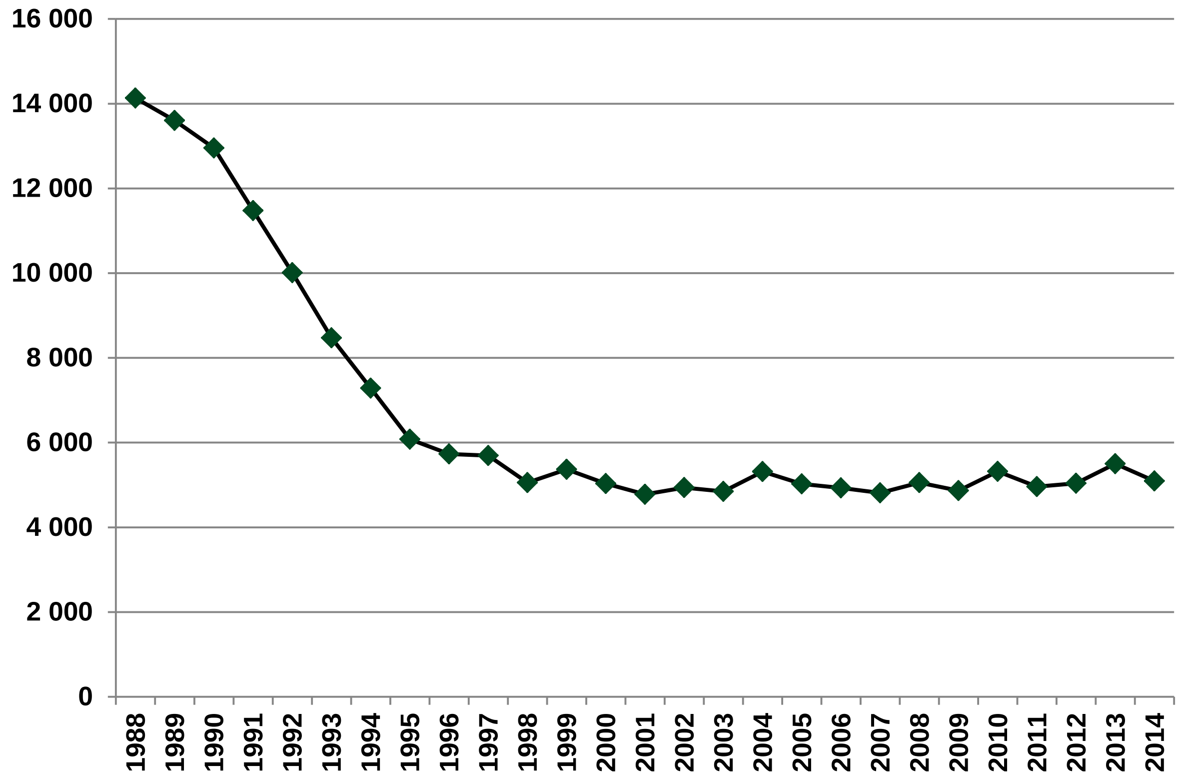

Figure 15 GHG emissions from Agriculture sector for 1988 – 2014, Gg CO_2 eq.

The emission reductions were mainly driven by systematic declines in the agricultural land area due to abandoning of arable lands and reduction in livestock population. Another driver for the emission reduction was the decline in the use of fertilizers.

Chapter 6 of this Report contains a more detailed analysis of GHG emissions in the sector.

Land-Use Change and Forestry

The LULUCF sector is serving as a sink of greenhouse gases for Bulgaria. The two categories – "Forest land" and "Grassland" are removals of CO_2. All other categories are sources of CO2 emissions. The trend of net CO_2 removals (CO_2 eq) from LULUCF decreases by 35.4% compared to the base year. The main reason for the overall decrease of the uptakes of CO_2 emissions from LULUCF is due to the fall in removals from category Forest land and the slight increase in emissions from CL, WL and SM categories. The key driver for the fall in removals from FL is the observed decline in the rate of forest growth as the average age of the forest stands increases steadily over the reporting period. In spite of the decrease observed, the share of the removals from the total GHG emissions (in CO_2eq) is still remarkable. The reason for this is that the emissions in the other sectors have dropped dramatically. The share of the removals in the base year has the figure of -13,3% from the total GHG emissions in CO_2-eq, while in the inventoried year the share is -19.7%.

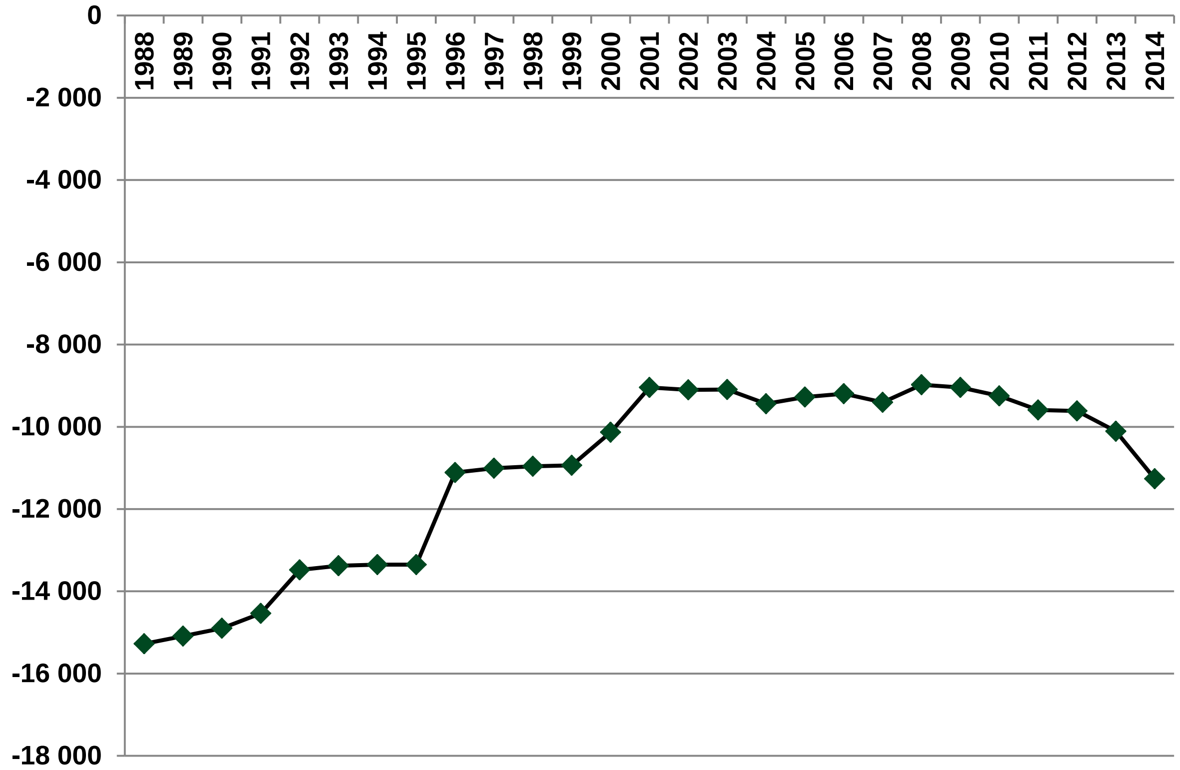

Figure 16 LULUCF emissions and removals for 1988 – 2014 CO_2 eq.

Comparing with the base year an increase in the emissions in croplands, settlements and wetlands is observed. The total emissions from croplands fluctuate during the whole time series. The emissions from Settlements increase last couple of years due to changes from other land uses to Settlements according to the risen infrastructural activities since Bulgaria's joined the EU.

Chapter 7 of this Report contains a more detailed analysis of GHG emissions in the sector.

Waste

The total sector emission reduction from the base year is 41.1 %. The decline was mainly driven by a steady population decline over the past 10 years.

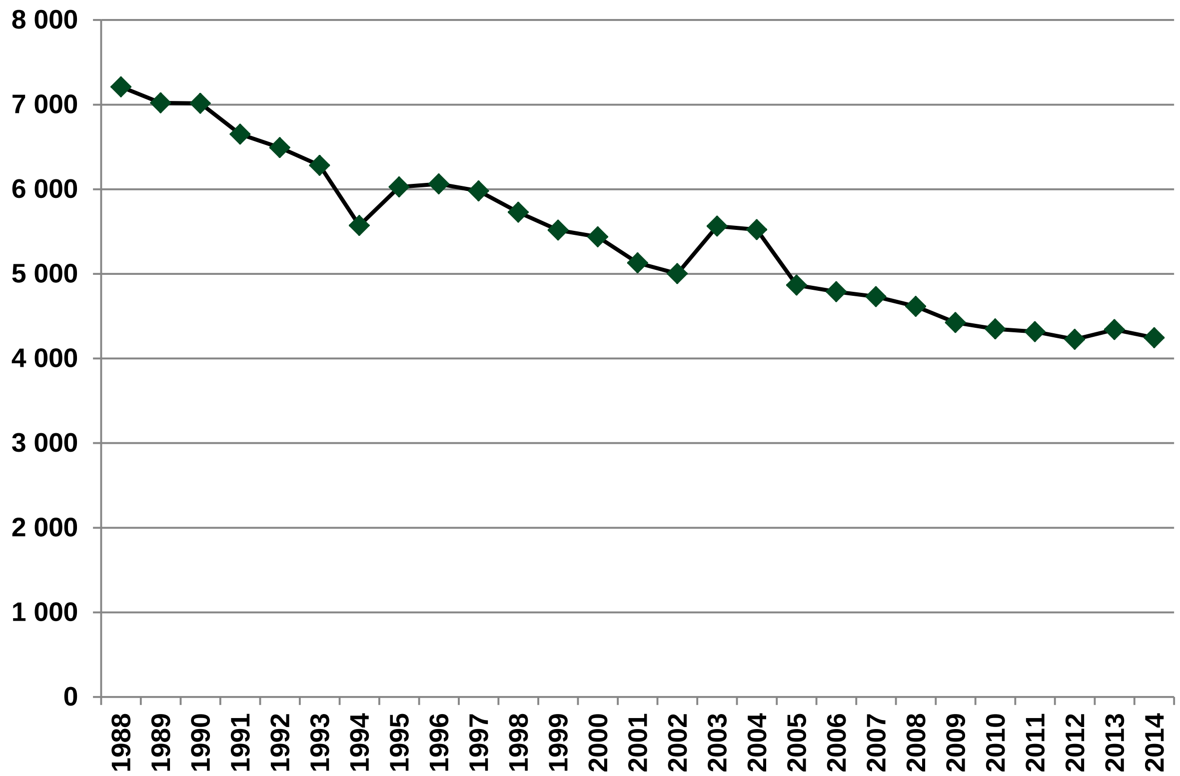

Figure 17 GHG emissions from Waste sector for 1988 – 2014, Gg CO_2 eq.

Chapter 8 of this Report contains a more detailed analysis of GHG emissions in the sector.

2.3 DESCRIPTION AND INTERPRETATION OF EMISSION TRENDS FOR INDIRECT GREENHOUSE GASES AND SULPHUR OXIDES

Compared to the base year the emissions of non-GHGs emissions decreased as follows:

- NO_x with 54%
- CO with 86%
- SO_x with 31%
- NMVOC with 92%

2.4 DESCRIPTION AND INTERPRETATION OF EMISSIONS AND REMOVALS FROM KP-LUCUCF INVENTORY

The coverage of carbon pools and emission sources reported under afforestation (A), reforestation (R) and deforestation (D) under Article 3.3, and forest management (FM) under Article 3.4 are presented in tables below.

Table 13 Activity coverage and other information relating to activities under Article 3.3 and Article 3.4

Activity	CHANGE IN CARBON POOL REPORTED							GREENHOUSE GAS SOURCES REPORTED							
	Above-ground biomass	Below-ground biomass	Litter	Dead wood	Soil		HWP	Fertilization	Drained, rewetted and other soils		Nitrogen mineralization in mineral soils	Indirect N2O from managed soil	Biomass burning		
					Min.	Org.		N_2O	CH_4	N_2O	N_2O	N_2O	CO_2	CH_4	N_2O
Article 3.3 activities															
Afforestation and reforestation	R	IE	R	NO	R	NO	R	NO	NO	NO	NO	NO	IE	R	R
Deforestation	R	IE	R	R	R	NO	R	NO	NO	NO	NO	NO	NO	NO	NO
Article 3.4 activities															
Forest management	R	IE	NO	NO	NO	NO	R	NO	NO	NO	NO	NO	IE	R	R
Cropland management	NA	NA	NA	NA	NA	NA			NA		NA		NA	NA	NA
Grazing land management	NA	NA	NA	NA	NA	NA			NA		NA		NA	NA	NA
Revegetation	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA
Wetland drainage and rewetting	NA	NA	NA	NA		NA		NA	NA	NA		NA	NA	NA	NA

Net removals from ARD in 2014 were 1.2 Mt CO2 eq. and net removals from FM 7.8 Mt CO2 eq. (Table 2.4-2). Area reported under AR in 2014 is 250.97 kha, under D 4.38 kha and under FM 3618.71 kha.

Table 14 Emissions and removals resulting from activities under Article 3.3 and 3.4 of Kyoto Protocol in 2014

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net CO_2 emissions/ removals	CH_4	N_2O	Net CO_2 equivalent emissions/removals
	(Kt)			
Article 3.3 activities				-1239,68
Afforestation and reforestation	-1326,78	0,00	0,00	-1326,78
Deforestation	87,11	NO	NO	87,11
Article 3.4 activities				-7769,52
Forest management	-7769,52	0,00	0,00	-7769,52
Cropland management	NA	NA	NA	NA
Grazing land management	NA	NA	NA	NA
Revegetation	NA	NA	NA	NA
Wetland drainage and rewetting	NA	NA	NA	NA

3 ENERGY (CRF CATEGORY 1)

3.1 OVERVIEW OF SECTOR

The Energy sector accounts for all GHG emissions originating from stationary fuel combustion activities in the energy and manufacturing industries, commercial, agricultural and residential sectors, mobile fuel combustion activities resulting from aviation, road transportation, railways and navigation (CRF category 1A), as well as fugitive emissions from fuels (CRF category 1B).

According to the IPCC guidelines, Energy sector consists of these categories:

- 1.A.1. Energy Industries
- 1.A.2. Manufacturing Industries and Construction
- 1.A.3. Transport
- 1.A.4. Other Sectors
- 1.A.5. Other
- 1.B. Fugitive Emissions from Fuels

Emissions from the energy sector are the main source of GHGs in Bulgaria: in 2014 the sector is responsible for 75.4% of national total GHG emissions (43 149 Gg CO_2e from sector 1A of the total 57 197 Gg CO_2e excl. LULUCF).

3.2 EMISSION TREND

Emissions from the energy sector in 2014 decreased by 47.1% compared to the base year (43 149 Gg CO_2e in 2014 compared to 81 593 Gg CO_2e in 1988). Compared to previous year, the emissions in 2014 increased with 6.0% mostly due to the increase of electricity production from fossil fuels in the energy industries sector and increase of fossil fuel use in the transport sector.

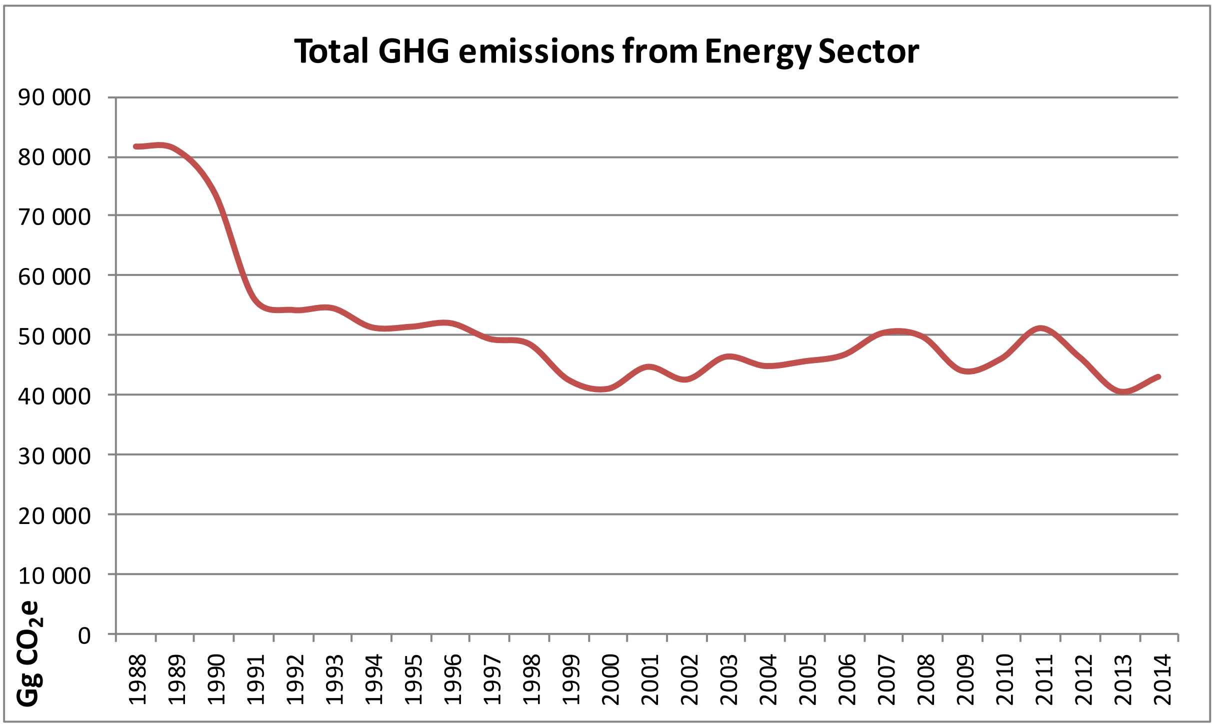

Figure 18 Total GHG emissions from Energy Sector

Main source of emissions in the energy sector is fuel combustion of solid fuels, which is responsible for 62.9% of the emissions from fuel combustion in 2014, followed by liquid fuels with 25.3% and gaseous fuels with 11.0%.

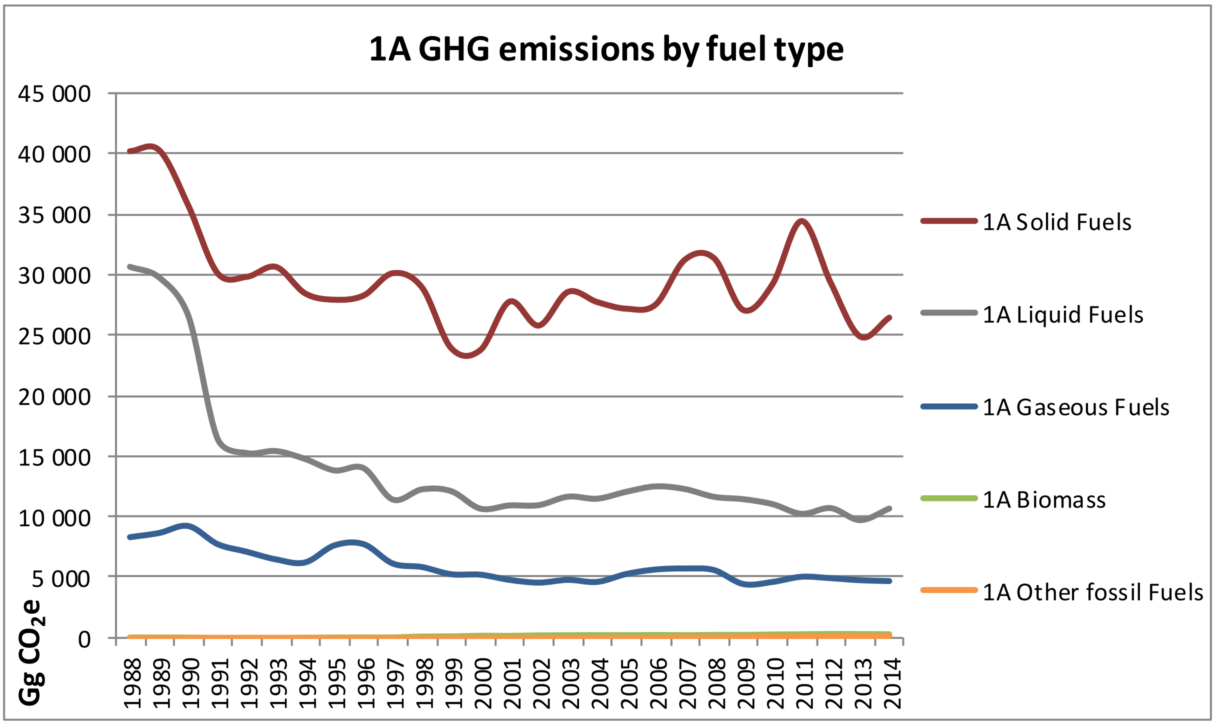

Figure 19 GHG emissions from fuel combustions by fuel type

On a subcategory level, energy industries is the major source of emissions, responsible for 69.0% of the emissions from fuel combustion, followed by transport with 20.2% and manufacturing industries and construction with 6.6%.

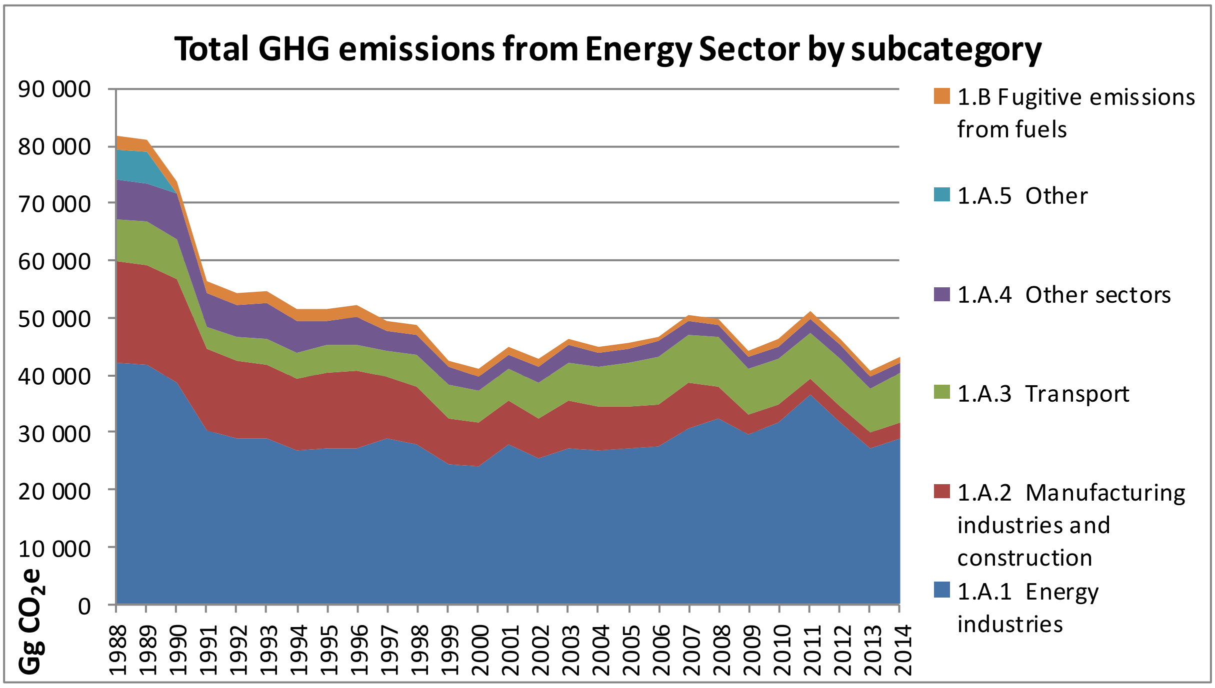

Figure 20 Total GHG emissions from Energy Sector by subcategory

Total emissions from energy sector mainly consist of CO_2; with total amount of 41 488 Gg for 2014, followed by CH_4 and N_2O, which only make up about 54.61 Gg and 0.99 Gg, respectively.

Table 15 Emissions of GHG and their trends for the years 1988 – 2014

Year	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1988	78 284.58	111.39	1.76	81 592.86
1989	77 836.67	112.36	1.77	81 172.24
1990	70 761.69	104.14	1.72	73 877.94
1991	53 710.84	87.73	1.21	56 264.12
1992	51 537.79	96.25	1.18	54 296.87
1993	51 836.25	96.51	1.23	54 615.80
1994	48 823.06	89.12	1.21	51 410.29
1995	48 831.09	92.19	1.25	51 507.92
1996	49 434.43	91.91	1.27	52 109.23
1997	47 098.69	81.51	1.14	49 477.19
1998	46 448.50	72.62	1.27	48 641.25
1999	40 780.56	59.97	1.21	42 641.95
2000	39 185.98	64.18	1.17	41 139.49
2001	43 010.64	57.81	1.18	44 807.86
2002	40 790.75	61.45	1.21	42 687.84
2003	44 452.59	66.35	1.27	46 491.12
2004	43 392.78	50.26	1.05	44 962.69
2005	44 101.87	52.35	1.08	45 733.71
2006	45 237.55	48.97	1.14	46 801.19
2007	48 785.12	54.21	1.14	50 480.57
2008	48 167.53	55.04	1.05	49 857.56
2009	42 585.22	52.04	0.98	44 178.30
2010	44 444.33	56.28	1.01	46 151.39
2011	49 253.80	67.54	1.10	51 268.77
2012	44 567.19	61.79	1.04	46 422.24
2013	39 066.45	54.88	0.95	40 721.73
2014	41 488.46	54.61	0.99	43 148.73

3.3 FUEL COMBUSTION (CRF 1.A)

3.3.1 COMPARISON OF THE SECTORAL APPROACH WITH THE REFERENCE APPROACH

Following the IPCC guidelines, two separate approaches are applied in order to estimate the emissions from fuel combustions activities: Reference approach (RA) and Sectoral approach (SA).

The Reference approach is a method for estimating CO_2 combustion emissions by a simplified top-down methodology, which uses the reported quantities of primary and secondary fuels from the national energy balance, taking into account the non-energy use of fuels. For the purpose of the RA, the apparent consumption of each fuel is calculated from the reported quantities for production, import, export, stock changes and international bunkers.

The Sectoral Approach (SA) is a more detailed bottom-up methodology, which uses the fuel consumption in each of the following subcategories:

- Energy Industries, including Public Electricity and Heat Production, Petroleum Refining and Manufacture of Solid Fuels and Other Energy Industries;
- Manufacturing Industries and Construction, including Iron and Steel, Non-Ferrous Metals, Chemicals, Pulp, Paper and Print, Food Processing, Beverages and Tobacco, Non-metallic minerals and Other
- Transport, including Civil Aviation, Road Transportation, Railways, Navigation and Other Transportation
- Other Sectors, including Commercial/Institutional, Residential, Agriculture/Forestry/Fisheries
- Other Stationary and Mobile sources

3.3.1.1 Methodology

Default methodologies are applied based on the fuel type and according to 2006 IPCC Guidelines, Ch. 6, Equations 6.1 and 6.2.

3.3.1.2 Results of the reference approach

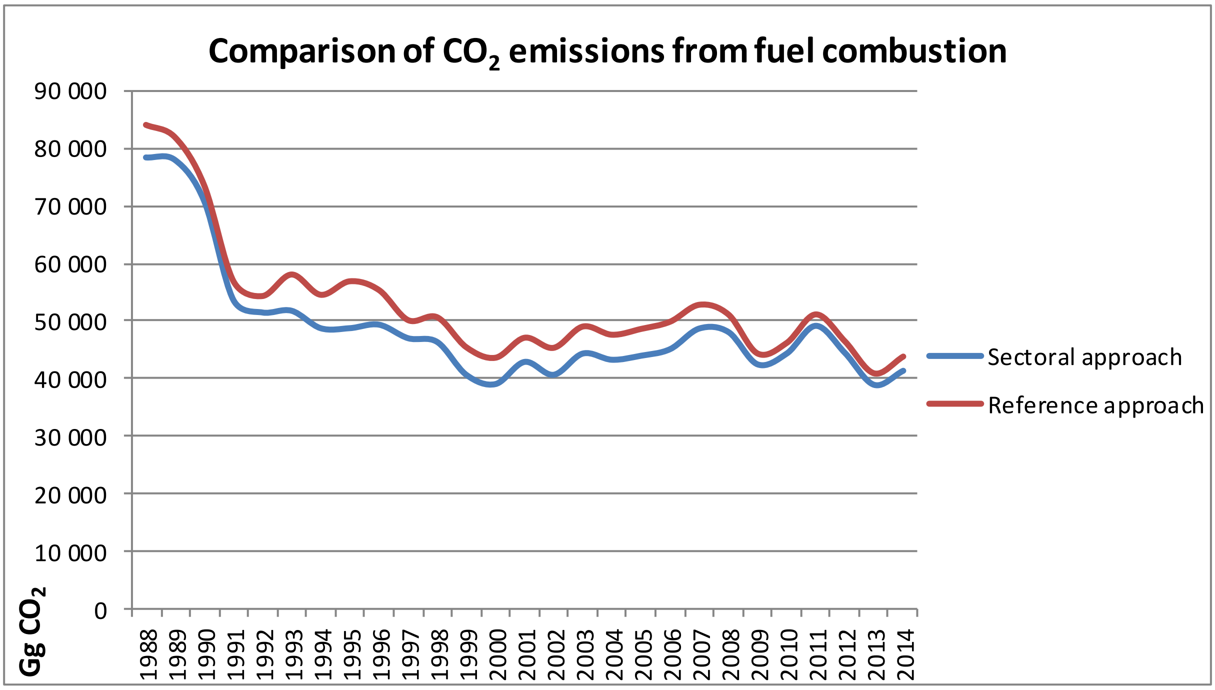

Figure 21 Comparison of the sectoral approach with the reference approach

The following tables compare the energy consumption and the emissions according to both approaches by fuel type.

Table 16 Comparison of the sectoral approach with the reference approach (all fuels)

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1988	1013.07	945.25	7.17%	84029.68	78279.59	7.35%
1989	991.42	941.10	5.35%	81859.30	77831.77	5.17%
1990	892.84	869.64	2.67%	73505.99	70757.57	3.88%
1991	682.63	654.04	4.37%	56874.97	53707.06	5.90%

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1992	640.62	621.11	3.14%	54257.04	51533.10	5.29%
1993	683.03	622.10	9.79%	58002.17	51830.72	11.91%
1994	643.73	586.98	9.67%	54473.76	48818.44	11.58%
1995	681.41	595.63	14.40%	56825.53	48826.32	16.38%
1996	658.51	602.48	9.30%	55298.37	49430.58	11.87%
1997	593.27	554.52	6.99%	50068.36	47095.43	6.31%
1998	582.96	548.73	6.24%	50563.06	46445.28	8.87%
1999	526.29	489.82	7.45%	45348.13	40777.08	11.21%
2000	505.57	468.73	7.86%	43524.62	39182.92	11.08%
2001	536.12	502.96	6.59%	46999.96	43007.65	9.28%
2002	521.71	478.07	9.13%	45252.74	40787.77	10.95%
2003	559.45	518.96	7.80%	48951.20	44450.14	10.13%
2004	540.35	509.53	6.05%	47522.91	43376.38	9.56%
2005	562.47	524.35	7.27%	48534.55	44076.75	10.11%
2006	579.37	539.87	7.32%	49794.89	45213.24	10.13%
2007	606.89	573.24	5.87%	52739.53	48770.69	8.14%
2008	581.93	560.61	3.80%	51042.63	48156.58	5.99%
2009	505.46	495.88	1.93%	44259.58	42583.02	3.94%
2010	521.50	512.04	1.85%	46097.68	44439.74	3.73%
2011	571.01	560.06	1.95%	51062.04	49233.11	3.71%
2012	526.33	513.45	2.51%	46366.30	44548.76	4.08%
2013	468.85	455.33	2.97%	40812.20	39051.94	4.51%
2014	500.76	481.89	3.92%	43727.78	41478.20	5.42%

Table 17 Comparison of the sectoral approach with the reference approach (liquid fuels)

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1988	459.41	402.65	14.10%	33819.43	30283.18	11.68%
1989	445.38	391.27	13.83%	32732.09	29391.55	11.37%
1990	362.86	353.05	2.78%	26781.40	26194.93	2.24%
1991	222.68	217.70	2.29%	16390.05	16175.94	1.32%
1992	195.10	200.57	-2.73%	14487.53	14988.92	-3.35%
1993	220.56	203.98	8.13%	16215.69	15138.40	7.12%
1994	208.39	195.11	6.81%	15295.83	14477.06	5.66%
1995	222.87	182.91	21.85%	16344.31	13515.07	20.93%
1996	194.07	185.17	4.81%	14260.34	13709.76	4.02%
1997	154.76	150.76	2.65%	11401.63	11161.60	2.15%
1998	164.00	162.45	0.95%	12000.02	11965.48	0.29%
1999	157.88	161.95	-2.51%	11544.61	11810.52	-2.25%
2000	145.58	142.44	2.20%	10640.67	10384.43	2.47%
2001	145.90	146.92	-0.70%	10662.88	10668.90	-0.06%
2002	164.26	145.29	13.06%	12057.62	10679.14	12.91%
2003	164.84	155.34	6.12%	12119.89	11380.36	6.50%
2004	157.07	155.88	0.76%	11558.21	11280.56	2.46%
2005	178.79	163.22	9.53%	13135.72	11844.34	10.90%
2006	184.99	169.08	9.41%	13574.93	12274.74	10.59%
2007	175.48	164.75	6.51%	12908.74	12070.90	6.94%
2008	167.22	157.56	6.13%	12262.58	11455.86	7.04%
2009	160.51	154.48	3.90%	11718.64	11265.33	4.02%

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
2010	152.70	146.83	4.00%	11267.48	10867.66	3.68%
2011	143.87	137.70	4.48%	10492.38	10063.87	4.26%
2012	150.97	143.34	5.32%	11069.93	10535.83	5.07%
2013	138.15	129.21	6.92%	10148.66	9553.63	6.23%
2014	153.12	141.75	8.02%	11230.81	10502.75	6.93%

Table 18 Comparison of the sectoral approach with the reference approach (solid fuels)

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1988	402.65	391.60	2.82%	41874.15	39660.31	5.58%
1989	388.59	392.38	-0.97%	40435.18	39748.18	1.73%
1990	359.99	348.46	3.31%	37340.32	35281.16	5.84%
1991	316.19	296.01	6.82%	32548.78	29784.33	9.28%
1992	314.62	291.96	7.76%	32543.30	29446.15	10.52%
1993	341.81	301.29	13.45%	35125.22	30242.76	16.14%
1994	317.10	279.70	13.37%	32650.71	28148.88	15.99%
1995	315.34	274.36	14.94%	32576.07	27673.34	17.72%
1996	319.14	277.01	15.21%	33017.43	27975.86	18.02%
1997	326.65	293.26	11.39%	32491.35	29834.12	8.91%
1998	311.83	281.19	10.90%	32649.21	28678.15	13.85%
1999	272.67	233.83	16.61%	28518.67	23774.63	19.95%
2000	264.99	232.95	13.75%	27638.78	23645.88	16.89%
2001	300.68	270.73	11.06%	31394.07	27629.46	13.63%
2002	272.75	251.64	8.39%	28519.27	25629.23	11.28%
2003	305.39	278.26	9.75%	31906.01	28357.63	12.51%
2004	297.88	271.39	9.76%	31249.25	27553.22	13.41%
2005	286.53	266.72	7.43%	30034.69	27018.55	11.16%
2006	289.36	269.57	7.34%	30421.55	27347.80	11.24%
2007	323.08	305.60	5.72%	33848.99	31017.11	9.13%
2008	309.96	302.61	2.43%	32997.58	31154.21	5.92%
2009	264.18	262.42	0.67%	28071.11	26944.50	4.18%
2010	285.29	283.00	0.81%	30210.84	29021.52	4.10%
2011	335.45	332.18	0.99%	35493.23	34172.69	3.86%
2012	286.00	281.85	1.47%	30349.38	29123.83	4.21%
2013	244.24	241.17	1.27%	25856.02	24770.52	4.38%
2014	262.64	256.61	2.35%	27836.58	26322.30	5.75%

Table 19 Comparison of the sectoral approach with the reference approach (gaseous fuels)

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1988	151.00	151.00	0.00%	8336.10	8336.10	0.00%
1989	157.45	157.45	0.00%	8692.03	8692.03	0.00%
1990	169.99	168.13	1.11%	9384.27	9281.47	1.11%
1991	143.76	140.33	2.44%	7936.13	7746.78	2.44%
1992	130.90	128.58	1.81%	7226.21	7098.03	1.81%
1993	120.67	116.83	3.28%	6661.26	6449.56	3.28%

Year	Energy consumption, PJ		Difference	CO_2 Emissions, Gg		Difference
	Reference approach	Sectoral approach		Reference approach	Sectoral approach	
1994	118.24	112.17	5.41%	6527.22	6192.50	5.41%
1995	143.20	138.36	3.50%	7905.15	7637.90	3.50%
1996	145.29	140.30	3.56%	8020.60	7744.96	3.56%
1997	111.86	110.49	1.24%	6175.38	6099.71	1.24%
1998	107.13	105.09	1.93%	5913.83	5801.64	1.93%
1999	95.73	94.05	1.79%	5284.84	5191.94	1.79%
2000	95.01	93.34	1.80%	5245.17	5152.60	1.80%
2001	89.54	85.31	4.96%	4943.01	4709.29	4.96%
2002	84.70	81.14	4.39%	4675.85	4479.40	4.39%
2003	89.22	85.36	4.52%	4925.30	4712.15	4.52%
2004	85.36	82.22	3.82%	4712.00	4539.14	3.81%
2005	97.12	94.37	2.91%	5361.33	5211.06	2.88%
2006	105.01	101.21	3.75%	5796.77	5589.06	3.72%
2007	108.22	102.77	5.30%	5972.07	5672.95	5.27%
2008	104.66	100.35	4.30%	5774.74	5538.78	4.26%
2009	80.51	78.72	2.28%	4447.40	4350.77	2.22%
2010	83.17	81.86	1.60%	4594.26	4525.45	1.52%
2011	91.38	89.88	1.67%	5050.01	4970.14	1.61%
2012	88.90	87.79	1.26%	4907.26	4849.37	1.19%
2013	85.90	84.39	1.79%	4755.95	4676.22	1.70%
2014	84.43	82.96	1.77%	4610.96	4603.71	0.16%

3.3.1.3 Explanation of differences

A comparison between the Reference Approach (RA) and the Sectoral Approach (RA) indicates a difference of 3.92% in terms of energy consumption and 5.42% in terms of CO_2 emissions for 2014.

One of the potential reasons for the difference in the previous emission estimates is the fact that the Reference Approach accounts part of the non-energy used fuels as oxidized. While this is generally true in the long term, the resulting emissions are excluded from the Sectoral approach and instead reported mostly in the IP sector. This could lead to a consistent difference between the two approaches, especially for gaseous fuels, where the default fraction of carbon stored from natural gas used as feedstock is rather low. Following a recommendation from the 2012 ARR, were revised the default assumptions about the fractions of carbon stored, which resulted in lower differences between the sectoral and the reference approach, compared to previous estimates. In addition, following ERT recommendations, the previously reported apparent consumption of fuels was corrected to exclude the non-energy use of fuels, which significantly reduced the difference between the reference and the sectoral approaches.

Additional reasons for differences between the two approaches are the significant statistical differences and losses reported for some of the years in the national energy balances. The highest differences are observed in the period 1993-1996, and most notably 1995. The analysis showed that the main reason for this are the differences in liquid fuels consumption resulting from the significant amounts of refinery loses reported (9.5% of total refinery intake in 1995 was reported as refinery losses, with an average of 3.9% for the period 1990-2014).

A reason for potential discrepancies is also the difference between the net calorific values of primary and secondary fuels in fuel transformation processes. This is especially valid for liquid fuels – the Reference approach calculation is based on the energy content of the refined crude oil, while the Sectoral approach uses the energy content of the produced secondary fuels. For solid fuels – the Reference approach is based on the net calorific value of the lignite coal, used in BKB plants, while the Sectoral approach disregards the lignite reported as transformation in BKB plants, instead using the net calorific value of the BKB fuel itself. The same note is also applicable for coking coal used for the production of coke oven coke and coke oven gas, although this activity is no longer occurring since 2009.

Discrepancies in the emission estimates between the reference and the sectoral approach occur due to the fact, that the Energy balance is mass-balanced, but not carbon-balanced – e.g. there are some differences in the carbon content of the primary fuels and the produced secondary fuels.

A special case for solid fuels used in blast furnaces in the Iron & Steel subcategory is an additional reason for differences between RA and SA for the period before 2008. In order to remove double counting between Energy and Industrial Processes categories (2C Metal production), part of the solid fuels reported in the Energy balance are not accounted in the Sectoral approach (details regarding exact fuel allocation are given in Annex II). This is the reason why after the closure of the biggest I&S plant in Bulgaria in 2008, the difference for solid fuels became much lower.

For liquid fuels (diesel fuel) there is an additional reason for difference, resulting from the blending of biodiesel. While in the sectoral approach the CO2 emissions from the biodiesel component in the diesel fuel are accounted under biomass, in the reference approach all diesel fuel consumption is accounted as fossil.

On the other hand, the use of alternative fuels, which is accounted in the sectoral approach, is not accounted in the reference.

3.3.1.4 Quantification of differences

For 2014 the difference due to statistical differences and distribution losses for gaseous fuels is equal to 219 TJ, which is 0.2% of the total consumption of gaseous fuels. In terms of emissions this would be equivalent to 12.1 Gg CO_2. For liquid fuels, in 2014 the refinery losses are 4.0% of the refinery intake, which is equal to 8763 TJ or 642.3 Gg CO_2. The use of alternative fuels, which are accounted in the sectoral approach, is equal to 566.40 TJ or 49.43 Gg CO_2.

If all those quantified differences are accounted, the remaining difference between the reference and the sectoral approaches for 2014 is equal to 2% in terms of energy consumption and 3.8% in terms of emissions.

3.3.2 INTERNATIONAL BUNKER FUELS

The International Bunkers represent the fuels and the emissions resulting from international air and marine transport of passengers and cargo. These GHG emissions are also a subject of the inventory and they are reported, but they are not included in the total sum of the emissions of the country. The Energy balance provides a split between the domestic and international fuel consumption.

Table 20 GHG Emissions from International bunker fuels

Year	Total [Gg CO_2e]	Aviation [Gg CO_2e]	Marine [Gg CO_2e]
1988	2 071.36	1 112.46	958.90
1989	2 164.43	1 187.34	977.10
1990	903.84	719.35	184.48
1991	1 405.87	470.86	935.01
1992	1 698.67	845.60	853.07
1993	1 958.13	1 133.51	824.61
1994	1 749.87	919.13	830.74
1995	1 774.90	912.48	862.41
1996	1 348.40	598.87	749.53
1997	471.90	443.40	28.50
1998	614.87	393.17	221.69
1999	238.50	213.20	25.30
2000	447.83	245.14	202.69
2001	620.70	316.70	304.00
2002	711.63	379.10	332.54
2003	918.71	484.83	433.88
2004	831.66	467.45	364.21
2005	921.74	573.36	348.37
2006	880.96	548.68	332.28
2007	718.73	554.04	164.69
2008	1 030.03	644.29	385.74
2009	1 117.09	463.80	653.29
2010	818.94	510.42	308.52
2011	756.23	516.70	239.53
2012	699.65	497.72	201.93
2013	771.02	485.30	285.72
2014	774.21	516.60	257.61

3.3.3 FEEDSTOCKS AND NON-ENERGY USE OF FUELS

Non-energy use of fuels is reported for the following fuels:

- Anthracite
- Coke Oven Coke
- Other bituminous coal
- Lubricants
- Bitumen
- Naphtha
- Paraffin waxes
- White spirit
- Residual Fuel Oil
- Other Oil Products
- Petroleum Coke
- Natural Gas as Feedstock

There are some fluctuations of the reported consumption for some of the fuels during the time series due to changes in the industrial production – differences in production volume, decommissioning of installations or shift from one fuel type to another. Some discrepancies with the quantities of fuels reported as non-energy use exist in the Energy balance – for some fuels only for the latest years is reported non-energy use, in addition some industrial plants do not properly report their non-energy use of fuels. In order to improve the consistency, additional data was collected from several chemical plants regarding the annual production of ammonia, soda ash and calcium carbide. The amounts of energy and non-energy use of natural gas, anthracite, other bituminous coal and coke oven coke we reallocated according to the quantities of fuels considered as emission sources in the Industrial Processes sector.

The non-energy use of fuels is on average 7.97% of the total apparent energy consumption during the period 1988-2014 and 5.66% for 2014. The apparent consumption is calculated according to Equation 6.2 in Vol. 2, Ch. 6 of the 2006 IPCC Guidelines.

Table 21 Non-energy use of fuels compared to total apparent energy consumption

Year	Non-energy use, PJ	Apparent energy consumption incl. non-energy use, PJ	%
1988	91.59	1104.66	8.29%
1989	90.33	1081.70	8.35%
1990	91.60	984.44	9.30%
1991	74.24	756.71	9.81%
1992	66.13	706.75	9.36%
1993	69.70	752.73	9.26%
1994	68.01	711.74	9.56%
1995	80.52	761.93	10.57%
1996	86.84	745.34	11.65%
1997	76.63	669.91	11.44%
1998	60.61	643.57	9.42%
1999	47.10	573.39	8.21%
2000	57.97	563.54	10.29%
2001	56.75	592.86	9.57%
2002	35.30	557.01	6.34%
2003	40.39	599.84	6.73%
2004	42.51	582.85	7.29%
2005	45.80	608.25	7.53%
2006	43.24	622.64	6.95%
2007	44.49	651.38	6.83%
2008	48.18	630.11	7.65%
2009	27.92	533.38	5.24%
2010	23.66	545.17	4.34%
2011	30.98	601.99	5.15%
2012	27.33	553.67	4.94%
2013	26.69	495.50	5.39%
2014	29.95	529.40	5.66%

The most significant fuels used as feedstock are bitumen, anthracite and natural gas. The use of naphtha has been discontinued since 2010.

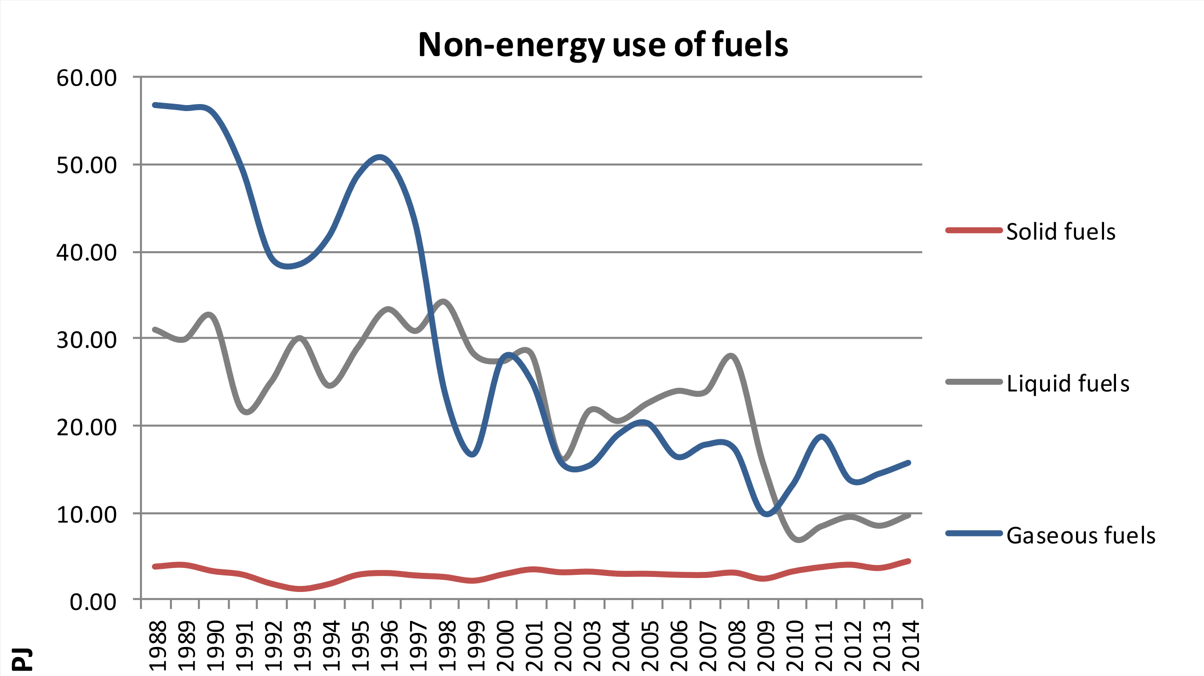

Figure 4 Non-energy use of fuels

In general, most of the non-energy use of fuels is attributed to the industrial sector (lubricants, paraffin wax), chemical and petrochemical industry (anthracite, natural gas, naphtha, white spirit and other petroleum products) and construction (bitumen). All sources of emissions due to non-energy use of fuels (natural gas) are reported under category 2B Chemical Industry. The quantities of waste oils, which are used with energy recovery in the non-metallic minerals and other industrial plants, are reported as other fuels under category 1.A.2.g Other industries.

Table 22 Apparent consumption of non-energy fuels

PJ	Solid fuels	Liquid fuels	Gaseous fuels
1988	3.83	30.96	56.80
1989	4.03	29.82	56.47
1990	3.30	32.38	55.91
1991	2.90	21.80	49.55
1992	1.82	24.95	39.36
1993	1.17	29.99	38.53
1994	1.76	24.55	41.71
1995	2.86	28.93	48.74
1996	3.07	33.28	50.49
1997	2.78	30.81	43.04
1998	2.60	34.14	23.88
1999	2.16	28.21	16.73
2000	2.90	27.35	27.72
2001	3.50	28.15	25.10
2002	3.16	16.26	15.88
2003	3.23	21.72	15.43
2004	2.98	20.52	19.01
2005	2.98	22.54	20.28
2006	2.87	23.94	16.44
2007	2.84	23.83	17.82
2008	3.11	27.72	17.35

PJ	Solid fuels	Liquid fuels	Gaseous fuels
2009	2.39	15.58	9.95
2010	3.25	7.27	13.14
2011	3.77	8.47	18.74
2012	4.06	9.55	13.72
2013	3.67	8.54	14.49
2014	4.48	9.73	15.74

3.3.4 CO2 CAPTURE FROM FLUE GASES AND SUBSEQUENT CO2 STORAGE

CO_2 capture from flue gases and CO_2 storage is not occurring in Bulgaria.

3.3.5 COUNTRY-SPECIFIC ISSUES

Because of the country specific issues regarding the National statistics, two sources of information were used depending on the period. The Eurostat energy balances prepared by the National Statistics Institute were the most relevant source of information and they were used for estimating the emissions for the years 1990-2014. The National statistics have not prepared official balances in the Eurostat format for the years before 1990, so the IEA Energy balances were used for the years 1988 and 1989.

For 1988 and 1989 the fuel allocation by category is different and significant quantities are allocated to sector 'Other'.

3.3.6 KEY CATEGORIES

The methodology and results of the key category analysis is presented in Annex I. Table 23 presents the key source categories of 1 A Fuel Combustion Activities.

Table 23 Key subcategories in sector 1.A. Fuel combustion

Category	Classification	Gas	Key Category Assessment*
1.A.1 - Energy Industries	Gaseous Fuels	CO_2	LA, TA
1.A.1 - Energy Industries	Liquid Fuels	CO_2	LA, TA
1.A.1 - Energy Industries	Solid Fuels	CO_2	LA, TA
1.A.2 - Manufacturing Industries and Construction	Gaseous Fuels	CO_2	LA, TA
1.A.2 - Manufacturing Industries and Construction	Liquid Fuels	CO_2	LA, TA
1.A.2 - Manufacturing Industries and Construction	Solid Fuels	CO_2	LA, TA
1.A.3.b - Road Transportation	Liquid fuels	CO_2	LA, TA
1.A.3.e - Other Transportation	Gaseous fuels	CO_2	LA, TA
1.A.4 - Other Sectors	Gaseous Fuels	CO_2	LA, TA
1.A.4 - Other Sectors	Liquid Fuels	CO_2	LA, TA
1.A.4 - Other Sectors	Solid Fuels	CO_2	LA, TA
1.A.5 – Other Stationary	Fossil Fuels	CO_2	LA, TA

*LA = Level Assessment w/o LULUCF; TA = Trend Assessment w/o LULUCF

3.3.7 COMPLETENESS

All occurring sources of emissions from 1.A Fuel combustion are estimated for solid, liquid, gaseous fuels, biomass and other fuels (industrial waste). All emissions from CO_2, CH_4 and N_2O were accounted.

3.3.8 METHODOLOGICAL ISSUES

3.3.8.1 Choice of Method

Tier 1 Methodology

Equation 2.1 from Vol. 2, Chapter 2 of the 2006 IPCC Guidelines is used to estimate the CO_2, CH_4 and N_2O emissions from stationary fuel combustion in CRF subcategories 1.A.1, 1.A.2., 1.A.4 and 1.A.5. The formula used in the calculations is the following:

$$Emissions_{GHG} = Fuel\ Consumption \bullet Emission\ Factor_{GHG}$$

where:

Emissions $_{GHG}$ = emissions of a given GHG by type of fuel (kg GHG)

Fuel Consumption = amount of fuel combusted (TJ)

Emission Factor $_{GHG}$ = default emission factor of a given GHG by type of fuel (t gas/TJ).

Tier 2 Methodology

The same equation is used for the CO_2 emission calculations using the Tier 2 approach in CRF subcategories 1.A.1, 1.A.2., 1.A.4 and 1.A.5, with the difference that the emission factor takes into account country-specific data for carbon contents of the fuels used and carbon oxidation factors.

3.3.8.2 Choice of emission factor

3.3.8.2.1 Choice of emission factors for stationary sources

For all fuels, for which no country-specific CO_2 emission factors are available, are used the default emission factors according to the 2006 IPCC Guidelines, Vol. 2, Ch. 2, Table 2.2-2.5. For CH_4 and N_2O emissions are used only the default emission factors for CRF subcategories 1.A.1, 1.A.2., 1.A.4 and 1.A.5. The country-specific carbon content of fuels was calculated based on the country-specific CO_2 emission factors using the following equation:

$$C = Emission\ Factor / (44/12)$$

where:

C = carbon content of fuel in t/TJ

Emission Factor = emission factor for CO_2 by type of fuel (t/TJ)

In comparison to the 1996 IPCC guidelines, the Tier 1 default emission factors in the 2006 IPCC Guidelines reflect the full carbon content of the fuel including any non-oxidized fraction of carbon retained in the ash, particulates or soot, e.g. a complete oxidation of the carbon contained in the fuel is assumed (carbon oxidation factor equal to 1). The 2006 IPCC guidelines do not provide default oxidation factors, so it is not possible to derive different emission factors (including and excluding the oxidation factor). As a result, the use of the default 2006 IPCC emission factors would lead to increase of the emission estimates with 0.5 to 2% depending on the fuel type, compared to the default emission factors from the 1996 IPCC Guidelines.

Table 24 Default Emission factors for CO_2 for different fuels

Fuel	EF C t/TJ	EF CO_2 t/TJ (excl. oxidation factor)
LIQUID FOSSIL Primary fuels		
Crude Oil	20.0	73.3
Orimulsion	21.0	77.0
Natural Gas Liquids	17.5	64.2
Secondary fuels/products		
Motor Gasoline	18.9	69.3
Aviation Gasoline	19.1	70.0
Jet Gasoline	19.1	70.0
Jet Kerosene	19.5	71.5
Other Kerosene	19.6	71.9
Shale Oil	20.0	73.3
Gas / Diesel Oil	20.2	74.1
Residual Fuel Oil	21.1	77.4
Liquefied Petroleum Gases	17.2	63.1
Ethane	16.8	61.6
Naphtha	20.0	73.3
Bitumen	22.0	80.7
Lubricants	20.0	73.3
Petroleum Coke*	26.6	97.5
Refinery Feedstocks	20.0	73.3
Refinery Gas	15.7	57.6
Paraffin Waxes	20.0	73.3
White Spirit and SBP	20.0	73.3
Other Petroleum Products	20.0	73.3
SOLID FOSSIL Primary Fuels		
Anthracite*	26.8	98.3
Coking Coal	25.8	94.6
Other Bituminous Coal*	25.8	94.6
Sub-Bituminous Coal	26.2	96.1
Lignite*	27.5	101.0
Oil Shale and Tar Sands	29.2	107.0
Secondary fuels/products		
Brown Coal Briquettes	26.6	97.5
Patent Fuel	26.6	97.5
Coke - Gas Coke	29.2	107.0
Coal Tar	22.0	80.7
Gas Works Gas	12.1	44.4
Coke Oven Gas	12.1	44.4
Blast Furnace Gas	70.9	260.0
Oxygen Steel Furnace Gas	49.6	182.0
GASEOUS FOSSIL		
Natural Gas*	15.3	56.1
OTHER FOSSIL		
Municipal Wastes (non-biomass fraction)	25.0	91.7

Fuel	EF C t/TJ	EF CO_2 t/TJ (excl. oxidation factor)
Industrial Wastes	39.0	143.0
Waste Oils	20.0	73.3
Peat	28.9	106.0
SOLID BIOMASS		
Wood / Wood Waste	30.5	112.0
Sulphite lyes (Black Liquor)	26.0	95.3
Other Primary Solid Biomass	27.3	100.0
Charcoal	30.5	112.0
LIQUID BIOMASS		
Biogasoline	19.3	70.8
Biodiesels	19.3	70.8
Other Liquid Biofuels	21.7	79.6
GASEOUS BIOMASS		
Landfill Gas	14.9	54.6
Sludge Gas	14.9	54.6
Other Biogas	14.9	54.6
OTHER BIOMASS		
Municipal Wastes (biomass fraction)	27.3	100.0

The above default EFs were used for the calculations, except for the following fuels, for which country-specific EFs were derived:

- Anthracite
- Other bituminous coal (Black coal)
- Lignite
- Petroleum coke
- Natural gas

The country-specific emission factors are listed in

Table 26 and Table 27.

3.3.8.2.2 Country specific emission factors for CO_2 for solid fuels

Emission data reported under the European Emission Trading Scheme

A total of 173 operators have provided their verified CO_2 emission reports required under the EU ETS for the years 2007-2014. These emissions have been incorporated in the inventory to the extent possible (see respective subchapters for more information). Furthermore, the background data for the emission calculations under the EU ETS were used for further QA/QC checks.

Data from the verified ETS reports was analyzed in order to apply a Tier 2 methodology for the national emission calculations. From all reporting operators, in 2014 only the largest 21 industrial plants used plant specific methodologies, so it was possible to derive country specific EFs for the major solid fuels only. The country-specific emission factors are derived from the verified ETS reports as a weighted average from all operators, which have declared that they have used plant-specific emission factors (Tier 3 according to Commission Regulation 601/2012 on the monitoring and reporting of greenhouse gas emissions). The EFs including oxidation factor are calculated as the total sum of the verified CO_2 emissions divided by the total amount of the respective fuel as reported by the operators. For the years

2007 to 2014 are applied the respective annual emission factors, while for the years 1988 to 2006 is applied an EF calculated as a weighted average. A subset of all operators reported plant-specific oxidation factors, based on which were calculated the country-specific EFs excluding oxidation factor by using the country-specific EFs including oxidation factor.

The following country-specific carbon contents were calculated:

Table 25 Country-specific carbon content for solid fuels [t/TJ]

Fuel	1988-2006	2007	2008	2009	2010	2011	2012	2013	2014
Anthracite	28.2586	27.4792	28.8427	28.6586	27.9950	27.7125	27.2728	27.2555	**27.4779**
Lignite	29.5732	29.3911	29.8238	29.5021	29.5215	29.3377	29.3820	29.3129	**29.3766**
Other Bituminous Coal	26.8169	27.3114	26.9270	26.7776	26.3476	26.5553	26.8637	26.5746	**26.1637**
Petroleum Coke	25.7857	26.1149	25.9131	25.3961	25.6574	25.1971	25.5126	25.6736	**25.8451**

The following emission factors excluding oxidation factor were calculated:

Table 26 Country-specific EFs excl. oxidation factor for CO2 for solid fuels [t/TJ]

Fuel	1988-2006	2007	2008	2009	2010	2011	2012	2013	2014
Anthracite	103.6147	100.7572	105.7566	105.0817	102.6484	101.6126	100.0003	99.9368	**100.7522**
Lignite	108.4352	107.7673	109.3540	108.1742	108.2456	107.5715	107.7340	107.4805	**107.7140**
Other Bituminous Coal	98.3287	100.1419	98.7324	98.1845	96.6078	97.3695	98.5004	97.4401	**95.9336**
Petroleum Coke	94.5477	95.7545	95.0147	93.1192	94.0772	92.3894	93.5463	94.1364	**94.7654**

The following country-specific emission factors including oxidation factor were used for the calculations of the emissions for all years and subcategories in CRF 1.A.

Table 27 Country-specific EFs incl. oxidation factor for CO_2 for solid fuels [t/TJ]

Fuel	1988-2006	2007	2008	2009	2010	2011	2012	2013	2014
Anthracite	98.4802	97.5236	100.7763	99.6547	97.3953	96.6057	96.3049	95.8515	**96.6008**
Lignite	105.8747	104.9506	106.8890	105.5404	105.8315	105.1891	105.3618	104.8037	**104.6660**
Other Bituminous Coal	95.6910	98.3294	96.2981	95.1683	93.4475	95.0759	96.4435	95.3831	**94.1733**
Petroleum Coke	94.5161	95.7225	94.9830	93.0881	94.0458	92.3586	93.5150	94.1049	**94.7434**

The national emission estimates were prepared using the country-specific emission factors including oxidation factor for anthracite, lignite, other bituminous coke and petroleum coke. For all other solid fuels were used the default emission factors and was applied an oxidation factor of 1.

For the purposes of the annual reports under Regulation 601/2012 on the monitoring and reporting of greenhouse gas emissions, plant operators should use either plant-specific emission factors, the country-specific emission factors excluding oxidation factor (Table 26) or the default emission factors (Table 24). Plant operators should apply either a plant-specific oxidation factor or an oxidation factor of 1, since the IPCC Guidelines do not provide default oxidation factors. Although the calculated weighted-average country-specific oxidation factors for solid fuels are representative on a national level, they cannot be applied on a plant level due to the significant technological differences of various installations.

3.3.8.2.3 Country specific emission factors for CO_2 for gaseous fuels

As CO_2 emissions from natural gas are a key category in several subcategories and following previous ARR (CC/ERT/ARR/2010/37, §82) recommendations, an improved calculation for a country-specific emission factor for natural gas was performed. Additional data from the relevant companies was collected:

- Bulgargaz EAD, the sole public supplier of natural gas for the territory of the Republic of Bulgaria for the period 2007-2014
- Petroceltic Bulgaria EOOD and Oil and Gas Exploration and Production AD - the companies licensed for oil and gas extraction for the period 2004-2014 and 1999-2014 respectively

The companies provided the following parameters of the natural gas they supply or extract for the previous years:

- the percentages of methane, ethane, propane, i-butane, n-butane, i-pentane, n-pentane, neo-pentane, i-hexane, N_2 and CO_2 as molar percentage;
- density, NCV/GCV and quantities supplied or extracted at a temperature of 20°C (293.15 K) and an absolute pressure of 101.325 kPa (760 mm Hg)

Using stoichiometric calculations and the above data it was possible to calculate a country specific emission factor for natural gas for each year and as a weighted average for the period 2007-2010.

The calculation showed that the average country-specific emission factor for natural gas is about 1.6% lower than the default emission factor, which was previously used.

Table 28 Country-specific carbon contents and EFs for CO_2 for gaseous fuels [t/TJ]

	1988-2006	2007	2008	2009	2010	2011	2012	2013	2014
Carbon content	15.0557	15.0501	15.0479	15.0647	15.0658	15.0717	15.0542	15.0999	**15.1186**
EF excl. oxidation factor	55.2044	55.1839	55.1758	55.2371	55.2413	55.2628	55.1987	55.3662	**55.4349**

As there is no country-specific oxidation factor for natural gas, the default value of 1 was used for the emission estimates.

Since all gas companies report and account the quantities of natural gas at a temperature of 20°C (293.15 K) and an absolute pressure of 101.325 kPa, all calculations were performed considering those conditions. Since 2012 the National Statistics started to report to Eurostat the used quantities of natural gas in cubic meters at a temperature of 15°C. In order to convert the reported values a conversion factor of 1.017 is used (e.g. $Q_{15} = Q_{20} / 1.017$ and $NCV_{15} = NCV_{20} * 1.017$).

For CH_4 emission estimates are applied the default emission factors referenced in IPCC 2006 guidelines, Vol. II, Ch. 2, Table 2-2, Table 2-3, Table 2-4, Table 2-5.

Table 29 Emission factors for CH_4 for different fuels [kg/TJ]

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
LIQUID FOSSIL Primary fuels				
Crude Oil	3	3	10	10
Orimulsion	3	3	10	10

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
Natural Gas Liquids	3	3	10	10
Secondary fuels/products				
Motor Gasoline	3	3	10	10
Aviation Gasoline	3	3	10	10
Jet Gasoline	3	3	10	10
Jet Kerosene	3	3	10	10
Other Kerosene	3	3	10	10
Shale Oil	3	3	10	10
Gas / Diesel Oil	3	3	10	10
Residual Fuel Oil	3	3	10	10
Liquefied Petroleum Gases	1	1	5	5
Ethane	1	1	5	5
Naphtha	3	3	10	10
Bitumen	3	3	10	10
Lubricants	3	3	10	10
Petroleum Coke	3	3	10	10
Refinery Feedstocks	3	3	10	10
Refinery Gas	1	1	5	5
Paraffin Waxes	3	3	10	10
White Spirit and SBP	3	3	10	10
Other Petroleum Products	3	3	10	10
SOLID FOSSIL Primary Fuels				
Anthracite	1	10	10	300
Coking Coal	1	10	10	300
Other Bituminous Coal	1	10	10	300
Sub-Bituminous Coal	1	10	10	300
Lignite	1	10	10	300
Oil Shale and Tar Sands	1	10	10	300
Secondary fuels/products				
Brown Coal Briquettes	1	10	10	300
Patent Fuel	1	10	10	300
Coke - Gas Coke	1	10	10	300
Coal Tar	1	1	5	5
Gas Works Gas	1	10	10	300
Coke Oven Gas	1	1	5	5
Blast Furnace Gas	1	1	5	5
Oxygen Steel Furnace Gas	1	1	5	5
GASEOUS FOSSIL				
Natural Gas	1	1	5	5
OTHER FOSSIL				
Municipal Wastes (non-biomass fraction)	30	30	300	300
Industrial Wastes	30	30	300	300
Waste Oils	30	30	300	300
Peat	1	2	10	300
SOLID BIOMASS				
Wood / Wood Waste	30	30	300	300
Sulphite lyes (Black Liquor)	3	3	3	3
Other Primary Solid Biomass	30	30	300	300
Charcoal	200	200	200	200
LIQUID BIOMASS				
Biogasoline	3	3	10	10

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
Biodiesels	3	3	10	10
Other Liquid Biofuels	3	3	10	10
GASEOUS BIOMASS				
Landfill Gas	1	1	5	5
Sludge Gas	1	1	5	5
Other Biogas	1	1	5	5
OTHER BIOMASS				
Municipal Wastes (biomass fraction)	30	30	300	300

For N_2O are applied the default emission factors referenced in IPCC 2006 guidelines, Vol. II, Ch. 2, Table 2-2, Table 2-3, Table 2-4, Table 2-5.

Table 30 Emission factors for N_2O for different fuels [kg/TJ]

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
LIQUID FOSSIL Primary fuels				
Crude Oil	0.6	0.6	0.6	0.6
Orimulsion	0.6	0.6	0.6	0.6
Natural Gas Liquids	0.6	0.6	0.6	0.6
Secondary fuels/products				
Motor Gasoline	0.6	0.6	0.6	0.6
Aviation Gasoline	0.6	0.6	0.6	0.6
Jet Gasoline	0.6	0.6	0.6	0.6
Jet Kerosene	0.6	0.6	0.6	0.6
Other Kerosene	0.6	0.6	0.6	0.6
Shale Oil	0.6	0.6	0.6	0.6
Gas / Diesel Oil	0.6	0.6	0.6	0.6
Residual Fuel Oil	0.6	0.6	0.6	0.6
Liquefied Petroleum Gases	0.1	0.1	0.1	0.1
Ethane	0.1	0.1	0.1	0.1
Naphtha	0.6	0.6	0.6	0.6
Bitumen	0.6	0.6	0.6	0.6
Lubricants	0.6	0.6	0.6	0.6
Petroleum Coke	0.6	0.6	0.6	0.6
Refinery Feedstocks	0.6	0.6	0.6	0.6
Refinery Gas	0.1	0.1	0.1	0.1
Paraffin Waxes	0.6	0.6	0.6	0.6
White Spirit and SBP	0.6	0.6	0.6	0.6
Other Petroleum Products	0.6	0.6	0.6	0.6
SOLID FOSSIL Primary Fuels				
Anthracite	1.5	1.5	1.5	1.5
Coking Coal	1.5	1.5	1.5	1.5
Other Bituminous Coal	1.5	1.5	1.5	1.5
Sub-Bituminous Coal	1.5	1.5	1.5	1.5
Lignite	1.5	1.5	1.5	1.5
Oil Shale and Tar Sands	1.5	1.5	1.5	1.5
Secondary fuels/products				
Brown Coal Briquettes	1.5	1.5	1.5	1.5
Patent Fuel	1.5	1.5	1.5	1.5

Fuel	Energy Industries	Manufacturing Industries and Construction	Commercial / Institutional	Residential and Agriculture / Forestry / Fishing
Coke - Gas Coke	1.5	1.5	1.5	1.5
Coal Tar	0.1	0.1	0.1	0.1
Gas Works Gas	1.5	1.5	1.5	1.5
Coke Oven Gas	0.1	0.1	0.1	0.1
Blast Furnace Gas	0.1	0.1	0.1	0.1
Oxygen Steel Furnace Gas	0.1	0.1	0.1	0.1
GASEOUS FOSSIL				
Natural Gas	0.1	0.1	0.1	0.1
OTHER FOSSIL				
Municipal Wastes (non-biomass fraction)	4	4	4	4
Industrial Wastes	4	4	4	4
Waste Oils	4	4	4	4
Peat	1.5	1.5	1.4	1.4
SOLID BIOMASS				
Wood / Wood Waste	4	4	4	4
Sulphite lyes (Black Liquor)	2	2	2	2
Other Primary Solid Biomass	4	4	4	4
Charcoal	4	4	1	1
LIQUID BIOMASS				
Biogasoline	0.6	0.6	0.6	0.6
Biodiesels	0.6	0.6	0.6	0.6
Other Liquid Biofuels	0.6	0.6	0.6	0.6
GASEOUS BIOMASS				
Landfill Gas	0.1	0.1	0.1	0.1
Sludge Gas	0.1	0.1	0.1	0.1
Other Biogas	0.1	0.1	0.1	0.1
OTHER BIOMASS				
Municipal Wastes (biomass fraction)	4	4	4	4

3.3.8.2.4 Choice of emission factors for mobile sources

The emission factors for mobile sources are presented in Chapter 3.3.12.3.4.

3.3.8.3 Choice of activity data for stationary sources

The activity data required for calculation of the emissions from stationary combustion is based on the National Energy Balances, which provide information about the indigenous production, imports, exports and inland consumption by subcategory of all types of fuels.

The balances provide the consumption of fuels in natural units (mass or volume units – thousands of tons/Gg for solid and liquid fuels, cubic meters for gaseous fuels) and the net calorific values for each fuel per subcategory.

Following the recommendations, the energy balances prepared by the National Statistics Institute in the Eurostat format were used for estimating the emissions for the years 1990-2014. The National statistics have not prepared balances in the Eurostat format for the years before 1990, so the IEA Energy balances were used for the years 1988 and 1989.

Additionally, since it was found that the use of alternative fuels (industrial waste) is not reported in the energy balances for the full time series, the reports provided by the plant operators according to the Bulgarian waste legislation and the ETS reports were used, in order to calculate the GHG from waste incineration in the cement plants.

According to the sectoral approach methodology for stationary combustion, only the fuel quantities that are combusted are relevant and thus considered for the emission calculations. Reported quantities of fuels for non-energy use and feedstock use, international bunker fuels, transformation and distribution losses, transformations of fuels to other fuels and internal refinery processes which have been reported in the transformation sector of the energy balances were not considered.

The correspondence between the energy balance categories and CRF categories can be reviewed in detail in Annex II.

The national energy balance is provided by NSI. The energy balance presents also the net calorific values (NCVs) used for converting mass or volume units of the fuel quantities into energy units [TJ].

3.3.8.3.1 Choice of NCV

The corresponding Net Calorific Values (NCVs) for each category from the Energy balances were used in order to convert the fuel consumption reported in natural units to energy units. For solid fuels there is more than one NCV provided in the Energy balance. Details about the correspondence between each type of NCV and each category are presented in Annex II.

For the reference approach for solid fuels was calculated the weighted average NCV from the NCVs of production, imports and exports. The calculated NCVs used for the reference approach can be found in Annex III.

For liquid fuels the balances provide average NCVs, which were used in all calculations.

For gaseous fuels was used directly the amount in TJ as reported by the energy balances. Since the reported values are Gross Calorific Values, all numbers were multiplied by 90% in order to calculate the NCV. (IEA Energy Statistics Manual, p. 183, Table A3.12)

Table 31 Selected Net Calorific Values for 2014

Fuel	Public electricity and heat production [TJ/Gg]	Industry [TJ/Gg]
Liquid fuels		
Crude oil	42.538	
Gasoline	43.224	
Jet Kerosene	43.000	
Gas/Diesel Oil	42.051	
Residual Fuel Oil	40.000	
LPG	46.000	
Naphtha	44.000	
Bitumen	37.700	
Lubricants	42.300	
Petroleum Coke	31.400	
Refinery Feedstocks	41.850	
Refinery Gas	45.238	
White Spirit SBP	44.000	
Paraffin Wax	30.000	
Other Petroleum Products	40.447	
Solid fuels		

Anthracite	24.872	29.810
Coking Coal	-	-
Other Bituminous Coal	25.768	24.536
Lignite and Sub-bituminous Coal	6.769	17.412
BKB & Patent Fuel	11.978	-
Coke Oven / Gas Coke	-	28.500
Gaseous fuels		
Natural Gas, 20°C [TJ/1000 m3]	0.034032	
Natural Gas, 15°C [TJ/1000 m3]	0.034610	

For all NCVs please consult Annex III.

3.3.8.4 Biomass

A wide range of biomass sources can be used to produce bioenergy in a variety of forms. Solid biofuels include the following:

- wood and wood waste combusted directly for energy purposes and biomass used for charcoal production
- black liquor - a concentrated residual from the pulp and paper industry
- other primary solid biomass - plant residues not included in the above mentioned black liquor and wood and wood waste
- charcoal - a product from destructive distillation and pyrolysis of wood and other vegetal material
- Liquid biofuels as biogasoline, biodiesel and other bioliquids are used mainly for transportation. This is further explained in the transport sector.

Landfill, sludge and other biogas are derived from anaerobic fermentation of biomass and solid wastes in landfills, from sludge and animal slurries and other sources, respectively. In addition, there is a biomass fraction from the municipal wastes. All these types are combusted to produce heat and/or power. However, CO_2 emissions released from these processes are reported as an information item, as the CO_2 is naturally captured from the air. That is not applicable for the methane and N_2O emissions that are reported and accounted for in the total inventory emissions.

In Bulgaria all types of biomass – solid, liquid and gaseous – are used as an energy source. Biomass is primarily used for the production of heat in transformation sector (autoproducer heat and CHP; main activity producer heat plants), industry, residential, commercial and public services sector, agriculture and other sectors.

Mostly solid biomass is combusted during the years in the following activities:

- Energy industries (main activity producer heat plants, own use in electricity, CHP and heat plants)
- Manufacturing Industries and construction (iron and steel, chemical and petrochemical, non-ferrous metals, non-metallic minerals, transport equipment, machinery, mining and quarrying, food and tobacco, paper, pulp and print, wood and wood products, construction, textile and leather and non-specified (industry); autoproducer CHP plants and autoproducer heat plants
- Other sectors (residential, commercial/institutional, agriculture/forestry/fishing, non-specified other)

- Regarding the liquid and gaseous types, only biodiesel and sludge gas are utilized for various activities. The amount is limited and consumed in commercial and public services and heat plants for both sludge gas and charcoal. Data for those sources is reported for 2009-2014 and 2008-2014, respectively.

For the estimate of the CH_4 and N_2O emissions were applied the EFs from 2006 IPCC Guidelines, Vol. 2, Ch. 2, Table 2.2-2.5.

3.3.8.5 Other fossil fuels

There is a specific case for other fuels used in the industry, for which a separate calculation model was developed. Due to the fact that all cement plants participate in the ETS, their verified reports were used in order to calculate the country-specific EFs for the following fuels:

- SRF/RDF
- Waste oils
- Tyres
- Filters
- Biomass

Data from the reports of all industrial plants submitted according to the Bulgarian waste legislation was used in order to calculate the emissions based on specific waste type.

The model accounts separately the emissions from biomass fraction and non-biological fraction, as CO_2 emissions from biomass fraction should not be included in the national totals.

3.3.8.6 Uncertainties in CRF 1.A

<u>STATIONARY COMBUSTION</u>

3.3.8.6.1 Uncertainty of AD

Solid fuels

About 80% of solid fuels consumption comes from national lignite production, another 19% of solid fuels (anthracite and bituminous coal) are imported predominantly from Russia and Ukraine. Except for electricity production, solid fuels are used in the chemical industry, as well as in the non-metallic minerals and iron and steel industry. The Eurostat format energy balances, which are prepared by NSI, are based on bottom-up and top-down approach.

There isn't always a consistent allocation between 'Transformation sector', 'Energy sector' and 'Total Final Consumption', and also between the subcategories for the early years, consumption tends to be allocated to the 'Other' categories (1.A.2.f and 1.A.5). Further reasons for uncertainties are the different coal qualities (ash, moisture, sulphur, and calorific value) even from the same mines. Finally, coal is quantified on a mass basis and therefore conversion factors which are associated can cause uncertainties. Solid fuels which are used in the plants, which are participating in the ETS, have a considerably lower uncertainty compared to solid fuels which are used in any kind of small combustion plants.

Based on the above background information, the uncertainties are estimated as following:

- For CRF categories 1.A.1 and 1.A.2: 1%
- For CRF category 1.A.4 and 1.A.5: 2%

Natural gas

The supply, transmission and storage of natural gas are licensed to 'Bulgargaz' and 'Bulgartransgaz' according to the energy act. The gas transmission network consists of gas pipelines with high-pressure branches (1700 km), three compressor stations (total capacity of 49 MW), 68 gas pressure-reduction stations and 8 gas measuring stations. The gas transmission network for natural gas transit is not connected to the national gas transmission network. Furthermore, underground gas storage and a related compressor stations exist. Losses are mainly due to leakages, maintenance, old pipes, and varying pressure. Whereas the uncertainty of natural gas supplied to the industry can be assed as low, the uncertainty for natural gas consumed by households is higher due to the large number of licensed providers and network complexity. Further reason for uncertainty is related to GCV and conversion factor m^3 to TJ.

Based on the above background information, the uncertainties are estimated as following:

- For CRF categories 1.A.1 and 1.A.2: 1%
- For CRF category 1.A.4 and 1.A.5: 5%

Liquid fuels

In Bulgaria 5 main importers and distributors of petrol oil are operating more than 3000 gas stations. Crude oil is more or less exclusively imported from Russia, Ukraine and other former Russian republics. Liquid fuels are either refined in the LUKOIL Neftochim refinery in Burgas or imported. Due to recent regulations the amounts of gasoline and diesel fuel, which are sold at gas stations are monitored in real-time since January 2011, which leads to low uncertainty. Nevertheless, before that period, there were occasional reports for small distributors not declaring the liquid fuels they have sold in order to avoid taxes. For some of the years the allocation of the various liquid fuels to the subcategories is not clear. Therefore, a higher uncertainty is estimated for small combustion plants and engines.

Based on the above background information, the uncertainties are estimated as following:

- For CRF categories 1.A.1 and 1.A.2: 3%
- For CRF category 1.A.4 and 1.A.5: 5%

3.3.8.6.2 Uncertainty for EF

Since for some of the fuels were used the default EFs from the 2006 IPCC GL, the data on default uncertainties presented in "Table A1-1 Uncertainties due to emission factors and activity data" (1996 IPCC GL, p. D 1.4) is applicable (referenced by the 2006 IPCC GL). For energy sector the uncertainty for emission factor and activity data is 7%.

For the country-specific EFs for solid fuels were used the ETS verified reports, which have much lower uncertainty. Nevertheless, the conditions in which solid fuels are burnt are very different, especially considering the oxidation factors for solid fuels in households could cause higher uncertainty.

Based on the above background information, the uncertainties are estimated as following:

- For solid fuels in CRF categories 1.A.1 and 1.A.2: 2%
- For solid fuels in CRF category 1.A.4 and 1.A.5: 5%
- For liquid fuels: 7%
- For gaseous fuels: 2%

Quantitative uncertainty estimates are provided in Annex VII.

3.3.8.7 Source-specific QA/QC and verification

For the calculation of the emissions from CRF category 1A was developed an Excel based spreadsheet model, which was liked directly to the Eurostat format energy balances provided by the NSI.

Wherever it was possible, automated data validation was implemented within the model, but many manual checks were performed too.

Following a recommendation FCCC/ARR/2011/BGR, §65 was investigated the possibility of obtaining a correlation between the carbon content and the NCV of each fuel reported by the selected facilities that have used higher tier methods under the EU ETS. Recent scientific literature was consulted (Fott, 1999; Mazumdar, 2000; Mesroghli et al., 2009). Due to the fact that the number of samples is relatively low and coal in Bulgaria is both locally produced and imported in a varying proportion, it was found that there is a very low correlation between the NCV and the CO_2 emission factors for all types of coal (Anthracite, Other Bituminous Coal, Sub-Bituminous Coal, Lignite). This is mostly due to the fact that the NCV is also dependent on other parameters like hydrogen, oxygen and sulphur contents, also ash and water contents.

3.3.8.7.1 Activity data checks

Trend analysis was performed regarding the activity data for all subcategories and fuels separately. The most notable data peaks/drops were discussed with the NSI in order to have an explanation of the variations. Since the methodologies used by the National statistics changed several times during the years, there are several sectors with significant differences in fuel consumption throughout the different time periods. These differences are a result of reallocation of the consumption in different subcategories. An attempt to compare the reallocated quantities was made – i.e. if a significant decrease in the consumption is noticed in a subcategory, it was compared if equal amount is noticeable in another subcategory in which the consumption was reallocated in the following years.

Some changes in the activity data were necessary, because NCVs are not provided for some of the years for some fuels (most notably solid fuels for 1990-91 and 1998) by the NSI. All changes on the activity data were discussed with and approved by the data provider.

For some subcategories the activity data regarding the energy consumption and the data for the production were checked for correlation.

Activity data peaks/drops were discussed with industrial processes experts in order to identify sectoral restructuring (closing or opening of plants) or technological changes within specific plants, which result in fuel mix or energy consumption changes.

3.3.8.7.2 Calculations checks

Manual data checks are performed in order to prevent calculation errors:

- Unit conversion checks – activity data units are checked in order to verify that the proper unit conversions are applied.

- Calculation formulas checks – cell formulas are manually checked in order to ensure consistency.

In order to assure integrity of the calculations and to prevent possible errors due to incomplete activity data, the automatic data validation checks were implemented in the Excel model. Each cell with a validation rule is colored red in case there is a logical problem with the calculations:

- Conversion from natural units to energy units – ensure all non-negative values reported in natural units are properly converted to energy units.
- Calculation of the emissions – ensure the corresponding emissions are calculated from all non-zero values in energy units.
- Emission factors validation – ensure chosen emission factors are within the 2006 GL ranges
- The model itself and the calculations were validated by international experts, and by national experts as part of the QA procedures implemented.

Currently the data from the calculation models is transferred manually to the CRF reporter import templates. In order to ensure that there are no differences due to technical errors, additional comparisons are made between the data in the calculation models and the CRF tables generated by the CRF Reporter software.

3.3.8.8 Source-specific recalculations, including changes made in response to the review process

Following the recommendation from a previous ARR (CC/ERT/ARR/2010/37, §72), a change in the calculation model was introduced. Until 2003, the National statistics provides only aggregated information regarding the consumption of anthracite coal and other bituminous coal – they are reported as other bituminous coal. Since the EF for anthracite coal is about 2% higher than the EF for other bituminous coal, in order to avoid underestimation of the emissions, it was decided to use the EF for anthracite coal to calculate the emissions from other bituminous coal.

Following a recommendation of a previous ARR (CC/ERT/ARR/2010/37, §66), the calculation models were improved, so they could be directly linked to the activity data.

Up to the 2011 submission, the country specific emission factors were calculated as a weighted average from the available ETS reports and applied to all the years in the time series, which was leading to an annual recalculation of the full time series. From the 2012 submission on, the country specific emission factors are calculated as a weighted average from all reports for 2007, 2008, 2009 and 2010 and applied for the period 1988-2006, while for the years after 2007 is used the respective annual EF. The differences in the country-specific factors can be found in Table 25.

For the 2015 submission all emission estimates were recalculated using updated emission and oxidation factors from the 2006 IPCC Guidelines and allocated according to the updated CRF categories. For the 2015 submission were also estimated the emissions from hydrogen production and reported under subcategory 1.A.1.b. Petroleum refining.

For the 2016 submission was identified an error in the calculation files - the quantities for liquid fuels for off-road machinery for the construction sector was erroneously linked to off-road machinery in Agriculture. An additional error was identified and corrected regarding the consumption of solid fuels in CRF category 1.A.2.c for 1988 and 1989.

3.3.8.9 Source-specific planned improvements, including those in response to the review process

We are currently applying a Tier 1 method for the estimation of emissions from category 1.B.1.a. Coal mining and handling. In order to implement a Tier 2/3 approach, the IPCC guidelines propose to examine measurement data from a number of underground coal mines and to measure the In-Situ gas content of coal samples. Currently, no such data is available for Bulgaria. Presently, around 2% of the coal production in Bulgaria is from underground mines. Moreover, in Bulgaria is produced mostly lignite coal, which has lower EF than higher coal ranks, such as bituminous. Currently, using the global average emission factors does not lead to underestimation of the emissions from this category. The financial costs related to the required laboratory measurements in order to derive a country-specific emission factor were estimated as very high. Depending on the available financial resources we plan to set the timeframe for implementing a Tier 2 approach.

3.3.9 EMISSION TREND

The fuel consumption in the following subcategories is included in this category:

- 1.A.1. Energy Industries
- 1.A.2. Manufacturing Industries and Construction
- 1.A.3. Transport
- 1.A.4. Other Sectors
- 1.A.5. Other

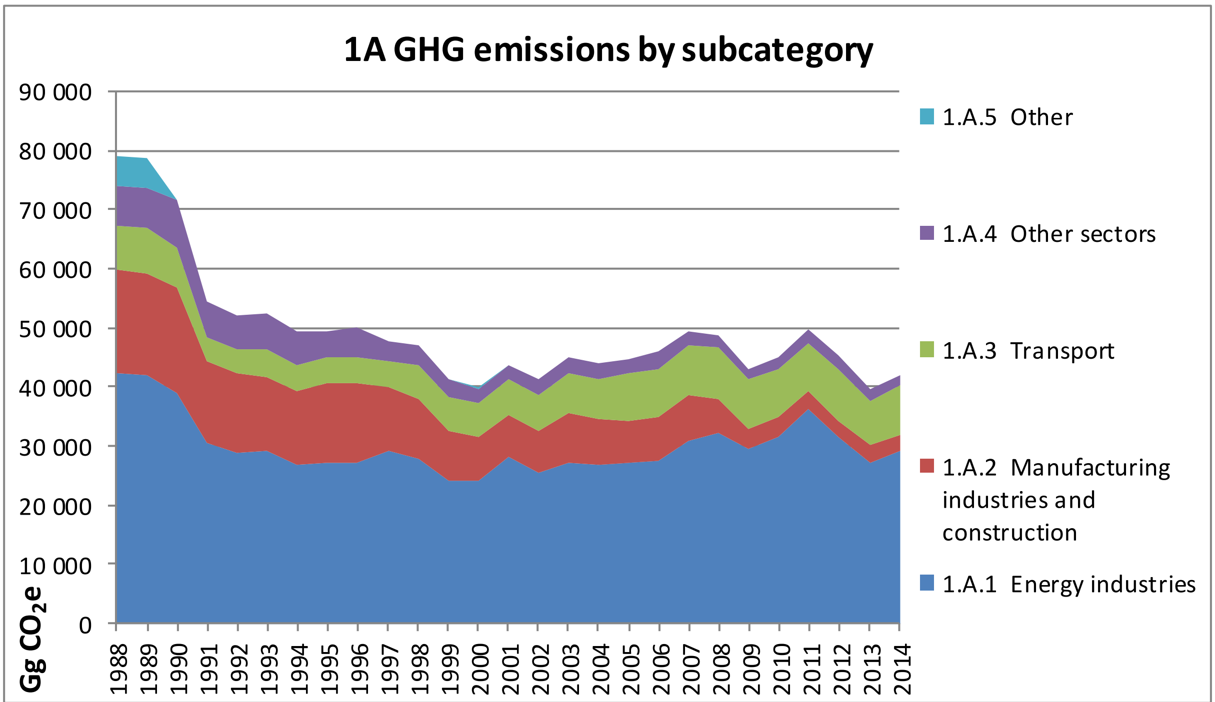

Figure 22 Total GHG emissions from Fuel combustion by subcategory

Energy Industries are the main source of GHG emissions from fuel combustion with 67.3% of the sector emissions for 2014. Transport is the second most important source with 19.7% of the sector emissions, followed by Manufacturing industries and construction with 6.4%

The general trend shows a notable drop in the country emissions after 1990-1991 due to the transition from planned economy to market economy, which happened in the country. The decrease of the GHG emissions continued up to 1999, followed by a slow increase after 2000, after the national economy started to grow. In the recent years (2008-2009) due to the economic crisis the emissions decreased again, approaching the 2000 levels. In 2010 and 2011 there is an increasing trend of the emissions, which is mostly due to the increase in energy industries. In 2012 and 2013 there is a drop in the country emissions mostly due to decrease of fossil fuels used for electricity generation and an increase in renewable energy sources. The drop was partially compensated in 2014 due to the increase of electricity exports and fuel consumption in Transport sector. In 2014 there is an increase of the emissions from fuel combustion of 6.1% compared to 2013.

Manufacturing industry and construction is the sector, which changed drastically – compared to 1988 the emissions decreased by 84.2% in 2014. The significant decrease of the emissions after 2008 is mostly due to the restructuring of the Iron and steel industry in Bulgaria. The closure of Bulgaria's biggest I&S plant, which was the only plant in the country operating coke ovens and blast furnaces, decreased significantly the emissions from solid fuels and the emissions from the industry subcategory in general. The trend for solid fuels was reversed in 2011 mostly due to the opening of a new coal power plant and the general increase of electricity production from lignite coal in the country. However, the reduced electricity exports and the increased renewable energy production (solar, wind and biomass) in 2012 and 2013 have led to a significant decrease of solid fuels usage and emissions, which was only partially compensated in 2014.

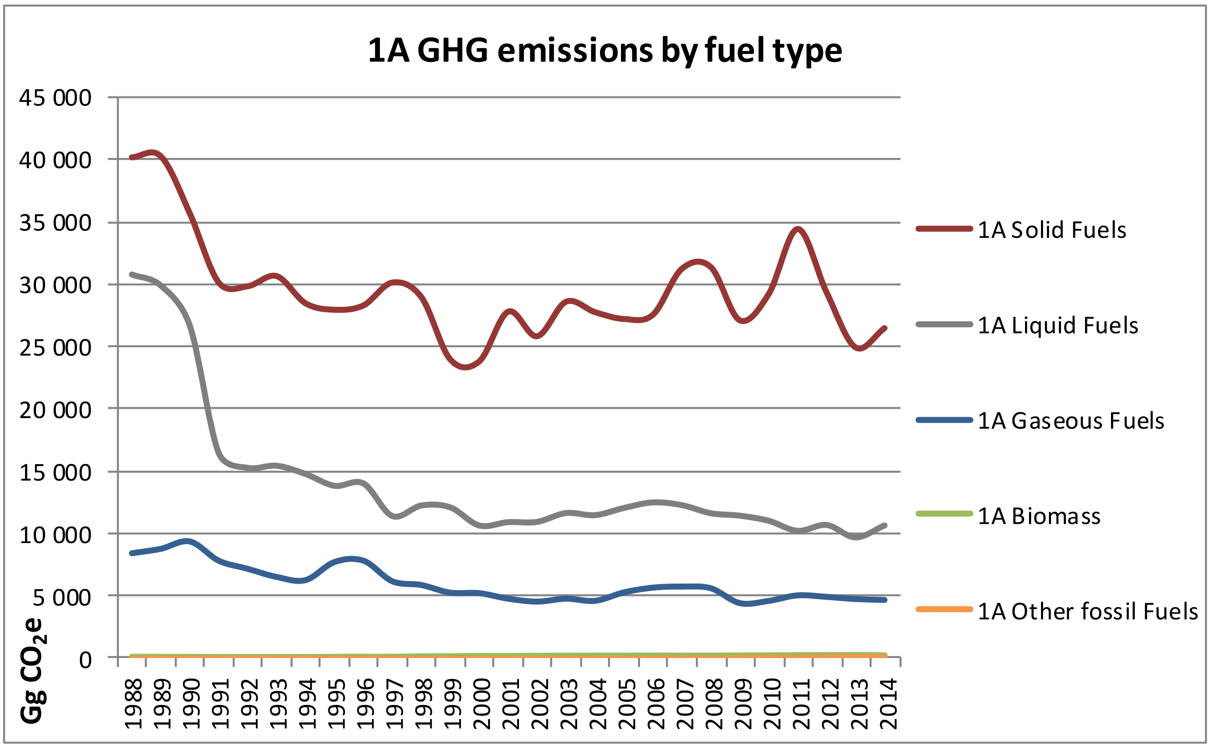

Figure 23 Total GHG emissions from Fuel combustion by fuel type

In 2014, 62.9% of the emissions from fuel combustion were from solid fuels, 25.3% were from liquid fuels, and 11.0% were from gaseous fuels.

The general trend shows an increase in the share of solid fuels, mostly due to the energy industries growth, decrease in liquid and gaseous fuels due to the decrease of the industry sector, regardless of the on-going gasification of industrial plants, residential sector and transport.

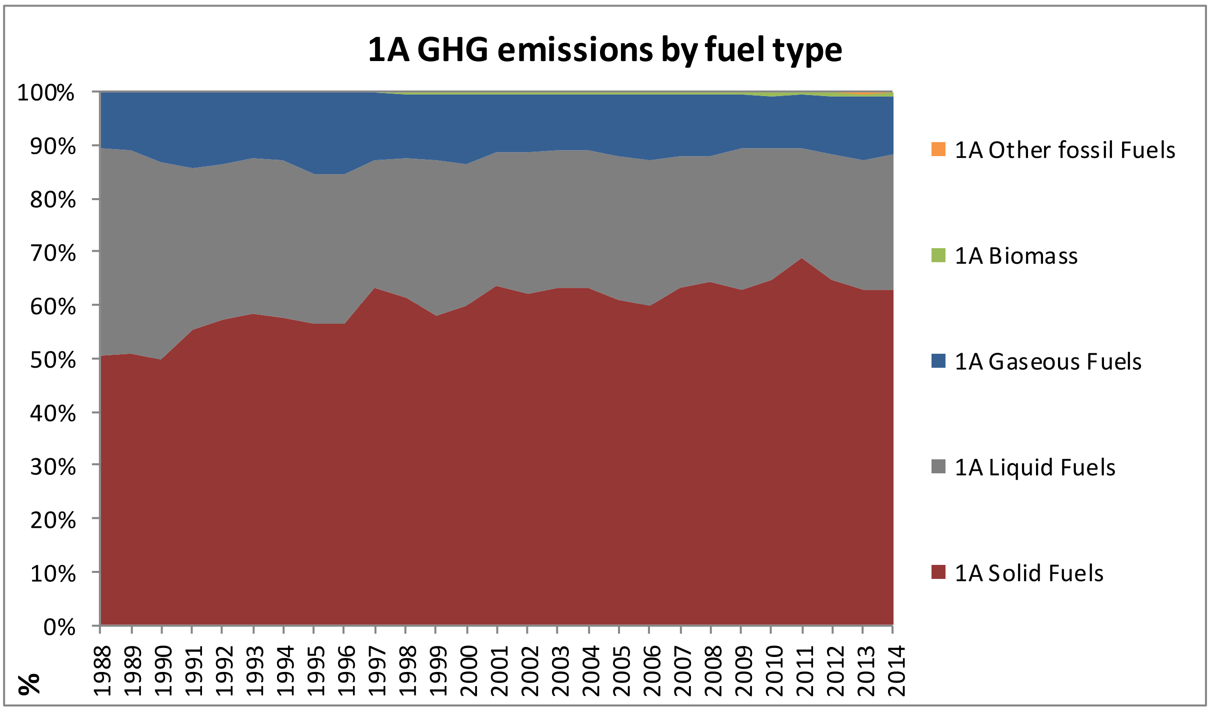

Figure 24 Total GHG emissions from Fuel combustion by fuel type

Table 32 CO_2 emissions in 1.A. Fuel Combustion

CO_2 (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	78 279.59	30 283.18	39 660.31	8 336.10	NO	NO
1989	77 831.77	29 391.55	39 748.18	8 692.03	NO	NO
1990	70 757.57	26 194.93	35 281.16	9 281.47	NO	NO
1991	53 707.06	16 175.94	29 784.33	7 746.78	NO	NO
1992	51 533.10	14 988.92	29 446.15	7 098.03	NO	NO
1993	51 830.72	15 138.40	30 242.76	6 449.56	NO	NO
1994	48 818.44	14 477.06	28 148.88	6 192.50	NO	NO
1995	48 826.32	13 515.07	27 673.34	7 637.90	NO	NO
1996	49 430.58	13 709.76	27 975.86	7 744.96	NO	NO
1997	47 095.43	11 161.60	29 834.12	6 099.71	NO	NO
1998	46 445.28	11 965.48	28 678.15	5 801.64	NO	NO
1999	40 777.08	11 810.52	23 774.63	5 191.94	NO	NO
2000	39 182.92	10 384.43	23 645.88	5 152.60	NO	NO
2001	43 007.65	10 668.90	27 629.46	4 709.29	NO	NO
2002	40 787.77	10 679.14	25 629.23	4 479.40	NO	NO
2003	44 450.14	11 380.36	28 357.63	4 712.15	NO	NO
2004	43 376.38	11 280.56	27 553.22	4 539.14	NO	3.4595
2005	44 076.75	11 844.34	27 018.55	5 211.06	NO	2.8073
2006	45 213.24	12 274.74	27 347.80	5 589.06	NO	1.6434
2007	48 770.69	12 070.90	31 017.11	5 672.95	NO	9.7319
2008	48 156.58	11 455.86	31 154.21	5 538.78	NO	7.7358
2009	42 583.02	11 265.33	26 944.50	4 350.77	NO	22.4192
2010	44 439.74	10 867.66	29 021.52	4 525.45	NO	25.1073
2011	49 233.11	10 063.87	34 172.69	4 970.14	NO	26.4157
2012	44 548.76	10 535.83	29 123.83	4 849.37	NO	39.7301

CO_2 (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2013	39 051.94	9 553.63	24 770.52	4 676.22	NO	51.5697
2014	41 478.20	10 502.75	26 322.30	4 603.71	NO	49.4349
Decrease 1988-2014	47.0%	65.3%	33.6%	44.8%	-	-
Decrease 1990-2014	41.4%	59.9%	25.4%	50.4%	-	-
Decrease 2013-2014	-6.2%	-9.9%	-6.3%	1.6%	-	4.1%

Table 33 CH_4 emissions in 1.A. Fuel Combustion

CH_4 (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	18.4647	3.8920	12.0393	0.1510	2.3823	NO
1989	18.2849	4.0886	11.7600	0.1575	2.2788	NO
1990	15.6359	3.8776	9.4208	0.1712	2.1663	NO
1991	12.3021	2.0553	8.7406	0.1412	1.3650	NO
1992	14.3839	2.2147	10.4379	0.1297	1.6017	NO
1993	14.8837	2.4853	10.8434	0.1180	1.4370	NO
1994	12.4093	2.4623	8.1679	0.1134	1.6657	NO
1995	11.4609	2.4831	6.6428	0.1417	2.1933	NO
1996	13.1451	2.2137	8.3420	0.1462	2.4431	NO
1997	10.8634	1.5943	6.7531	0.1139	2.4021	NO
1998	13.2725	1.9309	6.6097	0.1087	4.6232	NO
1999	11.3677	1.9000	4.5044	0.0977	4.8656	NO
2000	11.6286	1.6537	3.3861	0.0976	6.4913	NO
2001	10.1817	1.5711	2.3901	0.0908	6.1298	NO
2002	13.0936	1.6070	4.0429	0.0872	7.3565	NO
2003	14.1728	1.5928	4.8094	0.0934	7.6772	NO
2004	13.2732	1.4101	3.7550	0.1285	7.9784	0.0013
2005	12.9359	1.4093	3.4343	0.2240	7.8673	0.0010
2006	13.7035	1.4358	3.6492	0.2680	8.3499	0.0005
2007	12.8618	1.3280	3.2878	0.3282	7.9143	0.0035
2008	12.9919	1.2493	2.9837	0.3100	8.4461	0.0027
2009	12.2197	1.2230	2.0998	0.3553	8.5338	0.0077
2010	13.6775	1.1155	2.7964	0.4376	9.3177	0.0103
2011	14.6205	1.0045	3.4336	0.3692	9.8041	0.0091
2012	15.0953	0.9817	3.2763	0.3365	10.4869	0.0140
2013	14.1398	0.8630	2.7377	0.3502	10.1721	0.0169
2014	13.0722	0.9321	2.0289	0.3920	9.7022	0.0170
Decrease 1988-2014	29.2%	76.1%	83.1%	-159.6%	-307.3%	-
Decrease 1990-2014	16.4%	76.0%	78.5%	-129.0%	-347.9%	-
Decrease 2013-2014	7.6%	-8.0%	25.9%	-11.9%	4.6%	-0.4%

Table 34 N_2O emissions in 1.A. Fuel Combustion

N_2O (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1.7569	1.1364	0.5737	0.0151	0.0318	NO
1989	1.7669	1.1459	0.5749	0.0157	0.0304	NO

N_2O (Gg)	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1990	1.7202	1.1660	0.5085	0.0168	0.0289	NO
1991	1.2079	0.7336	0.4367	0.0140	0.0236	NO
1992	1.1844	0.7161	0.4292	0.0129	0.0262	NO
1993	1.2311	0.7534	0.4424	0.0117	0.0237	NO
1994	1.2051	0.7589	0.4080	0.0112	0.0270	NO
1995	1.2486	0.8026	0.3984	0.0138	0.0338	NO
1996	1.2652	0.8105	0.4040	0.0140	0.0367	NO
1997	1.1436	0.6656	0.4278	0.0110	0.0392	NO
1998	1.2661	0.7748	0.4122	0.0105	0.0685	NO
1999	1.2148	0.7918	0.3419	0.0094	0.0718	NO
2000	1.1715	0.7314	0.3386	0.0093	0.0922	NO
2001	1.1814	0.6842	0.3981	0.0085	0.0905	NO
2002	1.2112	0.7256	0.3696	0.0081	0.1079	NO
2003	1.2740	0.7421	0.4089	0.0085	0.1146	NO
2004	1.0518	0.5252	0.3989	0.0082	0.1193	0.0002
2005	1.0842	0.5651	0.3929	0.0095	0.1166	0.0001
2006	1.1389	0.6059	0.3982	0.0102	0.1245	0.0001
2007	1.1419	0.5631	0.4535	0.0104	0.1144	0.0005
2008	1.0537	0.4625	0.4511	0.0102	0.1295	0.0004
2009	0.9798	0.4496	0.3936	0.0081	0.1275	0.0010
2010	1.0070	0.4207	0.4245	0.0085	0.1520	0.0014
2011	1.0953	0.4249	0.4983	0.0094	0.1615	0.0012
2012	1.0411	0.4271	0.4228	0.0094	0.1799	0.0019
2013	0.9505	0.3927	0.3618	0.0093	0.1845	0.0023
2014	0.9899	0.4177	0.3849	0.0095	0.1756	0.0023
Decrease 1988-2014	43.7%	63.2%	32.9%	37.4%	-452.7%	-
Decrease 1990-2014	42.5%	64.2%	24.3%	43.8%	-507.8%	-
Decrease 2013-2014	-4.1%	-6.4%	-6.4%	-1.6%	4.8%	-0.4%

Table 35 GHG emissions in 1.A. Fuel Combustion

GHG (Gg)	TJ	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	953 194.55	79 264.77	30 719.12	40 132.25	8 344.38	69.0232	NO
1989	948 699.62	78 815.42	29 835.24	40 213.49	8 700.66	66.0244	NO
1990	876 858.08	71 661.09	26 639.33	35 668.23	9 290.76	62.7649	NO
1991	659 938.69	54 374.58	16 445.93	30 132.99	7 754.49	41.1578	NO
1992	627 659.90	52 245.64	15 257.67	29 835.01	7 105.10	47.8529	NO
1993	628 014.26	52 569.69	15 425.05	30 645.68	6 455.99	42.9737	NO
1994	593 723.56	49 487.78	14 764.77	28 474.66	6 198.68	49.6799	NO
1995	604 074.23	49 484.92	13 816.32	27 958.14	7 645.57	64.9009	NO
1996	611 661.58	50 136.24	14 006.63	28 304.79	7 752.79	72.0282	NO
1997	564 324.64	47 707.82	11 399.80	30 130.42	6 105.85	71.7405	NO
1998	565 858.46	47 154.38	12 244.65	28 966.24	5 807.49	135.9956	NO
1999	507 765.92	41 423.29	12 093.96	23 989.12	5 197.18	143.0295	NO
2000	491 765.95	39 822.74	10 643.72	23 831.45	5 157.83	189.7433	NO
2001	525 576.05	43 614.24	10 912.08	27 807.86	4 714.10	180.2008	NO
2002	505 046.00	41 476.06	10 935.55	25 840.44	4 483.99	216.0681	NO
2003	547 598.43	45 184.13	11 641.33	28 599.70	4 717.03	226.0679	NO

GHG (Gg)	TJ	1.A. Fuel Combustion	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2004	539 339.31	44 021.65	11 472.33	27 765.97	4 544.81	234.9983	3.5410
2005	553 488.82	44 723.24	12 047.97	27 221.48	5 219.49	231.4186	2.8728
2006	571 248.08	45 895.21	12 491.19	27 557.69	5 598.81	245.8369	1.6772
2007	601 953.13	49 432.52	12 271.91	31 234.44	5 684.27	231.9472	9.9566
2008	593 266.37	48 795.38	11 624.91	31 363.24	5 549.57	249.7542	7.9135
2009	528 063.73	43 180.49	11 429.88	27 114.30	4 362.07	251.3277	22.9200
2010	550 822.09	45 081.77	11 020.91	29 217.93	4 538.92	278.2385	25.7750
2011	601 055.55	49 925.03	10 215.59	34 407.01	4 982.18	293.2405	27.0055
2012	560 797.15	45 236.38	10 687.66	29 331.72	4 860.58	315.7839	40.6339
2013	504 796.74	39 688.69	9 692.24	24 946.76	4 687.75	309.2744	52.6650
2014	528 654.28	42 100.00	10 650.53	26 487.73	4 616.33	294.8745	50.5349
Decrease 1988-2014	44.5%	46.9%	65.3%	34.0%	44.7%	-327.2%	-
Decrease 1990-2014	39.7%	41.3%	60.0%	25.7%	50.3%	-369.8%	-
Decrease 2013-2014	-4.7%	-6.1%	-9.9%	-6.2%	1.5%	4.7%	4.0%

3.3.10 ENERGY INDUSTRIES (CRF 1.A.1)

The fuel consumption in the following subcategories is included in this category:

- Conventional electricity, CHP and heat plants (public and autoproducers),
- Petroleum refining plants,
- Solid fuel transformation plants,
- Oil and gas extraction and coal mining,
- Own consumption of the energy sector.

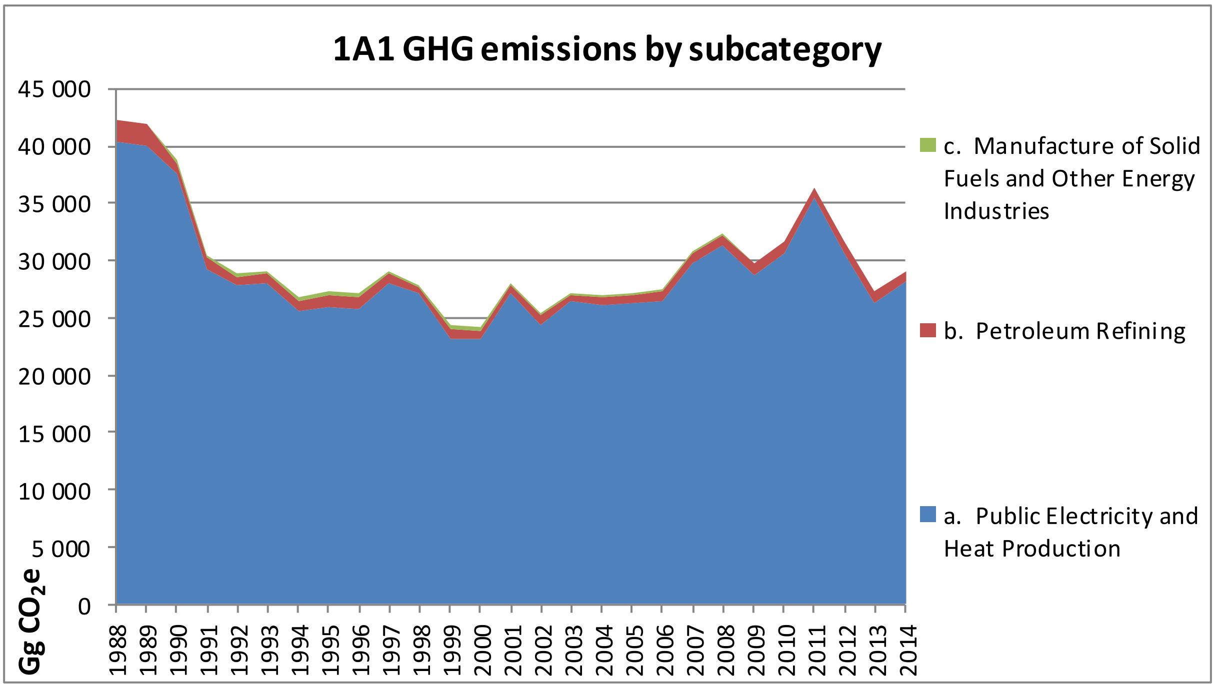

Figure 25 Total GHG emissions from 1.A.1 Energy industries by subcategory

For 2014 the general trend in CRF category 1.A.1 is a decrease in the emissions of 31.3% compared to base year and an increase of 6.2% compared to last year.

1.1.1.1 Public Electricity and Heat Production (CRF 1.A.1.a)

Category 1.A.1.a Public Electricity and Heat Production covers emissions from fuel combustion in public power and heat plants.

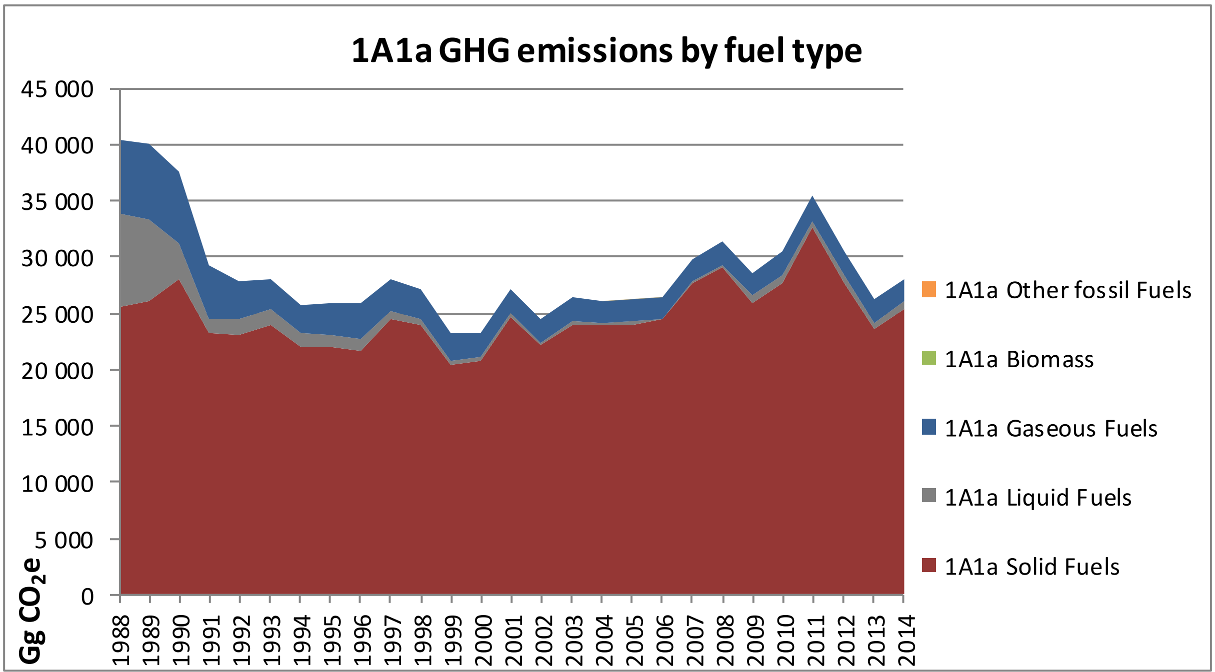

Figure 26 GHG emissions from 1.A.1.a Public Electricity and Heat Production

The share of CRF category 1.A.1.a from the total GHG emissions is 49.1% for the year 2014. The share of this subcategory from CRF category 1.A Fuel combustion is 66.8% for the year 2014. The increase of the emissions from this category is due to the increase of electricity and heat production from combustible fuels in 2014.

Table 36 CO_2 emissions in 1.A.1.a. Public Electricity and Heat Production

CO_2 (Gg)	CRF 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	40 247.48	8 241.55	25 497.33	6 508.60	NO	NO
1989	39 908.98	7 257.02	25 994.31	6 657.65	NO	NO
1990	37 442.64	3 245.34	27 901.85	6 295.45	NO	NO
1991	29 116.79	1 266.65	23 085.90	4 764.24	NO	NO
1992	27 806.13	1 458.95	22 903.34	3 443.84	0.1120	NO
1993	27 871.23	1 554.65	23 795.22	2 521.36	0.1120	NO
1994	25 560.60	1 226.42	21 979.25	2 354.92	0.1120	NO
1995	25 874.46	901.28	22 002.33	2 970.85	0.1120	NO
1996	25 741.79	1 136.54	21 552.62	3 052.63	NO	NO
1997	27 978.59	675.12	24 426.17	2 877.30	0.1120	NO
1998	26 978.15	597.64	23 828.04	2 552.46	0.1120	NO
1999	23 139.01	414.98	20 259.51	2 464.52	NO	NO
2000	23 124.37	291.18	20 668.71	2 164.48	NO	NO
2001	27 045.56	272.60	24 654.83	2 118.13	NO	NO
2002	24 339.09	244.47	22 082.17	2 012.45	NO	NO
2003	26 300.89	286.12	23 906.53	2 108.24	NO	NO
2004	25 981.53	240.21	23 862.87	1 878.45	0.1120	NO
2005	26 174.65	335.05	23 885.03	1 954.57	NO	NO
2006	26 357.74	150.62	24 322.71	1 884.41	NO	NO
2007	29 699.42	212.31	27 598.04	1 889.08	NO	NO
2008	31 222.99	297.54	28 943.34	1 982.11	3.5840	NO

CO_2 (Gg)	CRF 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2009	28 510.14	740.34	25 719.67	2 050.13	4.1440	NO
2010	30 479.81	839.68	27 482.65	2 157.47	9.0720	NO
2011	35 265.22	423.28	32 557.09	2 284.85	30.4640	NO
2012	30 482.23	625.97	27 634.52	2 221.74	17.6960	NO
2013	26 226.64	668.32	23 449.64	2 108.69	19.0036	NO
2014	27 990.64	742.67	25 233.10	2 014.87	80.5434	NO
Decrease 1988-2014	30.5%	91.0%	1.0%	69.0%	-	-
Decrease 1990-2014	25.2%	77.1%	9.6%	68.0%	-	-
Decrease 2013-2014	-6.7%	-11.1%	-7.6%	4.4%	-323.8%	-

Table 37 CH_4 emissions in CRF 1.A.1.a. Public Electricity and Heat Production

CH_4 (Gg)	CRF 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.6820	0.3194	0.2446	0.1179	NO	NO
1989	0.6512	0.2813	0.2493	0.1206	NO	NO
1990	0.5102	0.1259	0.2702	0.1140	NO	NO
1991	0.3612	0.0491	0.2258	0.0863	NO	NO
1992	0.3417	0.0567	0.2226	0.0624	0.0000	NO
1993	0.3386	0.0603	0.2326	0.0457	0.0000	NO
1994	0.3035	0.0476	0.2133	0.0427	0.0000	NO
1995	0.3013	0.0350	0.2125	0.0538	0.0000	NO
1996	0.3073	0.0441	0.2079	0.0553	NO	NO
1997	0.3127	0.0262	0.2344	0.0521	0.0000	NO
1998	0.2981	0.0232	0.2286	0.0462	0.0000	NO
1999	0.2555	0.0161	0.1948	0.0446	NO	NO
2000	0.2491	0.0113	0.1985	0.0392	NO	NO
2001	0.2866	0.0106	0.2377	0.0384	NO	NO
2002	0.2588	0.0094	0.2129	0.0365	NO	NO
2003	0.2791	0.0108	0.2301	0.0382	NO	NO
2004	0.2739	0.0091	0.2307	0.0340	0.0000	NO
2005	0.2794	0.0121	0.2319	0.0354	NO	NO
2006	0.2762	0.0058	0.2363	0.0341	NO	NO
2007	0.3114	0.0079	0.2693	0.0342	NO	NO
2008	0.3269	0.0107	0.2792	0.0359	0.0010	NO
2009	0.3148	0.0265	0.2500	0.0371	0.0011	NO
2010	0.3365	0.0278	0.2671	0.0391	0.0024	NO
2011	0.3792	0.0141	0.3156	0.0413	0.0082	NO
2012	0.3318	0.0200	0.2668	0.0402	0.0047	NO
2013	0.2917	0.0212	0.2277	0.0381	0.0047	NO
2014	0.3233	0.0236	0.2455	0.0363	0.0179	NO
Decrease 1988-2014	52.6%	92.6%	-0.4%	69.2%	-	-
Decrease 1990-2014	36.6%	81.3%	9.1%	68.1%	-	-
Decrease 2013-2014	-10.8%	-11.3%	-7.8%	4.6%	-278.1%	-

Table 38 N_2O emissions in 1.A.1.a. Public Electricity and Heat Production

N_2O (Gg)	CRF 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.4426	0.0639	0.3669	0.0118	NO	NO
1989	0.4423	0.0563	0.3740	0.0121	NO	NO
1990	0.4419	0.0252	0.4053	0.0114	NO	NO
1991	0.3571	0.0098	0.3387	0.0086	NO	NO
1992	0.3515	0.0113	0.3339	0.0062	0.0000	NO
1993	0.3655	0.0121	0.3489	0.0046	0.0000	NO
1994	0.3337	0.0095	0.3199	0.0043	0.0000	NO
1995	0.3311	0.0070	0.3187	0.0054	0.0000	NO
1996	0.3262	0.0088	0.3119	0.0055	NO	NO
1997	0.3620	0.0052	0.3516	0.0052	0.0000	NO
1998	0.3522	0.0046	0.3429	0.0046	0.0000	NO
1999	0.2998	0.0032	0.2921	0.0045	NO	NO
2000	0.3040	0.0023	0.2978	0.0039	NO	NO
2001	0.3624	0.0021	0.3565	0.0038	NO	NO
2002	0.3249	0.0019	0.3194	0.0036	NO	NO
2003	0.3511	0.0022	0.3451	0.0038	NO	NO
2004	0.3514	0.0018	0.3461	0.0034	0.0000	NO
2005	0.3538	0.0024	0.3479	0.0035	NO	NO
2006	0.3590	0.0012	0.3544	0.0034	NO	NO
2007	0.4090	0.0016	0.4039	0.0034	NO	NO
2008	0.4247	0.0021	0.4189	0.0036	0.0001	NO
2009	0.3841	0.0052	0.3750	0.0037	0.0001	NO
2010	0.4104	0.0055	0.4007	0.0039	0.0003	NO
2011	0.4815	0.0028	0.4735	0.0041	0.0011	NO
2012	0.4087	0.0039	0.4002	0.0040	0.0006	NO
2013	0.3502	0.0042	0.3416	0.0038	0.0006	NO
2014	0.3790	0.0047	0.3683	0.0036	0.0024	NO
Decrease 1988-2014	14.4%	92.7%	-0.4%	69.2%	-	-
Decrease 1990-2014	14.3%	81.4%	9.1%	68.1%	-	-
Decrease 2013-2014	-8.2%	-12.3%	-7.8%	4.6%	-277.2%	-

Table 39 GHG emissions in 1.A.1.a. Public Electricity and Heat Production

GHG (Gg)	TJ	CRF 1.A.1.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	469 001.13	40 396.43	8 268.58	25 612.80	6 515.06	NO	NO
1989	463 709.64	40 057.08	7 280.82	26 112.00	6 664.26	NO	NO
1990	426 234.80	37 587.09	3 255.99	28 029.40	6 301.70	NO	NO
1991	328 458.47	29 232.24	1 270.81	23 192.46	4 768.97	NO	NO
1992	303 886.86	27 919.42	1 463.74	23 008.42	3 447.26	0.0019	NO
1993	298 381.32	27 988.62	1 559.76	23 905.00	2 523.86	0.0019	NO
1994	271 779.96	25 667.62	1 230.45	22 079.91	2 357.26	0.0019	NO
1995	277 954.32	25 980.66	904.24	22 102.62	2 973.80	0.0019	NO
1996	277 920.40	25 846.70	1 140.27	21 650.76	3 055.66	NO	NO
1997	295 235.33	28 094.29	677.34	24 536.80	2 880.15	0.0019	NO
1998	282 594.88	27 090.56	599.60	23 935.95	2 555.00	0.0019	NO
1999	244 773.43	23 234.75	416.34	20 351.44	2 466.97	NO	NO
2000	241 526.54	23 221.19	292.13	20 762.43	2 166.63	NO	NO

2001	279 555.03	27 160.73	273.50	24 767.00	2 120.23	NO	NO
2002	252 527.38	24 442.37	245.26	22 182.66	2 014.45	NO	NO
2003	271 880.96	26 412.50	287.03	24 015.13	2 110.33	NO	NO
2004	267 811.25	26 093.08	240.98	23 971.79	1 880.32	0.0019	NO
2005	271 362.80	26 287.08	336.08	23 994.50	1 956.51	NO	NO
2006	272 358.76	26 471.63	151.12	24 434.24	1 886.28	NO	NO
2007	306 165.24	29 829.07	212.98	27 725.14	1 890.95	NO	NO
2008	319 212.67	31 357.72	298.43	29 075.15	1 984.08	0.0621	NO
2009	296 786.32	28 632.47	742.55	25 837.68	2 052.16	0.0719	NO
2010	315 983.41	30 610.53	842.02	27 608.74	2 159.61	0.1573	NO
2011	362 152.24	35 418.18	424.46	32 706.07	2 287.11	0.5282	NO
2012	314 348.18	30 612.33	627.64	27 760.44	2 223.94	0.3068	NO
2013	273 486.45	26 338.29	670.09	23 557.11	2 110.78	0.3063	NO
2014	290 806.57	28 111.65	744.66	25 348.98	2 016.86	1.1566	NO
Decrease 1988-2014	38.0%	30.4%	91.0%	1.0%	69.0%	-	-
Decrease 1990-2014	31.8%	25.2%	77.1%	9.6%	68.0%	-	-
Decrease 2013-2014	-6.3%	-6.7%	-11.1%	-7.6%	4.4%	-277.6%	-

1.1.1.2 Petroleum refining (CRF 1.A.1.b)

Category 1.A.1.b Petroleum refining covers emissions from fuel combustion in petroleum refineries.

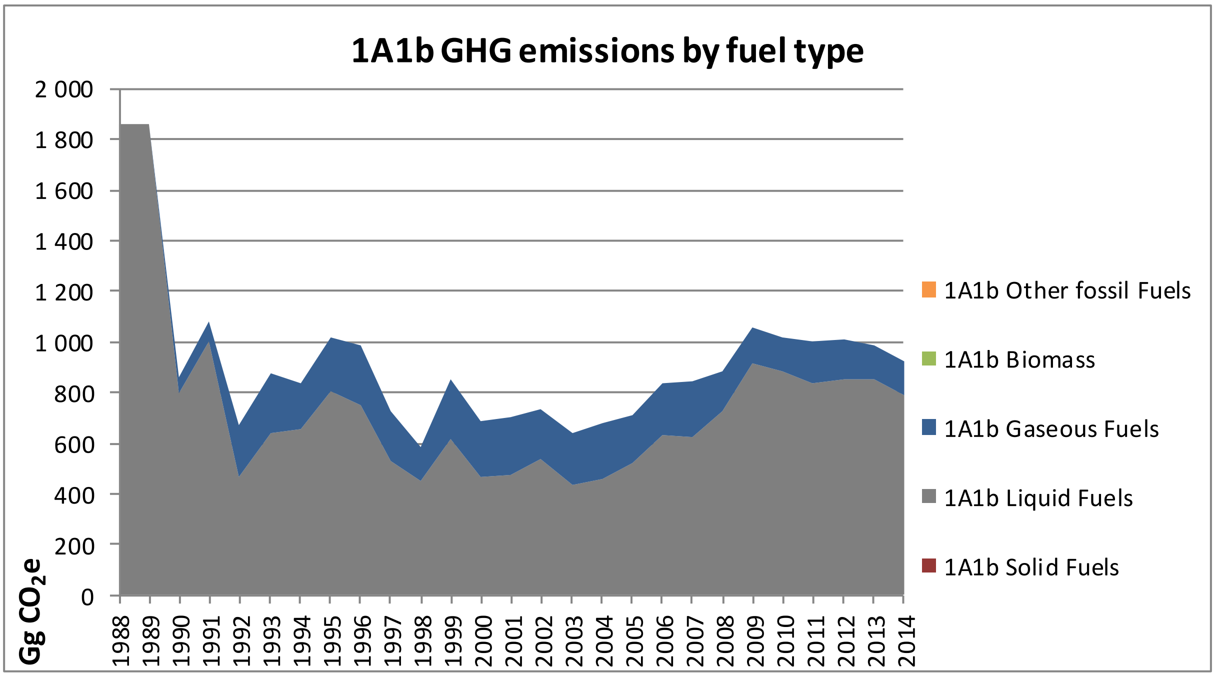

Figure 27 GHG emissions from CRF 1.A.1.b Petroleum refining

For the year 2014 the share of this subcategory from sector 1A Fuel Combustion is 2.2% while from the total GHG emissions it is 1.6%.

Table 40 CO_2 emissions in CRF 1.A.1.b Petroleum refining

CO_2 (Gg)	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1 857.60	1 857.60	NO	NO	NO	NO
1989	1 857.60	1 857.60	NO	NO	NO	NO

CO_2 (Gg)	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1990	861.38	792.72	NO	68.66	NO	NO
1991	1 077.51	1 002.24	NO	75.27	NO	NO
1992	672.26	464.33	NO	207.93	NO	NO
1993	871.79	640.66	NO	231.13	NO	NO
1994	836.82	650.81	NO	186.02	NO	NO
1995	1 014.54	800.35	NO	214.19	NO	NO
1996	983.26	752.18	NO	231.08	NO	NO
1997	728.68	530.78	NO	197.89	NO	NO
1998	585.49	450.00	NO	135.49	NO	NO
1999	852.45	613.87	NO	238.58	NO	NO
2000	689.60	469.01	NO	220.60	NO	NO
2001	704.30	475.70	NO	228.60	NO	NO
2002	733.97	537.12	NO	196.85	NO	NO
2003	641.09	437.34	NO	203.75	NO	NO
2004	681.20	455.43	NO	225.76	NO	NO
2005	709.69	517.07	NO	192.62	NO	NO
2006	836.57	628.24	NO	208.32	NO	NO
2007	839.93	626.07	NO	213.86	NO	NO
2008	880.03	724.25	NO	155.78	NO	NO
2009	1 053.49	917.62	NO	135.87	NO	NO
2010	1 019.96	881.50	NO	138.46	NO	NO
2011	998.83	833.65	NO	165.18	NO	NO
2012	1 009.50	853.71	NO	155.79	NO	NO
2013	988.25	853.71	NO	134.54	NO	NO
2014	919.29	791.41	NO	127.87	NO	NO
Decrease 1988-2014	50.5%	57.4%	-	-	-	-
Decrease 1990-2014	-6.7%	0.2%	-	-86.2%	-	-
Decrease 2013-2014	7.0%	7.3%	-	5.0%	-	-

Table 41 CH_4 emissions in CRF 1.A.1.b Petroleum refining

CH_4 (Gg)	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0720	0.0720	NO	NO	NO	NO
1989	0.0720	0.0720	NO	NO	NO	NO
1990	0.0223	0.0211	NO	0.0012	NO	NO
1991	0.0320	0.0307	NO	0.0014	NO	NO
1992	0.0173	0.0136	NO	0.0038	NO	NO
1993	0.0210	0.0168	NO	0.0042	NO	NO
1994	0.0208	0.0175	NO	0.0034	NO	NO
1995	0.0265	0.0226	NO	0.0039	NO	NO
1996	0.0271	0.0229	NO	0.0042	NO	NO
1997	0.0184	0.0148	NO	0.0036	NO	NO
1998	0.0149	0.0125	NO	0.0025	NO	NO
1999	0.0231	0.0187	NO	0.0043	NO	NO
2000	0.0173	0.0133	NO	0.0040	NO	NO
2001	0.0170	0.0128	NO	0.0041	NO	NO
2002	0.0169	0.0133	NO	0.0036	NO	NO
2003	0.0157	0.0120	NO	0.0037	NO	NO

CH_4 (Gg)	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2004	0.0170	0.0129	NO	0.0041	NO	NO
2005	0.0183	0.0148	NO	0.0035	NO	NO
2006	0.0198	0.0160	NO	0.0038	NO	NO
2007	0.0202	0.0163	NO	0.0039	NO	NO
2008	0.0210	0.0182	NO	0.0028	NO	NO
2009	0.0252	0.0227	NO	0.0025	NO	NO
2010	0.0238	0.0213	NO	0.0025	NO	NO
2011	0.0230	0.0200	NO	0.0030	NO	NO
2012	0.0232	0.0204	NO	0.0028	NO	NO
2013	0.0227	0.0203	NO	0.0024	NO	NO
2014	0.0206	0.0183	NO	0.0023	NO	NO
Decrease 1988-2014	71.3%	74.5%	-	-	-	-
Decrease 1990-2014	7.4%	12.9%	-	-85.5%	-	-
Decrease 2013-2014	9.2%	9.7%	-	5.1%	-	-

Table 42 N_2O emissions in CRF 1.A.1.b Petroleum refining

N_2O (Gg)	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0144	0.0144	NO	NO	NO	NO
1989	0.0144	0.0144	NO	NO	NO	NO
1990	0.0035	0.0034	NO	0.0001	NO	NO
1991	0.0056	0.0055	NO	0.0001	NO	NO
1992	0.0027	0.0024	NO	0.0004	NO	NO
1993	0.0031	0.0027	NO	0.0004	NO	NO
1994	0.0032	0.0029	NO	0.0003	NO	NO
1995	0.0042	0.0038	NO	0.0004	NO	NO
1996	0.0045	0.0041	NO	0.0004	NO	NO
1997	0.0028	0.0025	NO	0.0004	NO	NO
1998	0.0023	0.0021	NO	0.0002	NO	NO
1999	0.0038	0.0033	NO	0.0004	NO	NO
2000	0.0027	0.0023	NO	0.0004	NO	NO
2001	0.0025	0.0021	NO	0.0004	NO	NO
2002	0.0024	0.0021	NO	0.0004	NO	NO
2003	0.0023	0.0020	NO	0.0004	NO	NO
2004	0.0026	0.0021	NO	0.0004	NO	NO
2005	0.0028	0.0025	NO	0.0003	NO	NO
2006	0.0029	0.0025	NO	0.0004	NO	NO
2007	0.0030	0.0026	NO	0.0004	NO	NO
2008	0.0031	0.0028	NO	0.0003	NO	NO
2009	0.0038	0.0036	NO	0.0002	NO	NO
2010	0.0036	0.0033	NO	0.0003	NO	NO
2011	0.0034	0.0031	NO	0.0003	NO	NO
2012	0.0034	0.0032	NO	0.0003	NO	NO
2013	0.0034	0.0032	NO	0.0002	NO	NO
2014	0.0030	0.0028	NO	0.0002	NO	NO
Decrease 1988-2014	78.9%	80.5%	-	-	-	-
Decrease	14.5%	18.2%	-	-85.5%	-	-

N_2O (Gg)	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1990-2014						
Decrease 2013-2014	11.1%	11.5%	-	5.1%	-	-

Table 43 GHG emissions in CRF 1.A.1.b Petroleum refining

GHG (Gg)	TJ	CRF 1.A.1.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	24 000.00	1 863.69	1 863.69	NO	NO	NO	NO
1989	24 000.00	1 863.69	1 863.69	NO	NO	NO	NO
1990	13 493.80	863.00	794.27	NO	68.73	NO	NO
1991	16 013.50	1 079.98	1 004.63	NO	75.35	NO	NO
1992	10 686.50	673.50	465.37	NO	208.13	NO	NO
1993	14 126.80	873.24	641.89	NO	231.36	NO	NO
1994	13 389.60	838.30	652.10	NO	186.20	NO	NO
1995	15 959.90	1 016.46	802.06	NO	214.40	NO	NO
1996	15 195.90	985.28	753.97	NO	231.31	NO	NO
1997	11 644.70	729.98	531.89	NO	198.09	NO	NO
1998	9 304.30	586.56	450.93	NO	135.62	NO	NO
1999	13 301.80	854.15	615.34	NO	238.82	NO	NO
2000	11 066.00	690.83	470.02	NO	220.82	NO	NO
2001	11 450.90	705.48	476.65	NO	228.82	NO	NO
2002	12 065.80	735.11	538.06	NO	197.04	NO	NO
2003	10 589.06	642.18	438.23	NO	203.96	NO	NO
2004	11 213.71	682.38	456.40	NO	225.99	NO	NO
2005	11 551.15	710.99	518.18	NO	192.82	NO	NO
2006	13 873.26	837.92	629.38	NO	208.53	NO	NO
2007	13 879.37	841.32	627.25	NO	214.07	NO	NO
2008	14 498.61	881.47	725.54	NO	155.93	NO	NO
2009	16 432.79	1 055.26	919.26	NO	136.00	NO	NO
2010	15 870.33	1 021.62	883.02	NO	138.60	NO	NO
2011	15 604.82	1 000.42	835.09	NO	165.34	NO	NO
2012	15 706.52	1 011.10	855.15	NO	155.95	NO	NO
2013	15 136.49	989.83	855.16	NO	134.67	NO	NO
2014	14 179.16	920.71	792.71	NO	128.00	NO	NO
Decrease 1988-2014	40.9%	50.6%	57.5%	-	-	-	-
Decrease 1990-2014	-5.1%	-6.7%	0.2%	-	-86.2%	-	-
Decrease 2013-2014	6.3%	7.0%	7.3%	-	5.0%	-	-

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

Category 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries covers emissions from fuel combustion in Coal Mines, Patent Fuel Plants (Energy), Coke Ovens (Energy) and BKB Plants (Energy).

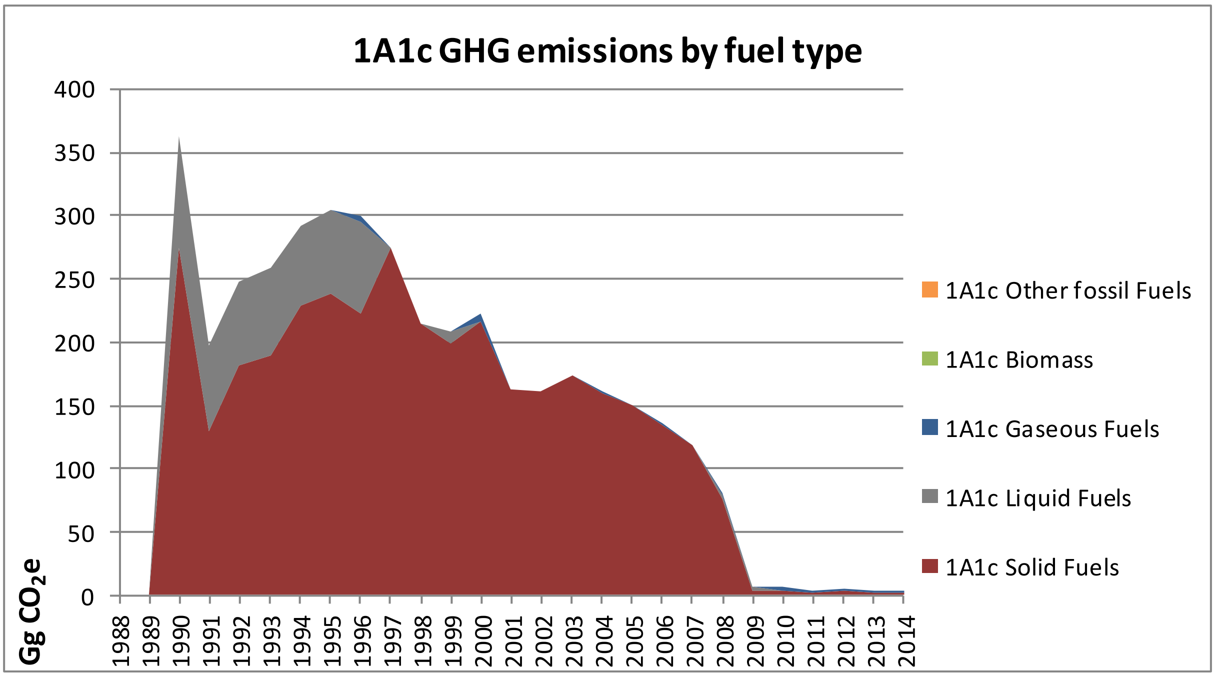

Figure 28 GHG emissions from 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

This sector has shrunk drastically due to the closure of the only I&S plant in Bulgaria, which was operating coke ovens and currently is responsible for 0.01% of the emissions from fuel combustion. This results also in a change in the fuel mix used in this category, which from mostly coke oven gas used in coke ovens in the previous years has now shifted to small quantities of natural gas.

Table 44 CO_2 emissions in CRF 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

CO_2 (Gg)	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	362.27	87.76	274.50	NO	NO	NO
1991	197.63	68.96	128.67	NO	NO	NO
1992	246.51	65.82	180.69	NO	NO	NO
1993	258.76	68.96	189.81	NO	0.1120	NO
1994	291.42	62.69	228.73	NO	0.1120	NO
1995	303.77	65.82	237.95	NO	NO	NO
1996	299.37	72.09	221.66	5.61	0.1120	NO
1997	273.85	NO	273.20	0.65	NO	NO
1998	213.93	NO	213.44	0.50	NO	NO
1999	208.16	9.40	198.76	NO	NO	NO
2000	221.37	NO	216.10	5.27	NO	NO
2001	161.85	NO	161.85	NO	0.1120	NO
2002	161.20	NO	161.20	NO	NO	NO
2003	173.60	NO	173.60	NO	0.1120	NO
2004	160.93	NO	159.69	1.24	0.1120	NO
2005	149.79	NO	149.79	NO	0.1120	NO
2006	135.06	NO	134.02	1.04	0.1120	NO
2007	119.10	NO	117.85	1.24	NO	NO
2008	80.39	2.90	75.84	1.64	NO	NO

CO_2 (Gg)	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2009	6.37	2.90	3.12	0.35	NO	NO
2010	6.11	NO	3.97	2.14	NO	NO
2011	3.35	NO	2.01	1.34	NO	NO
2012	5.26	NO	3.17	2.09	NO	NO
2013	3.93	NO	1.98	1.94	NO	NO
2014	4.07	NO	2.62	1.45	NO	NO
Decrease 1988-2014	-	-	-	-	-	-
Decrease 1990-2014	98.9%	-	99.0%	-	-	-
Decrease 2013-2014	-3.5%	-	-32.0%	25.5%	-	-

Table 45 CH_4 emissions in CRF 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

CH_4 (Gg)	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	0.0094	0.0036	0.0058	NO	NO	NO
1991	0.0057	0.0028	0.0029	NO	NO	NO
1992	0.0064	0.0027	0.0037	NO	NO	NO
1993	0.0067	0.0028	0.0039	NO	0.0000	NO
1994	0.0074	0.0025	0.0048	NO	0.0000	NO
1995	0.0077	0.0027	0.0050	NO	NO	NO
1996	0.0076	0.0029	0.0046	0.0001	0.0000	NO
1997	0.0054	NO	0.0053	0.0000	NO	NO
1998	0.0042	NO	0.0042	0.0000	NO	NO
1999	0.0044	0.0004	0.0040	NO	NO	NO
2000	0.0045	NO	0.0045	0.0001	NO	NO
2001	0.0034	NO	0.0034	NO	0.0000	NO
2002	0.0034	NO	0.0034	NO	NO	NO
2003	0.0038	NO	0.0038	NO	0.0000	NO
2004	0.0036	NO	0.0035	0.0000	0.0000	NO
2005	0.0033	NO	0.0033	NO	0.0000	NO
2006	0.0029	NO	0.0029	0.0000	0.0000	NO
2007	0.0025	NO	0.0025	0.0000	NO	NO
2008	0.0017	0.0000	0.0016	0.0000	NO	NO
2009	0.0001	0.0000	0.0000	0.0000	NO	NO
2010	0.0001	NO	0.0000	0.0000	NO	NO
2011	0.0000	NO	0.0000	0.0000	NO	NO
2012	0.0001	NO	0.0000	0.0000	NO	NO
2013	0.0001	NO	0.0000	0.0000	NO	NO
2014	0.0001	NO	0.0000	0.0000	NO	NO
Decrease 1988-2014	-	-	-	-	-	-
Decrease 1990-2014	99.4%	-	99.6%	-	-	-
Decrease 2013-2014	6.3%	-	-27.1%	25.6%	-	-

Table 46 N_2O emissions in CRF 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

N_2O (Gg)	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	0.0017	0.0007	0.0010	NO	NO	NO
1991	0.0008	0.0006	0.0003	NO	NO	NO
1992	0.0013	0.0005	0.0008	NO	NO	NO
1993	0.0014	0.0006	0.0008	NO	0.0000	NO
1994	0.0014	0.0005	0.0009	NO	0.0000	NO
1995	0.0014	0.0005	0.0009	NO	NO	NO
1996	0.0015	0.0006	0.0009	0.0000	0.0000	NO
1997	0.0014	NO	0.0014	0.0000	NO	NO
1998	0.0011	NO	0.0011	0.0000	NO	NO
1999	0.0009	0.0001	0.0009	NO	NO	NO
2000	0.0009	NO	0.0009	0.0000	NO	NO
2001	0.0006	NO	0.0006	NO	0.0000	NO
2002	0.0006	NO	0.0006	NO	NO	NO
2003	0.0005	NO	0.0005	NO	0.0000	NO
2004	0.0005	NO	0.0004	0.0000	0.0000	NO
2005	0.0004	NO	0.0004	NO	0.0000	NO
2006	0.0005	NO	0.0005	0.0000	0.0000	NO
2007	0.0004	NO	0.0004	0.0000	NO	NO
2008	0.0003	0.0000	0.0002	0.0000	NO	NO
2009	0.0001	0.0000	0.0000	0.0000	NO	NO
2010	0.0001	NO	0.0001	0.0000	NO	NO
2011	0.0000	NO	0.0000	0.0000	NO	NO
2012	0.0001	NO	0.0000	0.0000	NO	NO
2013	0.0000	NO	0.0000	0.0000	NO	NO
2014	0.0000	NO	0.0000	0.0000	NO	NO
Decrease 1988-2014	-	-	-	-	-	-
Decrease 1990-2014	97.5%	-	96.0%	-	-	-
Decrease 2013-2014	-21.7%	-	-27.1%	25.6%	-	-

Table 47 GHG emissions in 1.A.1.c. Manufacture of Solid Fuels and Other Energy Industries

GHG (Gg)	TJ	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO	NO
1990	6 985.19	363.00	88.06	274.94	NO	NO	NO
1991	3 828.60	198.02	69.19	128.83	NO	NO	NO
1992	4 586.81	247.06	66.05	181.02	NO	NO	NO
1993	4 844.79	259.34	69.19	190.14	NO	0.0019	NO
1994	5 631.36	292.02	62.90	229.12	NO	0.0019	NO
1995	5 928.39	304.38	66.05	238.34	NO	NO	NO
1996	5 667.93	300.01	72.34	222.05	5.62	0.0019	NO
1997	5 353.00	274.39	NO	273.75	0.65	NO	NO

GHG (Gg)	TJ	CRF 1.A.1.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1998	4 170.80	214.36	NO	213.87	0.50	NO	NO
1999	4 164.84	208.55	9.44	199.12	NO	NO	NO
2000	4 549.15	221.75	NO	216.48	5.27	NO	NO
2001	3 392.56	162.11	NO	162.11	NO	0.0019	NO
2002	3 423.32	161.46	NO	161.46	NO	NO	NO
2003	3 782.93	173.85	NO	173.85	NO	0.0019	NO
2004	3 532.26	161.15	NO	159.91	1.24	0.0019	NO
2005	3 269.80	150.00	NO	150.00	NO	0.0019	NO
2006	2 890.12	135.27	NO	134.22	1.04	0.0019	NO
2007	2 516.02	119.29	NO	118.05	1.24	NO	NO
2008	1 713.96	80.50	2.91	75.96	1.64	NO	NO
2009	83.73	6.39	2.91	3.14	0.35	NO	NO
2010	78.26	6.13	NO	3.99	2.14	NO	NO
2011	44.36	3.36	NO	2.02	1.34	NO	NO
2012	69.77	5.28	NO	3.19	2.09	NO	NO
2013	55.45	3.94	NO	1.99	1.95	NO	NO
2014	51.97	4.08	NO	2.63	1.45	NO	NO
Decrease 1988-2014	-	-	-	-	-	-	-
Decrease 1990-2014	99.3%	98.9%	-	99.0%	-	-	-
Decrease 2013-2014	6.3%	-3.6%	-	-32.0%	25.5%	-	-

3.3.11 MANUFACTURING INDUSTRIES AND CONSTRUCTION (1.A.2)

Sub-sector Manufacturing Industries and Construction includes the following groups:

- Iron and steel (CRF 1.A.2.a);
- Non-ferrous metals (CRF 1.A.2.b);
- Chemicals (CRF 1.A.2.c);
- Pulp, paper and print (CRF 1.A.2.d);
- Food processing, beverages and tobacco (CRF 1.A.2.e);
- Non-metallic minerals (CRF 1.A.2.f);
- Other (CRF 1.A.2.g).

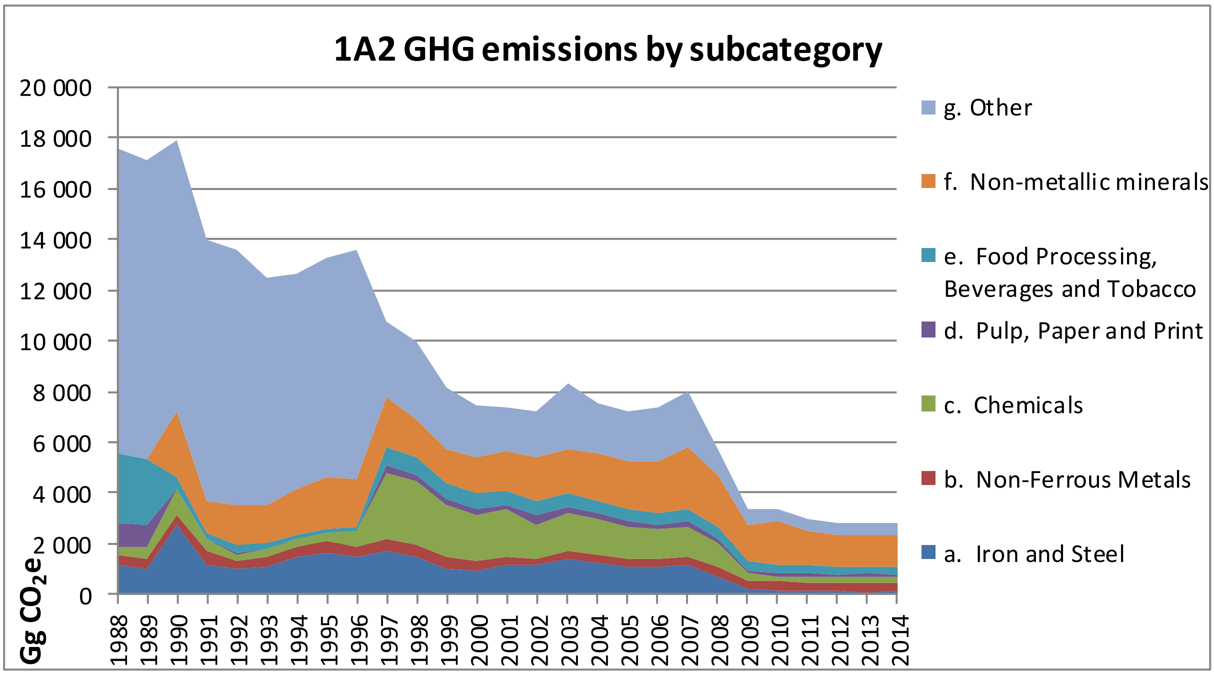

Figure 29 Total GHG emissions from 1.A.2 Manufacturing Industries and Construction by subcategory

Following the restructuring of the industry sector on the country, the general trend in CRF category 1.A.2 shows an emissions decrease of 84.2% compared to base year and a decrease of 1.3% compared to last year. Practically all subcategories within the industry sector are decreasing steadily through the whole time series.

3.3.11.1 Iron and Steel (CRF 1.A.2.a.)

Category 1.A.2.a. Iron and Steel covers emissions from fuel combustion in Iron and steel industry.

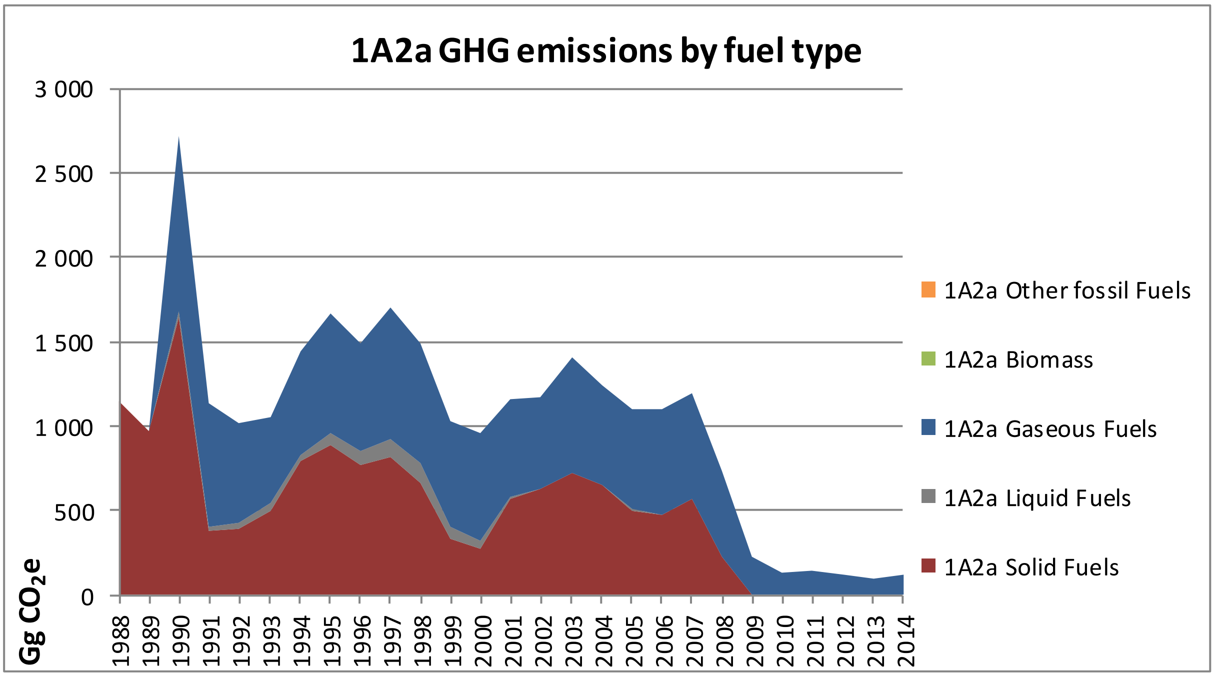

Figure 30 GHG emissions from 1.A.2.a. Iron and Steel

For the year 2014 the share of this subcategory from sector 1A Fuel Combustion and from the total GHG emissions is 0.2%. The drastic decrease in the emissions since 2009 in this subcategory is due to the closure of the biggest iron and steel plant in Bulgaria at the end of 2008.

Table 48 CO_2 emissions in CRF 1.A.2.a. Iron and Steel

CO_2 (Gg)	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1 141.10	NO	1 141.10	NO	NO	NO
1989	966.18	NO	966.18	NO	NO	NO
1990	2 705.60	37.34	1 631.25	1 037.00	NO	NO
1991	1 137.15	15.60	384.19	737.36	NO	NO
1992	1 013.78	31.23	392.86	589.70	0.1120	NO
1993	1 047.27	52.90	490.87	503.50	0.1120	NO
1994	1 440.98	37.42	792.55	611.01	0.2240	NO
1995	1 657.79	71.55	882.41	703.82	0.3360	NO
1996	1 488.44	74.73	770.75	642.96	0.2240	NO
1997	1 697.77	105.26	810.77	781.73	0.2240	NO
1998	1 488.99	108.40	664.60	716.00	NO	NO
1999	1 024.10	77.44	327.50	619.16	0.2240	NO
2000	959.30	37.19	279.15	642.96	0.3360	NO
2001	1 161.19	9.29	569.36	582.54	0.7840	NO
2002	1 169.15	NO	623.07	546.08	0.5600	NO
2003	1 405.28	NO	716.11	689.17	0.6720	NO
2004	1 242.34	NO	650.31	592.03	0.5600	NO
2005	1 103.07	6.24	496.80	600.03	0.5600	NO
2006	1 096.16	6.20	471.69	618.27	0.3360	NO
2007	1 189.96	3.13	566.45	620.37	0.4480	NO
2008	728.04	NO	229.97	498.07	0.4480	NO
2009	224.26	NO	NO	224.26	0.3360	NO
2010	130.95	NO	NO	130.95	0.2240	NO
2011	146.08	NO	NO	146.08	0.2240	NO
2012	116.25	NO	NO	116.25	NO	NO
2013	99.01	NO	NO	99.01	0.1120	NO
2014	117.39	NO	NO	117.39	NO	NO
Decrease 1988-2014	89.7%	-	-	-	-	-
Decrease 1990-2014	95.7%	-	-	88.7%	-	-
Decrease 2013-2014	-18.6%	-	-	-18.6%	-	-

Table 49 CH_4 emissions in CRF 1.A.2.a. Iron and Steel

CH_4 (Gg)	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0758	NO	0.0758	NO	NO	NO
1989	0.0594	NO	0.0594	NO	NO	NO
1990	0.1680	0.0015	0.1477	0.0188	NO	NO
1991	0.0461	0.0006	0.0321	0.0134	NO	NO
1992	0.0442	0.0012	0.0323	0.0107	0.0000	NO
1993	0.0541	0.0021	0.0429	0.0091	0.0000	NO
1994	0.0828	0.0015	0.0701	0.0111	0.0001	NO
1995	0.0919	0.0028	0.0762	0.0127	0.0001	NO
1996	0.0822	0.0030	0.0675	0.0116	0.0001	NO

CH_4 (Gg)	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1997	0.0891	0.0041	0.0708	0.0142	0.0001	NO
1998	0.0757	0.0042	0.0585	0.0130	NO	NO
1999	0.0420	0.0030	0.0278	0.0112	0.0001	NO
2000	0.0332	0.0014	0.0200	0.0116	0.0001	NO
2001	0.0614	0.0004	0.0503	0.0106	0.0002	NO
2002	0.0648	NO	0.0548	0.0099	0.0002	NO
2003	0.0759	NO	0.0633	0.0125	0.0002	NO
2004	0.0679	NO	0.0570	0.0107	0.0002	NO
2005	0.0553	0.0003	0.0440	0.0109	0.0002	NO
2006	0.0537	0.0003	0.0422	0.0112	0.0001	NO
2007	0.0631	0.0001	0.0516	0.0112	0.0001	NO
2008	0.0305	NO	0.0213	0.0090	0.0001	NO
2009	0.0041	NO	NO	0.0041	0.0001	NO
2010	0.0024	NO	NO	0.0024	0.0001	NO
2011	0.0027	NO	NO	0.0026	0.0001	NO
2012	0.0021	NO	NO	0.0021	NO	NO
2013	0.0018	NO	NO	0.0018	0.0000	NO
2014	0.0021	NO	NO	0.0021	NO	NO
Decrease 1988-2014	97.2%	-	-	-	-	-
Decrease 1990-2014	98.7%	-	-	88.7%	-	-
Decrease 2013-2014	-16.5%	-	-	-18.4%	-	-

Table 50 N_2O emissions in CRF 1.A.2.a. Iron and Steel

N_2O (Gg)	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0109	NO	0.0109	NO	NO	NO
1989	0.0084	NO	0.0084	NO	NO	NO
1990	0.0242	0.0003	0.0221	0.0019	NO	NO
1991	0.0062	0.0001	0.0048	0.0013	NO	NO
1992	0.0061	0.0002	0.0048	0.0011	0.0000	NO
1993	0.0077	0.0004	0.0064	0.0009	0.0000	NO
1994	0.0119	0.0003	0.0105	0.0011	0.0000	NO
1995	0.0132	0.0006	0.0113	0.0013	0.0000	NO
1996	0.0118	0.0006	0.0101	0.0012	0.0000	NO
1997	0.0127	0.0008	0.0105	0.0014	0.0000	NO
1998	0.0108	0.0008	0.0087	0.0013	NO	NO
1999	0.0058	0.0006	0.0041	0.0011	0.0000	NO
2000	0.0043	0.0003	0.0029	0.0012	0.0000	NO
2001	0.0086	0.0001	0.0074	0.0011	0.0000	NO
2002	0.0091	NO	0.0081	0.0010	0.0000	NO
2003	0.0107	NO	0.0094	0.0012	0.0000	NO
2004	0.0096	NO	0.0085	0.0011	0.0000	NO
2005	0.0077	0.0001	0.0065	0.0011	0.0000	NO
2006	0.0074	0.0001	0.0063	0.0011	0.0000	NO
2007	0.0089	0.0000	0.0077	0.0011	0.0000	NO
2008	0.0041	NO	0.0032	0.0009	0.0000	NO
2009	0.0004	NO	NO	0.0004	0.0000	NO

N_2O (Gg)	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2010	0.0002	NO	NO	0.0002	0.0000	NO
2011	0.0003	NO	NO	0.0003	0.0000	NO
2012	0.0002	NO	NO	0.0002	NO	NO
2013	0.0002	NO	NO	0.0002	0.0000	NO
2014	0.0002	NO	NO	0.0002	NO	NO
Decrease 1988-2014	98.1%	-	-	-	-	-
Decrease 1990-2014	99.1%	-	-	88.7%	-	-
Decrease 2013-2014	-15.8%	-	-	-18.4%	-	-

Table 51 GHG emissions in CRF 1.A.2.a. Iron and Steel

GHG (Gg)	TJ	CRF 1.A.2.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	16 396.80	1 146.24	NO	1 146.24	NO	NO	NO
1989	14 763.20	970.18	NO	970.18	NO	NO	NO
1990	35 474.30	2 717.03	37.47	1 641.52	1 038.03	NO	NO
1991	17 874.74	1 140.15	15.65	386.41	738.09	NO	NO
1992	15 595.66	1 016.70	31.33	395.08	590.28	0.0019	NO
1993	14 961.67	1 050.92	53.08	493.85	504.00	0.0019	NO
1994	19 863.32	1 446.59	37.55	797.42	611.62	0.0039	NO
1995	23 228.68	1 664.01	71.79	887.69	704.52	0.0058	NO
1996	20 772.27	1 494.01	74.98	775.43	643.60	0.0039	NO
1997	25 199.82	1 703.79	105.61	815.67	782.50	0.0039	NO
1998	22 262.85	1 494.11	108.75	668.64	716.71	NO	NO
1999	16 816.96	1 026.88	77.69	329.41	619.78	0.0039	NO
2000	16 535.12	961.42	37.31	280.51	643.60	0.0058	NO
2001	17 404.29	1 165.29	9.32	572.83	583.12	0.0136	NO
2002	17 050.10	1 173.49	NO	626.86	546.62	0.0097	NO
2003	20 596.93	1 410.35	NO	720.49	689.85	0.0117	NO
2004	18 109.01	1 246.89	NO	654.26	592.62	0.0097	NO
2005	16 753.11	1 106.74	6.26	499.85	600.63	0.0097	NO
2006	16 707.38	1 099.72	6.23	474.61	618.88	0.0058	NO
2007	17 293.10	1 194.17	3.15	570.03	620.99	0.0078	NO
2008	11 466.12	730.02	NO	231.45	498.57	0.0078	NO
2009	4 062.90	224.49	NO	NO	224.48	0.0058	NO
2010	2 372.60	131.09	NO	NO	131.08	0.0039	NO
2011	2 645.30	146.22	NO	NO	146.22	0.0039	NO
2012	2 106.00	116.36	NO	NO	116.36	NO	NO
2013	1 789.30	99.11	NO	NO	99.11	0.0019	NO
2014	2 117.70	117.51	NO	NO	117.51	NO	NO
Decrease 1988-2014	87.1%	89.7%	-	-	-	-	-
Decrease 1990-2014	94.0%	95.7%	-	-	88.7%	-	-
Decrease 2013-2014	-18.4%	-18.6%	-	-	-18.6%	-	-

3.3.11.1.1 Source-specific recalculations, including changes made in response to the review process

In 2012 after a discussion regarding the non-energy use of Coke Oven Coke in the iron and steel industry, the National Statistics Institute initiated talks with the plant operators in order to clarify the situation, which led to the revision of the national energy balances. The quantities of Coke Oven Coke, which were previously reported under energy use are now accounted as non-energy use.

In addition, following the recommendation of the Technical review of GHG inventories under the EU Effort Sharing Decision (ESD) in 2012, we revised the methodology concerning Iron & Steel sector in order to remove the double counting with the IP sector. The quantities of coke oven gas reported under blast furnaces; blast furnace gas reported under blast furnaces, autoproducers and Iron and Steel; coke oven coke in blast furnaces were disregarded from the Energy sector.

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

Category 1.A.2.b Non-Ferrous Metals enfolds emissions from fuel combustion in non-ferrous metal industry.

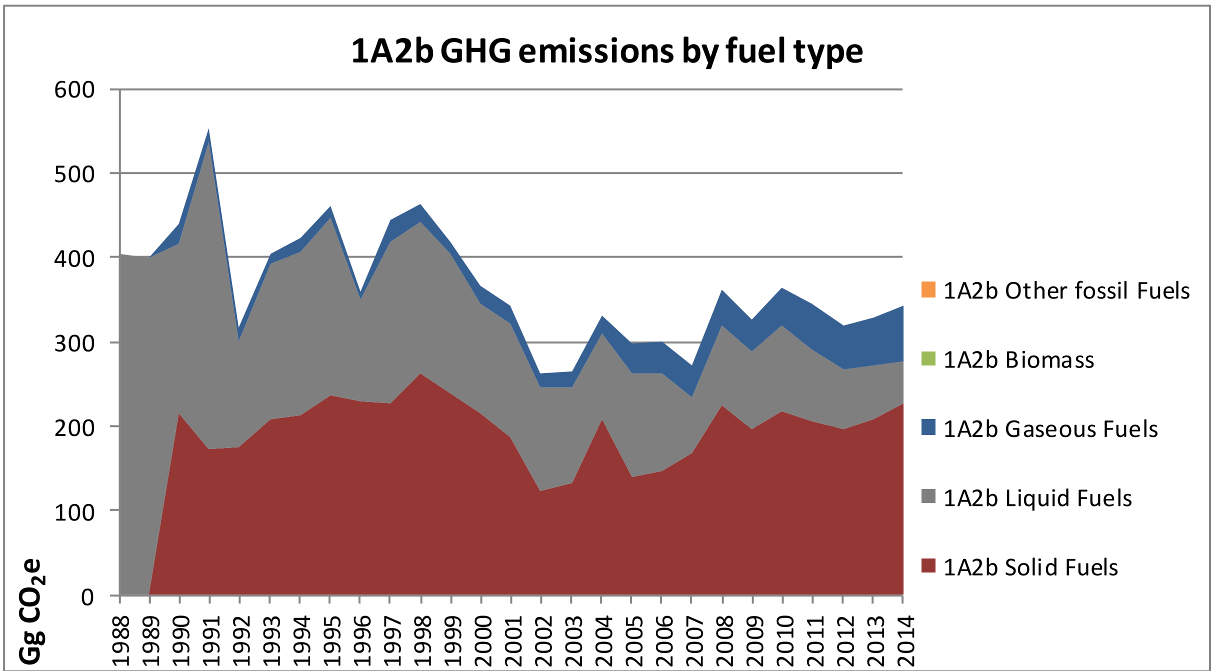

Figure 31 GHG emissions from CRF 1.A.2.b. Non-Ferrous Metals

The share of this subcategory from sector 1.A is 0.8% for the year 2014, while the share from the total GHG emissions is 0.6%.

Table 52 CO_2 emissions in CRF 1.A.2.b.Non-Ferrous Metals

CO_2 (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	404.06	404.06	NO	NO	NO	NO
1989	397.93	397.93	NO	NO	NO	NO
1990	437.53	199.30	214.83	23.40	NO	NO
1991	551.65	362.92	172.18	16.54	NO	NO
1992	315.70	124.57	174.79	16.35	2.5760	NO

CO_2 (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1993	403.41	183.39	207.65	12.37	2.3520	NO
1994	420.96	192.68	212.28	16.00	1.5680	NO
1995	459.61	208.43	235.48	15.70	1.9040	NO
1996	357.38	120.67	228.17	8.55	0.3360	NO
1997	443.67	191.84	225.16	26.68	0.4480	NO
1998	461.02	179.41	261.23	20.37	0.5600	NO
1999	417.39	163.93	238.25	15.20	0.4480	NO
2000	364.70	129.65	214.34	20.72	0.2240	NO
2001	341.08	135.84	184.97	20.27	0.1120	NO
2002	261.17	123.45	122.31	15.40	NO	NO
2003	263.30	114.24	131.72	17.34	NO	NO
2004	330.71	99.07	208.33	23.30	0.6720	NO
2005	298.02	121.15	140.06	36.82	NO	NO
2006	299.66	114.32	146.18	39.15	NO	NO
2007	270.38	65.02	167.72	37.65	0.1120	NO
2008	359.24	92.88	224.20	42.16	NO	NO
2009	325.48	92.53	194.72	38.23	NO	NO
2010	362.24	101.63	216.51	44.10	0.1120	NO
2011	343.28	86.15	204.32	52.82	NO	NO
2012	317.35	70.67	195.17	51.52	NO	NO
2013	326.46	64.44	207.37	54.66	NO	NO
2014	341.01	48.99	225.66	66.36	NO	NO
Decrease 1988-2014	15.6%	87.9%	-	-	-	-
Decrease 1990-2014	22.1%	75.4%	-5.0%	-183.6%	-	-
Decrease 2013-2014	-4.5%	24.0%	-8.8%	-21.4%	-	-

Table 53 CH_4 emissions in CRF 1.A.2.b. Non-Ferrous Metals

CH_4 (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0158	0.0158	NO	NO	NO	NO
1989	0.0156	0.0156	NO	NO	NO	NO
1990	0.0285	0.0079	0.0201	0.0004	NO	NO
1991	0.0305	0.0141	0.0161	0.0003	NO	NO
1992	0.0222	0.0049	0.0164	0.0003	0.0007	NO
1993	0.0274	0.0072	0.0194	0.0002	0.0006	NO
1994	0.0282	0.0075	0.0199	0.0003	0.0004	NO
1995	0.0310	0.0082	0.0221	0.0003	0.0005	NO
1996	0.0262	0.0046	0.0213	0.0002	0.0001	NO
1997	0.0290	0.0074	0.0210	0.0005	0.0001	NO
1998	0.0318	0.0069	0.0244	0.0004	0.0002	NO
1999	0.0290	0.0063	0.0223	0.0003	0.0001	NO
2000	0.0254	0.0049	0.0200	0.0004	0.0001	NO
2001	0.0228	0.0051	0.0173	0.0004	0.0000	NO
2002	0.0164	0.0047	0.0114	0.0003	NO	NO
2003	0.0169	0.0043	0.0123	0.0003	NO	NO
2004	0.0239	0.0038	0.0195	0.0004	0.0002	NO
2005	0.0183	0.0045	0.0131	0.0007	NO	NO

CH_4 (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2006	0.0187	0.0043	0.0137	0.0007	NO	NO
2007	0.0189	0.0025	0.0157	0.0007	0.0000	NO
2008	0.0254	0.0036	0.0210	0.0008	NO	NO
2009	0.0224	0.0035	0.0182	0.0007	NO	NO
2010	0.0248	0.0037	0.0202	0.0008	0.0000	NO
2011	0.0232	0.0031	0.0191	0.0010	NO	NO
2012	0.0217	0.0025	0.0182	0.0009	NO	NO
2013	0.0227	0.0023	0.0194	0.0010	NO	NO
2014	0.0240	0.0017	0.0211	0.0012	NO	NO
Decrease 1988-2014	-51.8%	89.2%	-	-	-	-
Decrease 1990-2014	15.7%	78.4%	-4.7%	-182.4%	-	-
Decrease 2013-2014	-5.9%	25.8%	-8.8%	-21.2%	-	-

Table 54 N_2O emissions in CRF 1.A.2.b. Non-Ferrous Metals

N_2O (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0032	0.0032	NO	NO	NO	NO
1989	0.0031	0.0031	NO	NO	NO	NO
1990	0.0046	0.0016	0.0030	0.0000	NO	NO
1991	0.0053	0.0028	0.0024	0.0000	NO	NO
1992	0.0035	0.0010	0.0025	0.0000	0.0001	NO
1993	0.0044	0.0014	0.0029	0.0000	0.0001	NO
1994	0.0046	0.0015	0.0030	0.0000	0.0001	NO
1995	0.0050	0.0016	0.0033	0.0000	0.0001	NO
1996	0.0041	0.0009	0.0032	0.0000	0.0000	NO
1997	0.0047	0.0015	0.0032	0.0000	0.0000	NO
1998	0.0051	0.0014	0.0037	0.0000	0.0000	NO
1999	0.0046	0.0013	0.0033	0.0000	0.0000	NO
2000	0.0040	0.0010	0.0030	0.0000	0.0000	NO
2001	0.0037	0.0010	0.0026	0.0000	0.0000	NO
2002	0.0027	0.0009	0.0017	0.0000	NO	NO
2003	0.0027	0.0009	0.0018	0.0000	NO	NO
2004	0.0038	0.0008	0.0029	0.0000	0.0000	NO
2005	0.0029	0.0009	0.0020	0.0001	NO	NO
2006	0.0030	0.0008	0.0020	0.0001	NO	NO
2007	0.0029	0.0005	0.0024	0.0001	0.0000	NO
2008	0.0039	0.0007	0.0032	0.0001	NO	NO
2009	0.0035	0.0007	0.0027	0.0001	NO	NO
2010	0.0039	0.0007	0.0030	0.0001	0.0000	NO
2011	0.0036	0.0006	0.0029	0.0001	NO	NO
2012	0.0033	0.0005	0.0027	0.0001	NO	NO
2013	0.0035	0.0004	0.0029	0.0001	NO	NO
2014	0.0036	0.0003	0.0032	0.0001	NO	NO
Decrease 1988-2014	-14.2%	89.6%	-	-	-	-
Decrease 1990-2014	22.2%	79.3%	-4.7%	-182.4%	-	-

N_2O (Gg)	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 2013-2014	-4.6%	26.6%	-8.8%	-21.2%	-	-

Table 55 GHG emissions in CRF 1.A.2.b. Non-Ferrous Metals

GHG (Gg)	TJ	CRF 1.A.2.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	5 267.60	405.39	405.39	NO	NO	NO	NO
1989	5 190.20	399.24	399.24	NO	NO	NO	NO
1990	5 066.91	439.62	199.96	216.23	23.42	NO	NO
1991	6 647.78	553.98	364.12	173.30	16.56	NO	NO
1992	3 615.94	317.32	124.98	175.93	16.36	0.0447	NO
1993	4 608.63	405.42	184.00	209.00	12.38	0.0408	NO
1994	4 836.30	423.03	193.32	213.67	16.01	0.0272	NO
1995	5 264.94	461.89	209.12	237.02	15.72	0.0330	NO
1996	3 863.12	359.27	121.06	229.66	8.55	0.0058	NO
1997	5 082.17	445.80	192.46	226.62	26.71	0.0078	NO
1998	5 143.72	463.33	179.99	262.93	20.39	0.0097	NO
1999	4 639.30	419.50	164.46	239.81	15.22	0.0078	NO
2000	4 072.44	366.53	130.06	215.73	20.74	0.0039	NO
2001	3 868.90	342.74	136.27	186.18	20.29	0.0019	NO
2002	3 034.09	262.37	123.84	123.11	15.42	NO	NO
2003	3 041.72	264.54	114.60	132.58	17.36	NO	NO
2004	3 655.13	332.42	99.40	209.69	23.32	0.0117	NO
2005	3 560.36	299.35	121.53	140.97	36.85	NO	NO
2006	3 571.75	301.01	114.68	147.14	39.19	NO	NO
2007	3 090.70	271.73	65.23	168.82	37.68	0.0019	NO
2008	4 064.27	361.05	93.18	225.67	42.20	NO	NO
2009	3 729.24	327.08	92.82	195.99	38.27	NO	NO
2010	4 163.10	364.01	101.94	217.92	44.14	0.0019	NO
2011	4 005.60	344.93	86.41	205.65	52.87	NO	NO
2012	3 697.60	318.88	70.88	196.44	51.57	NO	NO
2013	3 783.30	328.06	64.63	208.72	54.72	NO	NO
2014	3 966.30	342.69	49.13	227.13	66.42	NO	NO
Decrease 1988-2014	24.7%	15.5%	87.9%	-	-	-	-
Decrease 1990-2014	21.7%	22.0%	75.4%	-5.0%	-183.6%	-	-
Decrease 2013-2014	-4.8%	-4.5%	24.0%	-8.8%	-21.4%	-	-

3.3.11.2.1 Source-specific recalculations, including changes made in response to the review process

After a discussion regarding the non-energy use of Coke Oven Coke in the non-ferrous metals industry, the National Statistics Institute initiated talks with the plant operators in order to clarify the situation, which led to the revision of the national energy balances. The quantities of Coke Oven Coke, which were previously reported under energy use are now accounted as non-energy use.

3.3.11.3 Chemicals (CRF 1.A.2.c.)

Category 1.A.2.c Chemicals enfolds emissions from fuel combustion in chemical and petrochemical industries.

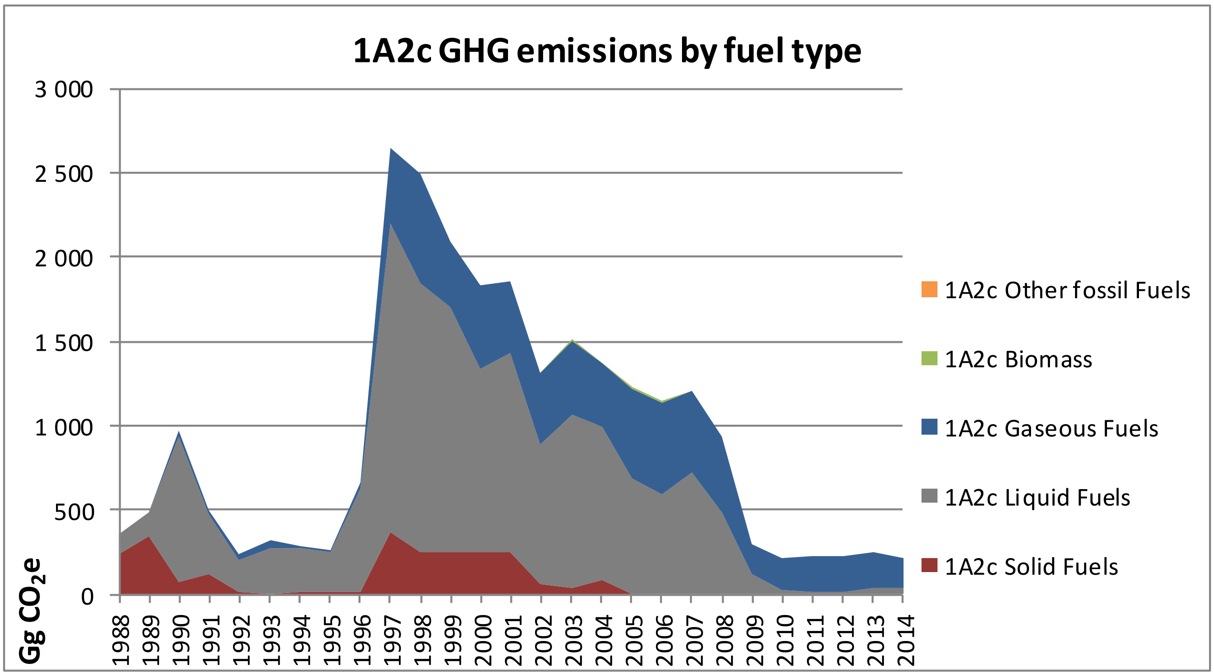

Figure 32 GHG emissions from CRF 1.A.2.c. Chemicals

The share of this subcategory from sector 1.A is 0.5% for the year 2014, while from the total GHG emissions it is 0.4%.

The trend analysis showed some significant variability in the fuel consumption in this category – after 1997 there is an increase in the liquid fuels and a decrease in the gaseous fuels. Additional checks revealed two separate factors contributing to this trend – after 1997 the National Statistics changed the methodologies for fuel allocation: fuels consumed by autoproducer electricity, CHP and heat plants were reallocated from transformation sector to the respective industry sector. The second factor, responsible for the decrease in gaseous fuel consumption is the long-term crisis in the fertilizer production industry in Bulgaria, which has caused the gradual closure of two of the plants around 2001.

Table 56 CO_2 emissions in CRF 1.A.2.c. Chemicals

CO_2 (Gg)	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	355.17	116.80	238.37	NO	NO	NO
1989	479.86	138.89	340.97	NO	NO	NO
1990	966.14	856.74	79.18	30.22	NO	NO
1991	497.28	352.36	118.32	26.59	NO	NO
1992	235.24	194.08	15.19	25.96	0.5600	NO
1993	319.49	271.64	8.63	39.23	0.1120	NO
1994	287.31	257.27	11.61	18.42	0.2240	NO
1995	267.15	238.35	11.28	17.52	0.2240	NO
1996	663.48	615.89	12.29	35.30	0.7840	NO
1997	2 645.39	1 826.63	368.47	450.30	0.2240	NO
1998	2 486.37	1 591.44	251.17	643.75	0.5600	NO
1999	2 086.08	1 447.97	245.45	392.66	3.2480	NO

CO_2 (Gg)	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2000	1 828.34	1 091.49	244.85	492.00	7.9520	NO
2001	1 854.52	1 174.03	252.11	428.37	104.6080	NO
2002	1 315.10	830.40	57.33	427.37	100.8000	NO
2003	1 503.59	1 025.79	41.10	436.70	155.2320	NO
2004	1 364.68	902.11	86.84	375.74	170.2400	NO
2005	1 222.56	685.21	2.18	535.18	189.3920	NO
2006	1 138.77	588.04	1.54	549.20	194.6560	NO
2007	1 204.03	727.10	NO	476.93	128.9120	NO
2008	938.77	485.85	NO	452.92	0.1120	NO
2009	301.74	119.20	NO	182.54	0.1120	NO
2010	215.67	24.16	NO	191.51	0.2240	NO
2011	223.73	17.97	NO	205.77	0.1120	NO
2012	225.87	12.46	NO	213.40	0.2240	NO
2013	248.48	38.48	NO	210.00	3.9200	NO
2014	218.72	35.38	NO	183.34	31.8080	NO
Decrease 1988-2014	38.4%	69.7%	-	-	-	-
Decrease 1990-2014	77.4%	95.9%	-	-506.6%	-	-
Decrease 2013-2014	12.0%	8.0%	-	12.7%	-711.4%	-

Table 57 CH_4 emissions in CRF 1.A.2.c. Chemicals

CH_4 (Gg)	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0270	0.0047	0.0223	NO	NO	NO
1989	0.0375	0.0056	0.0319	NO	NO	NO
1990	0.0301	0.0221	0.0074	0.0005	NO	NO
1991	0.0215	0.0099	0.0111	0.0005	NO	NO
1992	0.0083	0.0063	0.0015	0.0005	0.0002	NO
1993	0.0100	0.0085	0.0008	0.0007	0.0000	NO
1994	0.0098	0.0082	0.0012	0.0003	0.0001	NO
1995	0.0098	0.0083	0.0011	0.0003	0.0001	NO
1996	0.0256	0.0235	0.0012	0.0006	0.0002	NO
1997	0.1142	0.0686	0.0374	0.0082	0.0001	NO
1998	0.0952	0.0579	0.0255	0.0117	0.0002	NO
1999	0.0785	0.0456	0.0249	0.0071	0.0009	NO
2000	0.0680	0.0321	0.0248	0.0089	0.0021	NO
2001	0.0965	0.0352	0.0255	0.0078	0.0280	NO
2002	0.0686	0.0285	0.0054	0.0077	0.0270	NO
2003	0.0883	0.0349	0.0039	0.0079	0.0416	NO
2004	0.0911	0.0299	0.0087	0.0068	0.0456	NO
2005	0.0817	0.0211	0.0002	0.0097	0.0507	NO
2006	0.0791	0.0169	0.0001	0.0099	0.0521	NO
2007	0.0632	0.0200	NO	0.0086	0.0345	NO
2008	0.0197	0.0114	NO	0.0082	0.0000	NO
2009	0.0057	0.0024	NO	0.0033	0.0000	NO
2010	0.0043	0.0008	NO	0.0035	0.0001	NO
2011	0.0043	0.0005	NO	0.0037	0.0000	NO
2012	0.0044	0.0005	NO	0.0039	0.0001	NO

CH_4 (Gg)	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2013	0.0058	0.0009	NO	0.0038	0.0011	NO
2014	0.0126	0.0008	NO	0.0033	0.0085	NO
Decrease 1988-2014	53.2%	82.7%	-	-	-	-
Decrease 1990-2014	58.0%	96.3%	-	-504.1%	-	-
Decrease 2013-2014	-118.7%	12.8%	-	12.8%	-711.4%	-

Table 58 N_2O emissions in CRF 1.A.2.c. Chemicals

N_2O (Gg)	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0043	0.0009	0.0033	NO	NO	NO
1989	0.0059	0.0011	0.0048	NO	NO	NO
1990	0.0047	0.0035	0.0011	0.0001	NO	NO
1991	0.0034	0.0017	0.0017	0.0000	NO	NO
1992	0.0014	0.0011	0.0002	0.0000	0.0000	NO
1993	0.0017	0.0015	0.0001	0.0001	0.0000	NO
1994	0.0017	0.0015	0.0002	0.0000	0.0000	NO
1995	0.0018	0.0016	0.0002	0.0000	0.0000	NO
1996	0.0049	0.0046	0.0002	0.0001	0.0000	NO
1997	0.0199	0.0134	0.0056	0.0008	0.0000	NO
1998	0.0162	0.0112	0.0038	0.0012	0.0000	NO
1999	0.0128	0.0082	0.0037	0.0007	0.0001	NO
2000	0.0105	0.0056	0.0037	0.0009	0.0003	NO
2001	0.0145	0.0062	0.0038	0.0008	0.0037	NO
2002	0.0106	0.0054	0.0008	0.0008	0.0036	NO
2003	0.0134	0.0065	0.0006	0.0008	0.0055	NO
2004	0.0136	0.0055	0.0013	0.0007	0.0061	NO
2005	0.0115	0.0037	0.0000	0.0010	0.0068	NO
2006	0.0108	0.0029	0.0000	0.0010	0.0070	NO
2007	0.0088	0.0033	NO	0.0009	0.0046	NO
2008	0.0025	0.0017	NO	0.0008	0.0000	NO
2009	0.0006	0.0003	NO	0.0003	0.0000	NO
2010	0.0005	0.0001	NO	0.0003	0.0000	NO
2011	0.0005	0.0001	NO	0.0004	0.0000	NO
2012	0.0005	0.0001	NO	0.0004	0.0000	NO
2013	0.0007	0.0001	NO	0.0004	0.0001	NO
2014	0.0016	0.0001	NO	0.0003	0.0011	NO
Decrease 1988-2014	63.0%	87.5%	-	-	-	-
Decrease 1990-2014	66.1%	96.6%	-	-504.1%	-	-
Decrease 2013-2014	-139.5%	16.8%	-	12.8%	-711.4%	-

Table 59 GHG emissions in CRF 1.A.2.c. Chemicals

GHG (Gg)	TJ	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels

GHG (Gg)	TJ	CRF 1.A.2.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	3 804.00	357.12	117.20	239.93	NO	NO	NO
1989	5 061.00	482.56	139.37	343.19	NO	NO	NO
1990	14 763.29	968.28	858.34	79.70	30.25	NO	NO
1991	6 951.77	498.82	353.11	119.09	26.62	NO	NO
1992	3 445.19	235.87	194.58	15.29	25.99	0.0097	NO
1993	4 775.08	320.26	272.30	8.68	39.27	0.0019	NO
1994	4 187.13	288.06	257.92	11.69	18.44	0.0039	NO
1995	3 759.14	267.93	239.02	11.36	17.54	0.0039	NO
1996	9 309.30	665.57	617.85	12.37	35.33	0.0136	NO
1997	36 553.44	2 654.17	1 832.35	371.07	450.74	0.0039	NO
1998	36 258.83	2 493.57	1 596.22	252.95	644.39	0.0097	NO
1999	30 843.39	2 091.85	1 451.56	247.18	393.05	0.0563	NO
2000	27 902.65	1 833.15	1 093.95	246.58	492.49	0.1379	NO
2001	28 850.39	1 861.25	1 176.75	253.89	428.80	1.8138	NO
2002	20 873.58	1 319.96	832.71	57.71	427.80	1.7478	NO
2003	24 734.17	1 509.79	1 028.60	41.37	437.13	2.6916	NO
2004	22 561.82	1 371.00	904.49	87.45	376.11	2.9518	NO
2005	21 813.22	1 228.03	686.84	2.19	535.71	3.2839	NO
2006	20 826.82	1 143.98	589.31	1.55	549.74	3.3752	NO
2007	21 232.39	1 208.22	728.58	NO	477.40	2.2352	NO
2008	16 156.84	940.00	486.63	NO	453.37	0.0019	NO
2009	5 308.00	302.07	119.35	NO	182.72	0.0019	NO
2010	3 821.14	215.92	24.22	NO	191.70	0.0039	NO
2011	3 996.70	223.98	18.01	NO	205.97	0.0019	NO
2012	4 032.72	226.12	12.50	NO	213.62	0.0039	NO
2013	4 442.54	248.82	38.55	NO	210.20	0.0680	NO
2014	4 165.99	219.51	35.44	NO	183.52	0.5515	NO
Decrease 1988-2014	-9.5%	38.5%	69.8%	-	-	-	-
Decrease 1990-2014	71.8%	77.3%	95.9%	-	-506.6%	-	-
Decrease 2013-2014	6.2%	11.8%	8.1%	-	12.7%	-711.4%	-

3.3.11.3.1 Source-specific recalculations, including changes made in response to the review process

Following the recommendation of the Technical review of GHG inventories under the EU Effort Sharing Decision (ESD) in 2012, we revised the methodology concerning Chemical sector in order to remove the double counting with the IP sector. The National Statistics Institute initiated talks with the plant operators in order to clarify the situation, but the revision of the national energy balances is still pending due to disagreement with some of the reporting companies. This mandates a correction of the National Energy Balance for the purpose of the elaboration of the National GHG inventory. Using a stoichiometric calculation based on the reported production of ammonia, soda ash and calcium carbide, were estimated the actual quantities of natural gas and solid fuels as non-energy use in the chemical industry. The remaining quantities of natural gas and solid fuels, which were reported under Chemical industry, were considered as energy use and accounted in the Energy sector.

The following fuels have been reallocated to industrial processes sector:

- Natural gas used for ammonia production
- Anthracite used for soda ash and for calcium carbide
- Other bituminous coal used for soda ash and for calcium carbide
- Coke oven coke used for soda ash

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

Category 1.A.2.d Pulp, Paper and Print enfolds emissions from the fuel combustion in pulp, paper and print industries.

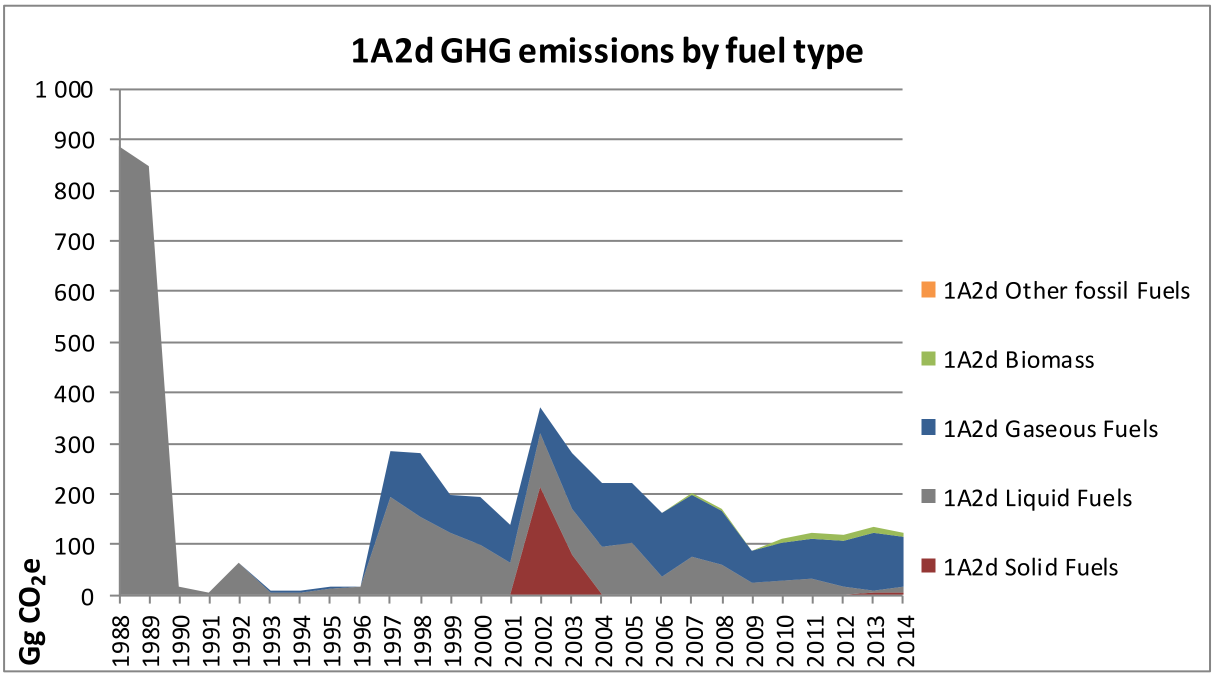

Figure 33 GHG emissions from CRF 1.A.2.d. Pulp, Paper and Print

The share of this subcategory from sector 1.A is 0.3% for 2014, while from the total GHG emissions it is 0.2%.

Table 60 CO_2 emissions in CRF 1.A.2.d. Pulp, Paper and Print

CO_2 (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	882.36	882.36	NO	NO	NO	NO
1989	845.21	845.21	NO	NO	NO	NO
1990	15.56	15.56	NO	NO	NO	NO
1991	6.27	6.27	NO	NO	NO	NO
1992	62.00	62.00	NO	NO	NO	NO
1993	9.95	6.27	NO	3.68	NO	NO
1994	8.95	6.27	NO	2.68	0.1120	NO
1995	15.39	12.46	NO	2.93	0.2240	NO
1996	18.74	15.56	NO	3.18	0.1120	NO
1997	283.06	191.99	NO	91.07	0.1120	NO
1998	278.60	154.84	NO	123.76	0.2240	NO
1999	196.37	123.88	NO	72.49	0.3360	NO
2000	192.07	99.11	NO	92.96	0.1120	NO
2001	138.79	65.05	NO	73.73	0.1120	NO
2002	367.41	105.30	213.47	48.64	0.2240	NO

CO_2 (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2003	280.23	92.96	77.87	109.40	0.3360	NO
2004	219.35	95.98	NO	123.37	0.1120	NO
2005	221.22	102.17	NO	119.04	32.8160	NO
2006	163.46	36.96	NO	126.50	31.1360	NO
2007	199.58	77.40	NO	122.18	20.0480	NO
2008	166.14	58.82	NO	107.31	290.1920	NO
2009	86.61	24.77	NO	61.84	86.6880	NO
2010	102.69	27.86	NO	74.82	540.8480	NO
2011	112.48	30.96	NO	81.52	660.2400	NO
2012	107.78	15.48	NO	92.30	649.7120	NO
2013	122.97	6.19	3.37	113.41	772.1280	NO
2014	113.31	12.38	4.13	96.79	612.1920	NO
Decrease 1988-2014	87.2%	98.6%	-	-	-	-
Decrease 1990-2014	-628.3%	20.4%	-	-	-	-
Decrease 2013-2014	7.9%	-100.0%	-22.6%	14.7%	20.7%	-

Table 61 CH_4 emissions in CRF 1.A.2.d. Pulp, Paper and Print

CH_4 (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0342	0.0342	NO	NO	NO	NO
1989	0.0328	0.0328	NO	NO	NO	NO
1990	0.0006	0.0006	NO	NO	NO	NO
1991	0.0003	0.0003	NO	NO	NO	NO
1992	0.0024	0.0024	NO	NO	NO	NO
1993	0.0003	0.0003	NO	0.0001	NO	NO
1994	0.0003	0.0003	NO	0.0000	0.0000	NO
1995	0.0006	0.0005	NO	0.0001	0.0001	NO
1996	0.0007	0.0006	NO	0.0001	0.0000	NO
1997	0.0091	0.0074	NO	0.0016	0.0000	NO
1998	0.0083	0.0060	NO	0.0022	0.0001	NO
1999	0.0062	0.0048	NO	0.0013	0.0001	NO
2000	0.0056	0.0038	NO	0.0017	0.0000	NO
2001	0.0039	0.0025	NO	0.0013	0.0000	NO
2002	0.0267	0.0041	0.0217	0.0009	0.0001	NO
2003	0.0136	0.0036	0.0079	0.0020	0.0001	NO
2004	0.0060	0.0037	NO	0.0022	0.0000	NO
2005	0.0149	0.0040	NO	0.0022	0.0088	NO
2006	0.0121	0.0014	NO	0.0023	0.0083	NO
2007	0.0106	0.0030	NO	0.0022	0.0054	NO
2008	0.0820	0.0023	NO	0.0019	0.0777	NO
2009	0.0253	0.0010	NO	0.0011	0.0232	NO
2010	0.1473	0.0011	NO	0.0014	0.1449	NO
2011	0.1795	0.0012	NO	0.0015	0.1769	NO
2012	0.1763	0.0006	NO	0.0017	0.1740	NO
2013	0.2094	0.0002	0.0003	0.0020	0.2068	NO
2014	0.1666	0.0005	0.0004	0.0017	0.1640	NO
Decrease	-387.2%	98.6%	-	-	-	-

CH_4 (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988-2014						
Decrease 1990-2014	-27046.5%	21.8%	-	-	-	-
Decrease 2013-2014	20.4%	-100.0%	-30.4%	14.8%	20.7%	-

Table 62 N_2O emissions in CRF 1.A.2.d. Pulp, Paper and Print

N_2O (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0068	0.0068	NO	NO	NO	NO
1989	0.0066	0.0066	NO	NO	NO	NO
1990	0.0001	0.0001	NO	NO	NO	NO
1991	0.0001	0.0001	NO	NO	NO	NO
1992	0.0005	0.0005	NO	NO	NO	NO
1993	0.0001	0.0001	NO	0.0000	NO	NO
1994	0.0001	0.0001	NO	0.0000	0.0000	NO
1995	0.0001	0.0001	NO	0.0000	0.0000	NO
1996	0.0001	0.0001	NO	0.0000	0.0000	NO
1997	0.0017	0.0015	NO	0.0002	0.0000	NO
1998	0.0014	0.0012	NO	0.0002	0.0000	NO
1999	0.0011	0.0010	NO	0.0001	0.0000	NO
2000	0.0009	0.0008	NO	0.0002	0.0000	NO
2001	0.0006	0.0005	NO	0.0001	0.0000	NO
2002	0.0042	0.0008	0.0033	0.0001	0.0000	NO
2003	0.0021	0.0007	0.0012	0.0002	0.0000	NO
2004	0.0010	0.0007	NO	0.0002	0.0000	NO
2005	0.0022	0.0008	NO	0.0002	0.0012	NO
2006	0.0016	0.0003	NO	0.0002	0.0011	NO
2007	0.0015	0.0006	NO	0.0002	0.0007	NO
2008	0.0110	0.0005	NO	0.0002	0.0104	NO
2009	0.0034	0.0002	NO	0.0001	0.0031	NO
2010	0.0197	0.0002	NO	0.0001	0.0193	NO
2011	0.0240	0.0002	NO	0.0001	0.0236	NO
2012	0.0235	0.0001	NO	0.0002	0.0232	NO
2013	0.0279	0.0000	0.0000	0.0002	0.0276	NO
2014	0.0222	0.0001	0.0001	0.0002	0.0219	NO
Decrease 1988-2014	-224.5%	98.6%	-	-	-	-
Decrease 1990-2014	-17982.0%	21.8%	-	-	-	-
Decrease 2013-2014	20.4%	-100.0%	-30.4%	14.8%	20.7%	-

Table 63 GHG emissions in CRF 1.A.2.d. Pulp, Paper and Print

GHG (Gg)	TJ	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	11 400.00	885.25	885.25	NO	NO	NO	NO
1989	10 920.00	847.98	847.98	NO	NO	NO	NO
1990	204.60	15.61	15.61	NO	NO	NO	NO

GHG (Gg)	TJ	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1991	84.60	6.29	6.29	NO	NO	NO	NO
1992	804.60	62.20	62.20	NO	NO	NO	NO
1993	151.20	9.97	6.29	NO	3.68	NO	NO
1994	134.20	8.98	6.29	NO	2.69	0.0019	NO
1995	219.70	15.44	12.50	NO	2.93	0.0039	NO
1996	263.20	18.79	15.61	NO	3.18	0.0019	NO
1997	4 133.00	283.78	192.62	NO	91.16	0.0019	NO
1998	4 246.20	279.24	155.35	NO	123.89	0.0039	NO
1999	2 918.40	196.85	124.29	NO	72.56	0.0058	NO
2000	2 967.20	192.49	99.44	NO	93.05	0.0019	NO
2001	2 178.90	139.07	65.27	NO	73.80	0.0019	NO
2002	4 413.03	369.32	105.65	214.98	48.69	0.0039	NO
2003	3 980.15	281.21	93.26	78.42	109.51	0.0058	NO
2004	3 477.57	219.79	96.30	NO	123.49	0.0019	NO
2005	3 771.27	222.24	102.51	NO	119.16	0.5690	NO
2006	3 048.71	164.24	37.08	NO	126.62	0.5399	NO
2007	3 393.00	200.30	77.65	NO	122.30	0.3476	NO
2008	5 295.90	171.47	59.02	NO	107.42	5.0317	NO
2009	2 213.60	88.26	24.85	NO	61.90	1.5031	NO
2010	6 543.50	112.23	27.96	NO	74.90	9.3779	NO
2011	7 770.10	124.11	31.06	NO	81.60	11.4481	NO
2012	7 673.20	119.19	15.53	NO	92.39	11.2655	NO
2013	9 054.56	136.52	6.21	3.39	113.52	13.3881	NO
2014	7 413.95	124.09	12.42	4.16	96.89	10.6150	NO
Decrease 1988-2014	35.0%	86.0%	98.6%	-	-	-	-
Decrease 1990-2014	-3523.6%	-695.0%	20.4%	-	-	-	-
Decrease 2013-2014	18.1%	9.1%	-100.0%	-22.7%	14.7%	20.7%	-

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

Category 1.A.2.e Food Processing, Beverages and Tobacco enfolds emissions from fuel combustion in food processing, beverages and tobacco industry.

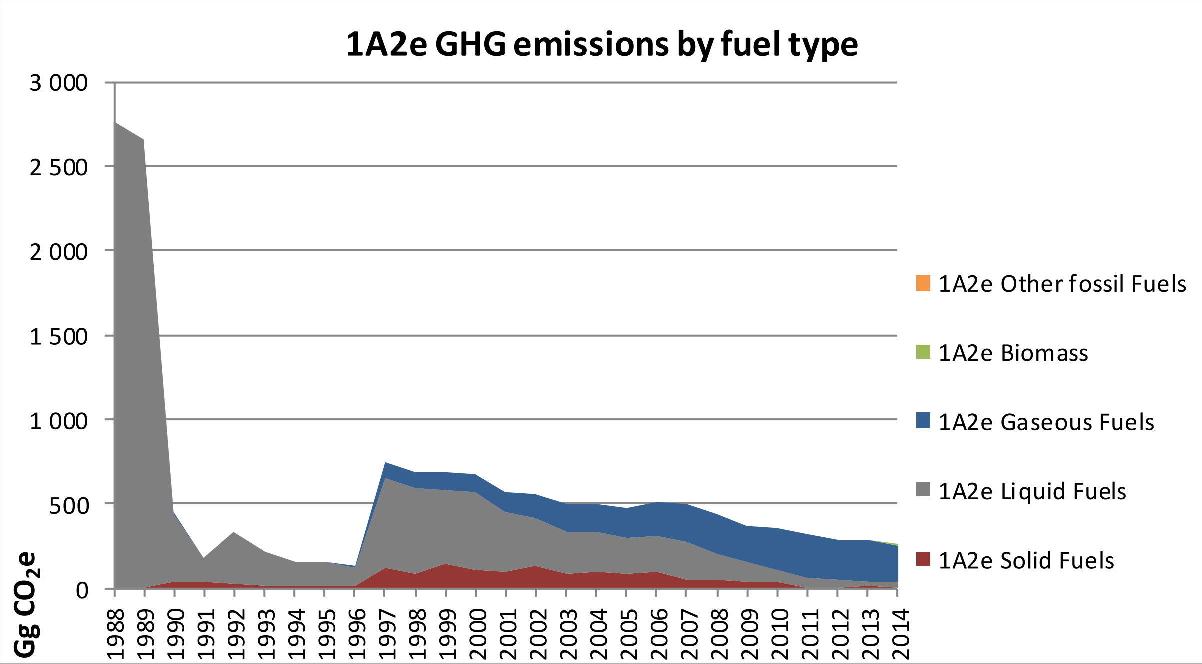

Figure 34 GHG emissions from 1.A.2.e. Food Processing, Beverages and Tobacco

The share of this subcategory from sector 1.A is 0.6% for 2014 and the share from total GHG emissions is 0.5%.

Table 64 CO_2 emissions in CRF 1.A.2.e. Food Processing, Beverages and Tobacco

CO_2 (Gg)	CRF 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	2 760.71	2 760.71	NO	NO	NO	NO
1989	2 651.81	2 651.81	NO	NO	NO	NO
1990	453.70	409.27	33.01	11.43	NO	NO
1991	183.95	141.05	39.37	3.53	NO	NO
1992	330.04	305.21	21.99	2.83	3.2480	NO
1993	214.82	199.57	14.16	1.09	0.7840	NO
1994	161.29	146.66	13.98	0.65	0.8960	NO
1995	154.83	140.32	11.08	3.43	1.9040	NO
1996	130.74	112.15	11.04	7.55	3.0240	NO
1997	739.55	526.44	126.51	86.60	44.2400	NO
1998	689.89	508.65	86.94	94.30	30.5760	NO
1999	688.63	440.61	138.87	109.16	26.7680	NO
2000	669.53	450.17	112.88	106.47	36.8480	NO
2001	569.76	354.10	97.65	118.00	22.0640	NO
2002	560.18	285.59	130.95	143.64	24.7520	NO
2003	498.44	245.33	88.30	164.80	22.8480	NO
2004	500.50	239.05	99.19	162.27	25.6480	NO
2005	476.91	204.94	89.93	182.04	19.4880	NO
2006	506.79	206.92	98.55	201.32	24.8640	NO
2007	496.54	229.09	49.18	218.28	6.2720	NO
2008	433.73	147.99	55.13	230.61	9.6320	NO
2009	373.72	119.93	41.56	212.23	45.2480	NO
2010	354.30	70.59	39.85	243.86	33.0400	NO
2011	318.41	51.82	8.96	257.64	24.7520	NO
2012	289.79	46.01	4.42	239.35	60.9280	NO
2013	289.28	24.50	10.35	254.43	63.0560	NO
2014	256.40	30.75	4.13	221.52	94.4160	NO

CO_2 (Gg)	CRF 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 1988-2014	90.7%	98.9%	-	-	-	-
Decrease 1990-2014	43.5%	92.5%	87.5%	-1838.5%	-	-
Decrease 2013-2014	11.4%	-25.5%	60.1%	12.9%	-49.7%	-

Table 65 CH_4 emissions in 1.A.2.e. Food Processing, Beverages and Tobacco

CH_4 (Gg)	CRF 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.1080	0.1080	NO	NO	NO	NO
1989	0.1038	0.1038	NO	NO	NO	NO
1990	0.0198	0.0164	0.0032	0.0002	NO	NO
1991	0.0095	0.0057	0.0038	0.0001	NO	NO
1992	0.0151	0.0121	0.0021	0.0001	0.0009	NO
1993	0.0095	0.0079	0.0013	0.0000	0.0002	NO
1994	0.0075	0.0058	0.0014	0.0000	0.0002	NO
1995	0.0072	0.0056	0.0011	0.0001	0.0005	NO
1996	0.0065	0.0044	0.0011	0.0001	0.0008	NO
1997	0.0465	0.0204	0.0127	0.0016	0.0119	NO
1998	0.0384	0.0198	0.0087	0.0017	0.0082	NO
1999	0.0403	0.0171	0.0140	0.0020	0.0072	NO
2000	0.0408	0.0176	0.0114	0.0019	0.0099	NO
2001	0.0318	0.0139	0.0099	0.0021	0.0059	NO
2002	0.0336	0.0111	0.0132	0.0026	0.0066	NO
2003	0.0276	0.0096	0.0089	0.0030	0.0061	NO
2004	0.0293	0.0092	0.0102	0.0029	0.0069	NO
2005	0.0257	0.0079	0.0093	0.0033	0.0052	NO
2006	0.0284	0.0079	0.0102	0.0036	0.0067	NO
2007	0.0194	0.0088	0.0049	0.0040	0.0017	NO
2008	0.0179	0.0055	0.0056	0.0042	0.0026	NO
2009	0.0246	0.0043	0.0043	0.0038	0.0121	NO
2010	0.0199	0.0025	0.0042	0.0044	0.0089	NO
2011	0.0139	0.0017	0.0009	0.0047	0.0066	NO
2012	0.0227	0.0016	0.0004	0.0043	0.0163	NO
2013	0.0234	0.0008	0.0010	0.0046	0.0169	NO
2014	0.0308	0.0011	0.0004	0.0040	0.0253	NO
Decrease 1988-2014	71.5%	99.0%	-	-	-	-
Decrease 1990-2014	-55.9%	93.4%	86.7%	-1830.4%	-	-
Decrease 2013-2014	-31.9%	-30.4%	59.3%	13.0%	-49.7%	-

Table 66 N_2O emissions in 1.A.2.e. Food Processing, Beverages and Tobacco

N_2O (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0216	0.0216	NO	NO	NO	NO
1989	0.0208	0.0208	NO	NO	NO	NO

N_2O (Gg)	CRF 1.A.2.d.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1990	0.0038	0.0033	0.0005	0.0000	NO	NO
1991	0.0017	0.0011	0.0006	0.0000	NO	NO
1992	0.0029	0.0024	0.0003	0.0000	0.0001	NO
1993	0.0018	0.0016	0.0002	0.0000	0.0000	NO
1994	0.0014	0.0012	0.0002	0.0000	0.0000	NO
1995	0.0014	0.0011	0.0002	0.0000	0.0001	NO
1996	0.0012	0.0009	0.0002	0.0000	0.0001	NO
1997	0.0077	0.0041	0.0019	0.0002	0.0016	NO
1998	0.0065	0.0039	0.0013	0.0002	0.0011	NO
1999	0.0067	0.0034	0.0021	0.0002	0.0010	NO
2000	0.0067	0.0035	0.0017	0.0002	0.0013	NO
2001	0.0053	0.0028	0.0015	0.0002	0.0008	NO
2002	0.0053	0.0022	0.0020	0.0003	0.0009	NO
2003	0.0044	0.0019	0.0013	0.0003	0.0008	NO
2004	0.0046	0.0018	0.0015	0.0003	0.0009	NO
2005	0.0040	0.0016	0.0014	0.0003	0.0007	NO
2006	0.0044	0.0016	0.0015	0.0004	0.0009	NO
2007	0.0031	0.0018	0.0007	0.0004	0.0002	NO
2008	0.0027	0.0011	0.0008	0.0004	0.0003	NO
2009	0.0035	0.0008	0.0006	0.0004	0.0016	NO
2010	0.0027	0.0005	0.0006	0.0004	0.0012	NO
2011	0.0018	0.0003	0.0001	0.0005	0.0009	NO
2012	0.0030	0.0003	0.0001	0.0004	0.0022	NO
2013	0.0030	0.0002	0.0002	0.0005	0.0023	NO
2014	0.0040	0.0002	0.0001	0.0004	0.0034	NO
Decrease 1988-2014	81.3%	99.0%	-	-	-	-
Decrease 1990-2014	-7.2%	93.7%	86.7%	-1830.4%	-	-
Decrease 2013-2014	-33.7%	-32.2%	59.3%	13.0%	-49.7%	-

Table 67 GHG emissions in 1.A.2.e. Food Processing, Beverages and Tobacco

GHG (Gg)	TJ	CRF 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	36 011.40	2 769.85	2 769.85	NO	NO	NO	NO
1989	34 588.00	2 660.59	2 660.59	NO	NO	NO	NO
1990	5 984.34	455.32	410.65	33.23	11.44	NO	NO
1991	2 344.95	184.70	141.53	39.63	3.53	NO	NO
1992	4 319.24	331.26	306.24	22.14	2.83	0.0563	NO
1993	2 806.06	215.60	200.24	14.25	1.09	0.0136	NO
1994	2 104.79	161.90	147.16	14.08	0.65	0.0155	NO
1995	2 045.98	155.41	140.79	11.16	3.43	0.0330	NO
1996	1 772.86	131.25	112.52	11.12	7.56	0.0524	NO
1997	10 064.60	743.02	528.16	127.40	86.69	0.7671	NO
1998	9 505.86	692.79	510.32	87.55	94.39	0.5302	NO
1999	9 391.03	691.63	442.06	139.84	109.26	0.4641	NO
2000	9 289.09	672.55	451.66	113.68	106.58	0.6389	NO
2001	7 972.40	572.11	355.27	98.34	118.12	0.3826	NO
2002	7 908.14	562.61	286.52	131.87	143.78	0.4292	NO

GHG (Gg)	TJ	CRF 1.A.2.e.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2003	7 301.38	500.43	246.14	88.92	164.97	0.3962	NO
2004	7 337.51	502.60	239.82	99.90	162.43	0.4447	NO
2005	7 090.76	478.74	205.60	90.57	182.22	0.3379	NO
2006	7 600.79	508.80	207.59	99.26	201.52	0.4311	NO
2007	7 501.24	497.96	229.83	49.52	218.50	0.1088	NO
2008	6 780.69	434.98	148.45	55.52	230.84	0.1670	NO
2009	6 273.22	375.37	120.29	41.86	212.44	0.7846	NO
2010	6 082.06	355.62	70.79	40.15	244.10	0.5729	NO
2011	5 690.71	319.30	51.96	9.02	257.89	0.4292	NO
2012	5 551.54	291.24	46.15	4.45	239.59	1.0564	NO
2013	5 600.49	290.76	24.56	10.42	254.68	1.0933	NO
2014	5 304.20	258.37	30.84	4.16	221.74	1.6371	NO
Decrease 1988-2014	85.3%	90.7%	98.9%	-	-	-	-
Decrease 1990-2014	11.4%	43.3%	92.5%	87.5%	-1838.5%	-	-
Decrease 2013-2014	5.3%	11.1%	-25.5%	60.1%	12.9%	-49.7%	-

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

Category 1.A.2.f Non-metallic minerals enfolds emissions from fuel combustion from all activities in the non-metallic minerals industry (mostly cement production industry).

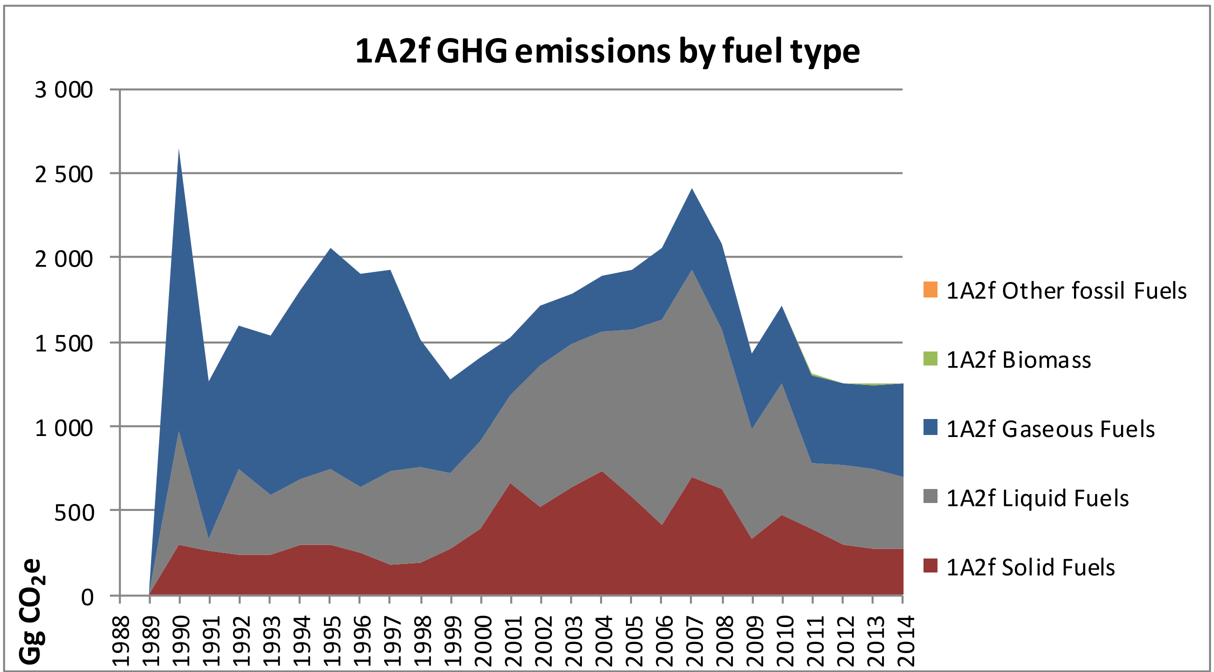

Figure 35 GHG emissions from 1.A.2.f. Non-metallic minerals

The share of this subcategory from sector 1.A is 3.0% for 2014, while the share from total GHG emissions is 2.2%.

This industry experienced a notable growth until 2007, which was followed by a significant decline after 2008 as a result of the global financial crisis and the decline in the construction sector. Additionally, the sector experienced some restructuring resulting in the closure of some of the cement plants in the country.

Table 68 CO_2 emissions in 1.A.2.f. Non-metallic minerals

CO_2 (Gg)	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	2 648.92	666.44	298.40	1 684.09	NO	NO
1991	1 261.74	78.36	257.42	925.96	NO	NO
1992	1 593.80	504.87	235.21	853.72	2.1280	NO
1993	1 530.35	359.46	232.31	938.58	1.3440	NO
1994	1 810.08	390.40	297.47	1 122.21	1.0080	NO
1995	2 053.36	445.93	294.98	1 312.45	1.5680	NO
1996	1 906.30	383.63	249.86	1 272.80	0.8960	NO
1997	1 925.81	562.47	174.46	1 188.89	1.0080	NO
1998	1 505.90	566.06	192.29	747.54	0.8960	NO
1999	1 280.91	445.59	272.21	563.12	0.6720	NO
2000	1 402.70	520.00	387.95	494.75	0.6720	NO
2001	1 525.75	516.88	664.10	344.76	0.4480	NO
2002	1 710.55	834.33	518.35	357.87	0.3360	NO
2003	1 775.62	848.36	636.01	291.25	0.5600	NO
2004	1 881.13	826.12	730.38	324.63	2.4494	NO
2005	1 917.04	987.48	577.05	352.51	3.5753	NO
2006	2 056.12	1 204.68	418.54	432.90	1.9259	NO
2007	2 409.60	1 231.12	692.41	486.08	22.0172	NO
2008	2 079.15	938.20	628.33	512.62	85.8245	NO
2009	1 428.13	651.42	329.74	446.97	94.3505	NO
2010	1 711.63	778.07	469.30	464.26	79.4105	NO
2011	1 303.51	393.31	386.97	523.23	60.7299	NO
2012	1 246.71	468.16	294.23	484.32	119.5003	NO
2013	1 244.98	470.38	272.72	501.88	116.9269	NO
2014	1 253.73	417.00	278.99	557.74	89.8125	NO
Decrease 1988-2014	-	-	-	-	-	-
Decrease 1990-2014	52.7%	37.4%	6.5%	66.9%	-	-
Decrease 2013-2014	-0.7%	11.3%	-2.3%	-11.1%	23.2%	-

Table 69 CH_4 emissions in 1.A.2.f. Non-metallic minerals

CH_4 (Gg)	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	0.0857	0.0256	0.0296	0.0305	NO	NO
1991	0.0463	0.0032	0.0264	0.0168	NO	NO
1992	0.0596	0.0194	0.0241	0.0155	0.0006	NO
1993	0.0549	0.0138	0.0237	0.0170	0.0004	NO
1994	0.0660	0.0150	0.0304	0.0203	0.0003	NO
1995	0.0715	0.0171	0.0302	0.0238	0.0004	NO
1996	0.0635	0.0146	0.0256	0.0231	0.0002	NO
1997	0.0605	0.0214	0.0173	0.0215	0.0003	NO
1998	0.0547	0.0218	0.0192	0.0135	0.0002	NO
1999	0.0550	0.0172	0.0275	0.0102	0.0002	NO

CH_4 (Gg)	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2000	0.0659	0.0175	0.0393	0.0090	0.0002	NO
2001	0.0912	0.0175	0.0673	0.0062	0.0001	NO
2002	0.0857	0.0270	0.0522	0.0065	0.0001	NO
2003	0.0971	0.0273	0.0643	0.0053	0.0002	NO
2004	0.1078	0.0267	0.0746	0.0059	0.0007	NO
2005	0.0977	0.0316	0.0588	0.0064	0.0010	NO
2006	0.0896	0.0387	0.0426	0.0078	0.0005	NO
2007	0.1240	0.0390	0.0703	0.0088	0.0059	NO
2008	0.1257	0.0299	0.0635	0.0093	0.0230	NO
2009	0.0883	0.0212	0.0337	0.0081	0.0253	NO
2010	0.1037	0.0250	0.0491	0.0084	0.0213	NO
2011	0.0789	0.0129	0.0402	0.0095	0.0163	NO
2012	0.0863	0.0151	0.0304	0.0088	0.0320	NO
2013	0.0838	0.0150	0.0284	0.0091	0.0313	NO
2014	0.0765	0.0133	0.0291	0.0101	0.0241	NO
Decrease 1988-2014	-	-	-	-	-	-
Decrease 1990-2014	10.7%	48.2%	1.7%	67.0%	-	-
Decrease 2013-2014	8.7%	11.8%	-2.7%	-11.0%	23.2%	-

Table 70 N_2O emissions in 1.A.2.f. Non-metallic minerals

N_2O (Gg)	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	0.0126	0.0051	0.0044	0.0031	NO	NO
1991	0.0063	0.0006	0.0040	0.0017	NO	NO
1992	0.0091	0.0039	0.0036	0.0015	0.0001	NO
1993	0.0081	0.0027	0.0036	0.0017	0.0000	NO
1994	0.0096	0.0030	0.0046	0.0020	0.0000	NO
1995	0.0104	0.0034	0.0045	0.0024	0.0001	NO
1996	0.0091	0.0029	0.0038	0.0023	0.0000	NO
1997	0.0090	0.0043	0.0026	0.0022	0.0000	NO
1998	0.0086	0.0043	0.0029	0.0014	0.0000	NO
1999	0.0086	0.0034	0.0041	0.0010	0.0000	NO
2000	0.0103	0.0035	0.0059	0.0009	0.0000	NO
2001	0.0142	0.0035	0.0101	0.0006	0.0000	NO
2002	0.0139	0.0054	0.0078	0.0006	0.0000	NO
2003	0.0157	0.0055	0.0097	0.0005	0.0000	NO
2004	0.0172	0.0053	0.0112	0.0006	0.0001	NO
2005	0.0159	0.0063	0.0088	0.0006	0.0001	NO
2006	0.0150	0.0077	0.0064	0.0008	0.0001	NO
2007	0.0200	0.0078	0.0105	0.0009	0.0008	NO
2008	0.0195	0.0060	0.0095	0.0009	0.0031	NO
2009	0.0135	0.0042	0.0051	0.0008	0.0034	NO
2010	0.0160	0.0050	0.0074	0.0008	0.0028	NO
2011	0.0117	0.0026	0.0060	0.0009	0.0022	NO
2012	0.0127	0.0030	0.0046	0.0009	0.0043	NO

N_2O (Gg)	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2013	0.0123	0.0030	0.0043	0.0009	0.0042	NO
2014	0.0112	0.0026	0.0044	0.0010	0.0032	NO
Decrease 1988-2014	-	-	-	-	-	-
Decrease 1990-2014	10.7%	47.8%	1.7%	67.0%	-	-
Decrease 2014-2014	9.0%	11.8%	-2.7%	-11.0%	23.2%	-

Table 71 GHG emissions in CRF 1.A.2.f. Non-metallic minerals

GHG (Gg)	TJ	CRF 1.A.2.f.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO	NO
1990	42 276.98	2 654.81	668.59	300.46	1 685.76	NO	NO
1991	20 466.56	1 264.77	78.63	259.26	926.88	NO	NO
1992	24 501.19	1 598.00	506.51	236.89	854.57	0.0369	NO
1993	24 117.66	1 534.12	360.62	233.96	939.51	0.0233	NO
1994	28 524.79	1 814.59	391.66	299.59	1 123.33	0.0175	NO
1995	32 659.47	2 058.24	447.37	297.08	1 313.75	0.0272	NO
1996	30 653.84	1 910.59	384.86	251.65	1 274.07	0.0155	NO
1997	30 599.44	1 930.02	564.27	175.66	1 190.07	0.0175	NO
1998	22 811.76	1 509.84	567.90	193.63	748.29	0.0155	NO
1999	18 733.75	1 284.85	447.04	274.12	563.68	0.0117	NO
2000	18 825.47	1 407.42	521.48	390.69	495.24	0.0117	NO
2001	18 833.48	1 532.27	518.36	668.80	345.10	0.0078	NO
2002	20 736.64	1 716.83	836.61	521.98	358.23	0.0058	NO
2003	20 853.32	1 782.71	850.67	640.50	291.54	0.0097	NO
2004	22 329.00	1 888.95	828.37	735.58	324.96	0.0425	NO
2005	22 866.49	1 924.22	990.15	581.15	352.86	0.0620	NO
2006	25 037.10	2 062.82	1 207.95	421.51	433.33	0.0334	NO
2007	29 043.64	2 418.67	1 234.42	697.30	486.56	0.3818	NO
2008	26 409.73	2 088.10	940.73	632.75	513.13	1.4881	NO
2009	19 416.54	1 434.36	653.21	332.09	447.42	1.6360	NO
2010	22 382.67	1 719.00	780.18	472.72	464.72	1.3769	NO
2011	18 367.29	1 308.98	394.40	389.77	523.75	1.0530	NO
2012	17 954.95	1 252.66	469.44	296.34	484.80	2.0720	NO
2013	17 990.40	1 250.75	471.65	274.70	502.38	2.0274	NO
2014	18 229.61	1 258.99	418.12	281.02	558.29	1.5573	NO
Decrease 1988-2014	-	-	-	-	-	-	-
Decrease 1990-2014	56.9%	52.6%	37.5%	6.5%	66.9%	-	-
Decrease 2013-2014	-1.3%	-0.7%	11.3%	-2.3%	-11.1%	23.2%	-

3.3.11.7 Other (CRF 1.A.2.g.)

Category 1.A.2.g Other enfolds emissions from fuel combustion from all activities which could not be classified under any of the other subcategories from 1.A.2 subcategory.

Most notably these are:

- Autoproducer Electricity Plants
- Autoproducer CHP Plants
- Autoproducer Heat Plants
- Manufacturing of machinery
- Manufacturing of transport equipment
- Mining and quarrying
- Wood and wood products
- Construction
- Textile and leather
- Off-road vehicles and other machinery
- Other non-specified (Industry)

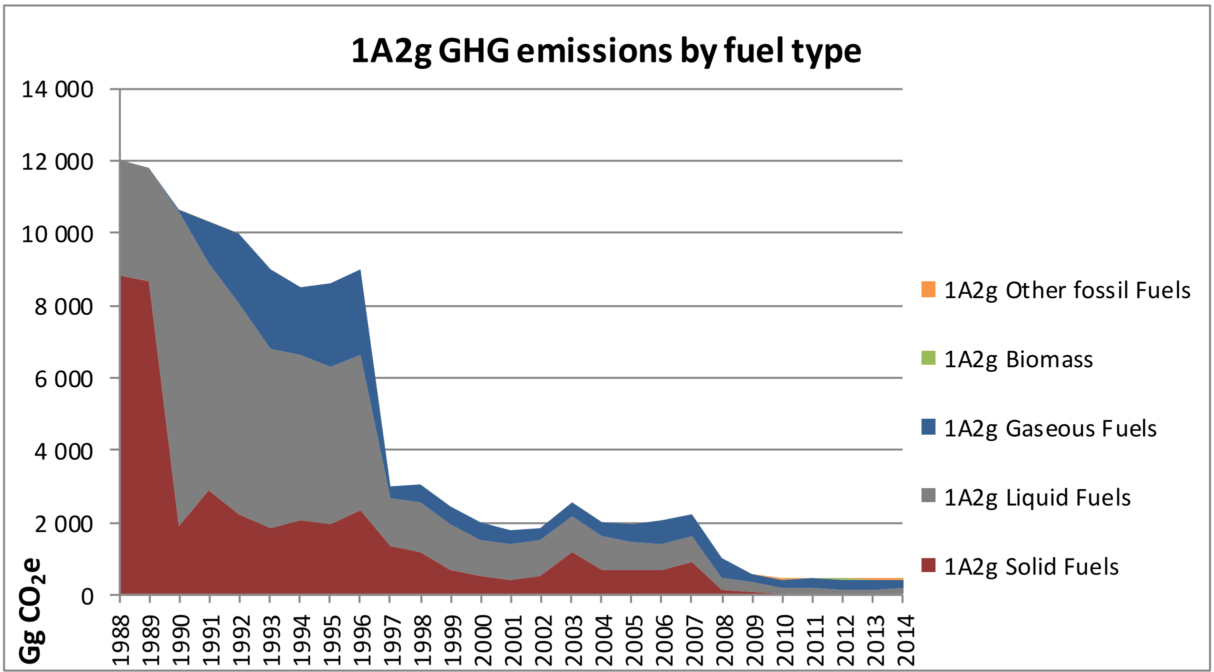

Figure 36 GHG emissions from 1.A.2.g. Other industries

The share of this subcategory from sector 1.A is 1.1% for 2014, while the share from total GHG emissions is 0.8%.

Up to 1997 there was a significantly higher consumption in this sector, due to the fact that the total amount of fuels used by autoproducers CHP and heat plants was reported under autoproducers instead of reporting only the quantities sold to third parties. The National statistics changed their methodologies after 1997 and reallocated fuels used for the production of electricity and heat for own use to the respective subcategories from category 1.A.2. This sector also includes the emissions from the use of alternative fuels (e.g. SRF/RDF, waste oils and tires, etc.) in cement and other industries, which started after 2004.

Table 72 CO_2 emissions in 1.A.2.g. Other industries

CO_2 (Gg)	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	11 929.05	3 155.83	8 773.22	NO	NO	NO
1989	11 675.65	3 090.27	8 585.38	NO	NO	NO
1990	10 600.28	8 638.14	1 873.16	88.98	NO	NO

CO_2 (Gg)	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1991	10 289.46	6 248.03	2 855.66	1 185.76	168.0000	NO
1992	9 958.24	5 830.33	2 186.21	1 941.70	142.3520	NO
1993	8 938.31	4 932.38	1 822.76	2 183.16	134.9600	NO
1994	8 477.46	4 556.27	2 057.60	1 863.60	143.9200	NO
1995	8 591.53	4 312.13	1 928.85	2 350.55	134.9600	NO
1996	8 979.14	4 280.72	2 294.51	2 403.91	124.2080	NO
1997	2 966.53	1 300.69	1 340.90	324.93	177.5200	NO
1998	3 028.75	1 363.36	1 153.00	512.39	180.6560	NO
1999	2 416.64	1 235.86	691.74	489.04	183.0080	NO
2000	1 980.58	990.09	516.85	473.64	128.1280	NO
2001	1 762.65	969.87	392.38	400.40	143.3600	NO
2002	1 812.70	975.95	510.67	326.08	178.7520	NO
2003	2 519.44	993.13	1 147.47	378.84	199.5840	NO
2004	1 965.49	922.00	667.80	372.23	200.7040	3.4595
2005	1 952.83	771.44	679.80	498.78	117.1520	2.8073
2006	2 050.52	706.53	680.95	661.39	140.0000	1.6434
2007	2 206.43	694.55	900.31	601.85	91.3920	9.7319
2008	998.03	332.75	139.12	518.43	140.0000	7.7358
2009	564.09	254.40	58.24	229.03	191.9568	22.4192
2010	444.61	167.11	12.26	240.13	163.8182	25.1073
2011	469.10	179.77	10.36	252.56	155.6198	26.4157
2012	461.40	124.04	12.67	284.96	220.0744	39.7301
2013	448.46	127.13	12.94	256.82	281.3230	51.5697
2014	441.79	139.72	9.81	242.82	335.6318	49.4349
Decrease 1988-2014	96.3%	95.6%	99.9%	-	-	-
Decrease 1990-2014	95.8%	98.4%	99.5%	-172.9%	-	-
Decrease 2013-2014	1.5%	-9.9%	24.2%	5.5%	-19.3%	4.1%

Table 73 CH_4 emissions in 1.A.2.g. Other industries

CH_4 (Gg)	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1.0087	0.1312	0.8775	NO	NO	NO
1989	0.9876	0.1282	0.8594	NO	NO	NO
1990	0.5158	0.3398	0.1743	0.0016	NO	NO
1991	0.5913	0.2423	0.2824	0.0215	0.0450	NO
1992	0.5146	0.2278	0.2134	0.0352	0.0381	NO
1993	0.4428	0.1927	0.1744	0.0395	0.0362	NO
1994	0.4478	0.1776	0.1979	0.0338	0.0386	NO
1995	0.4307	0.1677	0.1843	0.0426	0.0362	NO
1996	0.4675	0.1685	0.2222	0.0435	0.0333	NO
1997	0.2333	0.0505	0.1294	0.0059	0.0476	NO
1998	0.2243	0.0532	0.1134	0.0093	0.0484	NO
1999	0.1745	0.0481	0.0686	0.0089	0.0490	NO
2000	0.1323	0.0392	0.0502	0.0086	0.0343	NO
2001	0.1221	0.0382	0.0383	0.0073	0.0384	NO
2002	0.1428	0.0383	0.0507	0.0059	0.0479	NO
2003	0.2158	0.0399	0.1156	0.0069	0.0535	NO

CH_4 (Gg)	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2004	0.1667	0.0367	0.0682	0.0067	0.0538	0.0013
2005	0.1419	0.0308	0.0697	0.0090	0.0314	0.0010
2006	0.1491	0.0288	0.0702	0.0120	0.0375	0.0005
2007	0.1583	0.0281	0.0914	0.0109	0.0245	0.0035
2008	0.0769	0.0132	0.0140	0.0094	0.0375	0.0027
2009	0.0806	0.0115	0.0059	0.0041	0.0513	0.0077
2010	0.0661	0.0072	0.0013	0.0043	0.0430	0.0103
2011	0.0631	0.0078	0.0011	0.0046	0.0406	0.0091
2012	0.0847	0.0054	0.0013	0.0052	0.0589	0.0140
2013	0.1033	0.0058	0.0014	0.0046	0.0746	0.0169
2014	0.1168	0.0065	0.0010	0.0044	0.0880	0.0170
Decrease 1988-2014	88.4%	95.1%	99.9%	-	-	-
Decrease 1990-2014	77.3%	98.1%	99.4%	-171.7%	-	-
Decrease 2013-2014	-13.1%	-11.3%	23.6%	5.6%	-17.9%	-0.4%

Table 74 N_2O emissions in 1.A.2.g. Other industries

N_2O (Gg)	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.3021	0.1704	0.1316	NO	NO	NO
1989	0.2963	0.1674	0.1289	NO	NO	NO
1990	0.2138	0.1877	0.0260	0.0002	NO	NO
1991	0.1509	0.1005	0.0423	0.0021	0.0060	NO
1992	0.1411	0.1006	0.0319	0.0035	0.0051	NO
1993	0.1153	0.0805	0.0260	0.0040	0.0048	NO
1994	0.1102	0.0722	0.0296	0.0034	0.0051	NO
1995	0.1106	0.0740	0.0275	0.0043	0.0048	NO
1996	0.1148	0.0728	0.0332	0.0044	0.0044	NO
1997	0.0393	0.0130	0.0194	0.0006	0.0063	NO
1998	0.0393	0.0150	0.0170	0.0009	0.0065	NO
1999	0.0354	0.0178	0.0103	0.0009	0.0065	NO
2000	0.0313	0.0184	0.0075	0.0009	0.0046	NO
2001	0.0297	0.0182	0.0057	0.0007	0.0051	NO
2002	0.0328	0.0182	0.0076	0.0006	0.0064	NO
2003	0.0460	0.0209	0.0173	0.0007	0.0071	NO
2004	0.0394	0.0212	0.0102	0.0007	0.0072	0.0002
2005	0.0473	0.0317	0.0104	0.0009	0.0042	0.0001
2006	0.0655	0.0487	0.0105	0.0012	0.0050	0.0001
2007	0.0616	0.0431	0.0137	0.0011	0.0033	0.0005
2008	0.0356	0.0272	0.0021	0.0009	0.0050	0.0004
2009	0.0549	0.0457	0.0009	0.0004	0.0068	0.0010
2010	0.0303	0.0225	0.0002	0.0004	0.0057	0.0014
2011	0.0323	0.0250	0.0002	0.0005	0.0054	0.0012
2012	0.0267	0.0163	0.0002	0.0005	0.0079	0.0019
2013	0.0350	0.0221	0.0002	0.0005	0.0099	0.0023
2014	0.0404	0.0258	0.0002	0.0004	0.0117	0.0023
Decrease 1988-2014	86.6%	84.9%	99.9%	-	-	-

N_2O (Gg)	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
Decrease 1990-2014	81.1%	86.2%	99.4%	-171.7%	-	-
Decrease 2013-2014	-15.4%	-16.6%	23.6%	5.6%	-17.9%	-0.4%

Table 75 GHG emissions in CRF 1.A.2.g. Other industries

GHG (Gg)	TJ	CRF 1.A.2.g.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	129 484.31	12 044.28	3 209.90	8 834.38	NO	NO	NO
1989	126 719.04	11 788.64	3 143.36	8 645.28	NO	NO	NO
1990	135 047.71	10 676.90	8 702.56	1 885.26	89.07	NO	NO
1991	133 761.50	10 349.22	6 284.03	2 875.33	1 186.93	2.9130	NO
1992	135 239.91	10 013.15	5 865.99	2 201.07	1 943.63	2.4683	NO
1993	124 576.95	8 983.75	4 961.19	1 834.88	2 185.33	2.3401	NO
1994	116 465.91	8 521.51	4 582.21	2 071.36	1 865.45	2.4955	NO
1995	120 844.05	8 635.26	4 338.38	1 941.66	2 352.88	2.3401	NO
1996	125 283.86	9 025.03	4 306.62	2 309.96	2 406.29	2.1537	NO
1997	38 338.69	2 984.06	1 305.82	1 349.90	325.26	3.0781	NO
1998	40 949.95	3 046.07	1 369.15	1 160.90	512.90	3.1324	NO
1999	34 248.30	2 431.57	1 242.36	696.51	489.52	3.1732	NO
2000	28 554.65	1 993.22	996.55	520.34	474.11	2.2216	NO
2001	25 741.73	1 774.57	976.24	395.04	400.80	2.4858	NO
2002	25 887.16	1 826.03	982.33	514.20	326.40	3.0994	NO
2003	33 976.12	2 538.55	1 000.35	1 155.52	379.22	3.4606	NO
2004	28 377.82	1 981.41	929.24	672.55	372.60	3.4801	3.5410
2005	27 918.06	1 970.48	781.65	684.66	499.27	2.0313	2.8728
2006	30 119.35	2 073.76	721.77	685.84	662.05	2.4275	1.6772
2007	30 685.17	2 228.75	708.09	906.68	602.44	1.5847	9.9566
2008	16 784.74	1 010.57	341.19	140.09	518.95	2.4275	7.9135
2009	10 152.57	582.46	268.30	58.66	229.26	3.3213	22.9200
2010	8 562.14	455.28	174.00	12.35	240.37	2.7807	25.7750
2011	8 819.60	480.29	187.41	10.43	252.81	2.6243	27.0055
2012	9 383.55	471.47	129.02	12.77	285.24	3.8124	40.6339
2013	9 585.88	461.48	133.88	13.03	257.08	4.8289	52.6650
2014	9 997.94	456.74	147.57	9.88	243.06	5.6921	50.5349
Decrease 1988-2014	92.3%	96.2%	95.4%	99.9%	-	-	-
Decrease 1990-2014	92.6%	95.7%	98.3%	99.5%	-172.9%	-	-
Decrease 2013-2014	-4.3%	1.0%	-10.2%	24.2%	5.5%	-17.9%	4.0%

3.3.11.7.1 Source-specific recalculations, including changes made in response to the review process

During the 2014 submission was identified a calculation error for the CH_4 and N_2O emissions resulting from the use of alternative fuels, which was leading to double counting of the emissions (they were reported both under 'Biomass' and 'Other fuels'). Since the alternative fuels contain both a biomass and a fossil fraction, the resulting emissions from the biomass fraction are currently reported under biomass, while the emissions from the fossil fraction are reported under 'Other fuels'.

3.3.12 TRANSPORT (CRF 1.A.3)

The GHG emissions in Transport (CRF 1.A.3) are estimated following the 2006 IPCC Guidelines and the recommendations of ERT set out in FCCC/ARR/2013/BGR and FCCC/ARR/2014/BGR.

3.3.12.1 Source category description

The IPCC source category for transport covers all types of mobile sources and the range of characteristics that affect the emission factors and consequently the emissions. Those are compiled according to the source in five categories.

Table 76 Transport sector categories

Number	Category	CO_2	CH_4	N_2O	Method
CRF 1.A.3.a	Civil aviation (domestic)	✓	✓	✓	TIER 2
CRF 1.A.3.b	Road transport	✓	✓	✓	TIER 2
CRF 1.A.3.c	Railways	✓	✓	✓	TIER 1
CRF 1.A.3.d	Navigation	✓	✓	✓	TIER 1
CRF 1.A.3.e	Other Transport	✓	✓	✓	TIER 1

For each of the main emissions from transport – carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) – has been chosen the most appropriate calculation method based on the type of emission, transport category and data availability. The uncertainty of the main inputs regarding the emission type has been considered and evaluated. Furthermore, for the GHG inventory compilation, the ERT recommendations set out in FCCC/ARR/2012/BGR have been followed.

Emission trends over the years depend mostly on the amount of fuel consumed for CO_2, while for CH_4 and N_2O the vehicle fleet and the fuel quality parameters are more important factors. The fuel quantities used in the CRF 1.A.3 Transport for 1988 – 2014 are shown below.

Table 77 Fuels for CRF 1.A.3 Transport in TJ 1988 - 2014

CRF 1A3 Transport	a. Civil Aviation	b. Road Transportation	c. Railways	d. Navigation	e. Other Transport
	TJ				
1988	2937	96173	NO	NO	NO
1989	3134	102096	NO	NO	NO
1990	1899	81973	4357	761	1777
1991	1685	47124	3140	42	NO
1992	1519	48787	4080	85	NO
1993	1395	55426	4693	125	40
1994	1404	51629	3450	167	40
1995	1280	56070	3066	167	40
1996	1156	55898	1855	254	40
1997	1076	56439	1819	85	472
1998	904	70062	1734	125	3719
1999	2239	72408	1607	205	3296
2000	887	68599	1607	85	6887
2001	1893	71090	1396	77	5777
2002	1119	75330	1311	114	5821
2003	990	85180	1184	141	3665
2004	820	91021	1200	132	5631
2005	561	100129	1227	153	9042
2006	1050	105874	1214	161	9538
2007	1737	100379	1058	179	10974
2008	560	106416	1354	207	10808
2009	990	106353	846	152	5846
2010	646	104200	846	117	5896
2011	904	104123	761	127	8528
2012	474	111430	931	115	8519
2013	517	100371	630	96	7608
2014	388	114022	504	116	7032

The fuel consumption for navigation in the years mentioned with notation key NO is explained in section CRF 1.A.3.d Navigation and CRF 1.A.3.c Railways.

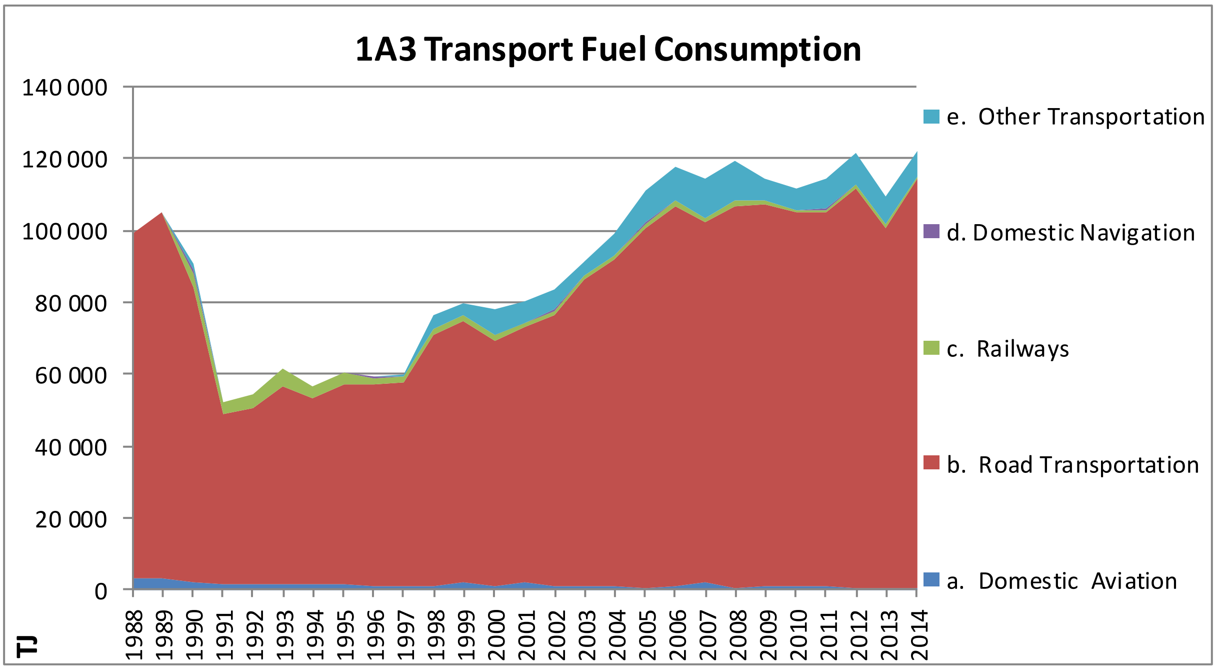

Figure 37 Fuels for CRF 1.A.3 transport for 1988 - 2014

In period 1988 to 1991 the fuel consumption in the transport sector decreased by 48% due to the economy collapse. But since 1991 the fuel consumption steadily increases mainly due to road transport. Although there was a decrease for 2013, in 2014 road transport fuels increase again. The share of the transport categories for the period of the inventory is the following:

Table 78 Share of fuel consumption in 1A3 Transport fuel

Number	Category	2007	2008	2009	2010	2011	2012	2013	2014
CRF 1.A.3.a	Civil aviation (domestic)	1.5%	0.5%	0.9%	0.6%	0.8%	0.4%	0.5%	0.3%
CRF 1.A.3.b	Road transport	87.8%	89.2%	93.1%	93.3%	91.0%	91.7%	91.9%	93.4%
CRF 1.A.3.c	Railways	0.9%	1.1%	0.7%	0.8%	0.7%	0.8%	0.6%	0.4%
CRF 1.A.3.d	Navigation	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
CRF 1.A.3.e	Other Transport	9.6%	9.1%	5.1%	5.3%	7.5%	7.0%	7.0%	5.8%

3.3.12.2 CRF 1.A.3.a Civil Aviation

3.3.12.2.1 Source description

The IPCC source category for civil aviation includes emissions from all civil commercial use of airplanes (international and domestic) consisting of scheduled and charter traffic for passengers and freight as well as general aviation. Emissions from aviation come from the combustion of jet kerosene and aviation gasoline. Aircrafts emit carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), as well as carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs), sulfur dioxide (SO_2), particulate matter (PM) and nitrogen oxides (NO_x). Domestic aviation is related to the transport of passengers and cargo as well as general aviation. The types of flights include both scheduled and non-scheduled. The international aviation is differentiated from the domestic aviation based on the departure and landing locations.

3.3.12.2.2 Emission trend

For 2014 there is a decrease of 86.7% in the emissions from civil aviation compared to the base year, and a decrease of 24.9% compared to last year. In 2014 the sector is responsible for 0.07% from the emissions allocated to 1.A Fuel combustion and for 0.05% from the total GHG emissions (excluding LULUCF). The main source of emissions is the use of jet kerosene and currently only insignificant amounts of aviation gasoline are consumed.

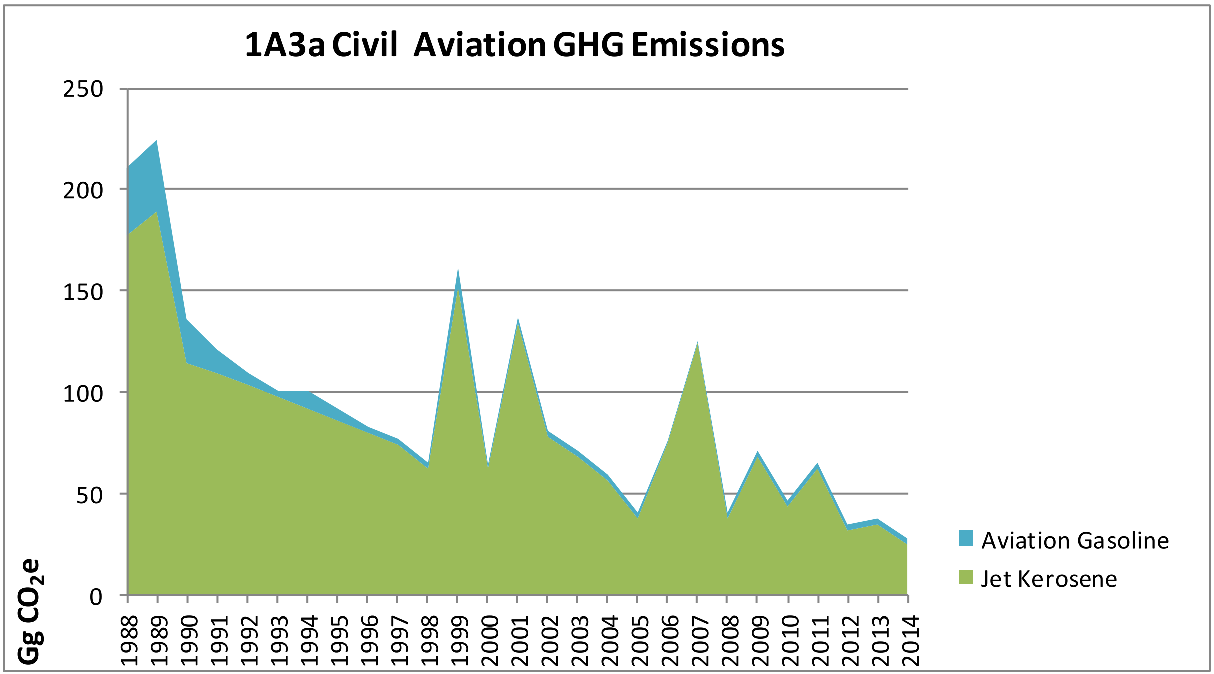

Figure 38 GHG emission in CRF 1.A.3.a Civil aviation – domestic (1988 - 2014)

Table 79 Fuel consumption and emissions from Civil aviation - all fuels

Year	TJ	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1988	2 936.74	208.93	0.0015	0.0059	210.72
1989	3 134.41	222.99	0.0016	0.0063	224.90
1990	1 899.00	135.10	0.0009	0.0038	136.26
1991	1 685.14	120.10	0.0008	0.0034	121.13
1992	1 519.29	108.44	0.0008	0.0030	109.36
1993	1 395.43	99.68	0.0007	0.0028	100.53
1994	1 403.57	100.06	0.0007	0.0028	100.92
1995	1 279.71	91.31	0.0006	0.0026	92.08
1996	1 155.86	82.55	0.0006	0.0023	83.25
1997	1 076.00	76.84	0.0005	0.0022	77.49
1998	904.00	64.67	0.0009	0.0019	65.25
1999	2 239.00	160.01	0.0018	0.0045	161.41
2000	887.19	63.62	0.0018	0.0018	64.21
2001	1 893.00	135.49	0.0029	0.0039	136.71
2002	1 119.00	80.10	0.0019	0.0023	80.83
2003	990.00	70.89	0.0018	0.0020	71.54

Year	TJ	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
2004	820.12	58.70	0.0015	0.0017	59.24
2005	561.40	40.20	0.0011	0.0012	40.59
2006	1 049.71	75.17	0.0010	0.0022	75.84
2007	1 737.38	124.35	0.0013	0.0036	125.45
2008	560.00	40.17	0.0010	0.0013	40.57
2009	990.00	70.93	0.0010	0.0021	71.58
2010	646.00	46.30	0.0008	0.0014	46.75
2011	904.00	64.78	0.0012	0.0020	65.40
2012	474.00	34.01	0.0008	0.0011	34.36
2013	517.00	37.05	0.0005	0.0011	37.38
2014	388.00	27.81	0.0006	0.0008	28.07

Table 80 Fuel consumption and emissions from Civil aviation - jet kerosene

Year	TJ	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1988	2 460.43	175.92	0.0012	0.0049	177.42
1989	2 626.04	187.76	0.0013	0.0053	189.36
1990	1 591.00	113.76	0.0008	0.0032	114.72
1991	1 511.14	108.05	0.0008	0.0030	108.97
1992	1 431.29	102.34	0.0007	0.0029	103.21
1993	1 351.43	96.63	0.0007	0.0027	97.45
1994	1 271.57	90.92	0.0006	0.0025	91.69
1995	1 191.71	85.21	0.0006	0.0024	85.93
1996	1 111.86	79.50	0.0006	0.0022	80.17
1997	1 032.00	73.79	0.0005	0.0021	74.42
1998	860.00	61.62	0.0008	0.0018	62.17
1999	2 107.00	150.86	0.0017	0.0043	152.18
2000	860.00	61.74	0.0018	0.0018	62.31
2001	1 849.00	132.44	0.0029	0.0038	133.63
2002	1 075.00	77.05	0.0019	0.0022	77.76
2003	946.00	67.84	0.0018	0.0019	68.46
2004	776.16	55.65	0.0015	0.0016	56.17
2005	517.44	37.16	0.0011	0.0011	37.52
2006	1 034.88	74.14	0.0010	0.0022	74.81
2007	1 720.00	123.15	0.0013	0.0035	124.23
2008	516.00	37.12	0.0010	0.0012	37.49
2009	946.00	67.88	0.0010	0.0020	68.51
2010	602.00	43.25	0.0008	0.0014	43.68
2011	860.00	61.73	0.0012	0.0019	62.33
2012	430.00	30.96	0.0008	0.0010	31.28
2013	473.00	34.00	0.0005	0.0010	34.31
2014	344.00	24.76	0.0005	0.0007	25.00

Table 81 Fuel consumption and emissions from Civil aviation – aviation gasoline

Year	TJ	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1988	476.31	33.01	0.00024	0.0010	33.30
1989	508.37	35.23	0.00025	0.0010	35.54
1990	308.00	21.34	0.00015	0.0006	21.53
1991	174.00	12.06	0.00009	0.0003	12.16
1992	88.00	6.10	0.00004	0.0002	6.15
1993	44.00	3.05	0.00002	0.0001	3.08
1994	132.00	9.15	0.00007	0.0003	9.23
1995	88.00	6.10	0.00004	0.0002	6.15

Year	TJ	CO_2 [Gg]	CH_4 [Gg]	N_2O [Gg]	Total GHG [Gg CO_2e]
1996	44.00	3.05	0.00002	0.0001	3.08
1997	44.00	3.05	0.00002	0.0001	3.08
1998	44.00	3.05	0.00002	0.0001	3.08
1999	132.00	9.15	0.00007	0.0003	9.23
2000	27.19	1.88	0.00001	0.0001	1.90
2001	44.00	3.05	0.00002	0.0001	3.08
2002	44.00	3.05	0.00002	0.0001	3.08
2003	44.00	3.05	0.00002	0.0001	3.08
2004	43.96	3.05	0.00002	0.0001	3.07
2005	43.96	3.05	0.00002	0.0001	3.07
2006	14.83	1.03	0.00001	0.0000	1.04
2007	17.38	1.20	0.00001	0.0000	1.22
2008	44.00	3.05	0.00002	0.0001	3.08
2009	44.00	3.05	0.00002	0.0001	3.08
2010	44.00	3.05	0.00002	0.0001	3.08
2011	44.00	3.05	0.00002	0.0001	3.08
2012	44.00	3.05	0.00002	0.0001	3.08
2013	44.00	3.05	0.00002	0.0001	3.08
2014	44.00	3.05	0.00002	0.0001	3.08

3.3.12.2.3 Methods

Civil aviation is considered a minor contributor to the emissions from the Transport sector as a result of the small quantities fuel consumed, as reported by the NSI. Nevertheless, following a planned improvement the emission estimates for domestic aviation were calculated according to Tier 2 and following 2006 IPCC GL.

The Tier 2 method requires as a first step to perform a calculations based on landing and take-off cycles per aircraft type per year, separately for domestic and international flights. For each LTO per aircraft type are applied the corresponding emission factors and fuel consumption factors according to the following equations:

LTO Emissions = Number of LTOs • Emission Factor LTO

LTO Fuel Consumption = Number of LTOs • Fuel Consumption per LTO

As a second step the total amount of fuel consumed in all LTOs is subtracted from the total fuel reported in order to calculate the cruise fuel consumption and are applied the appropriate cruise emission factors by the following equation:

Cruise Emissions = (Total Fuel Consumption – LTO Fuel Consumption) • Emission Factor Cruise

The final step includes the sum of LTOs and cruise emissions in order to calculate the total emissions from aviation by the following equation:

Total Emissions = LTO Emissions + Cruise Emissions

3.3.12.2.4 Activity data

Total fuel consumption is obtained from Energy balance and converted into energy units using the country-specific NCV.

The LTOs per aircraft type per year were obtained from Eurocontrol for the period 1996-2014 with the note that data for 1996 and 1997 is incomplete, since Bulgaria became an Eurocontrol member on 1st June 1997. The primary data for all years consists of 477 airplane types classified by ICAO code. The data was matched with the information from ICAO DOC 8643 Aircraft Type Designators document, which currently consists of more than 9400 type designators in order to identify the manufacturer, model, engine type, engine count and wake turbulence category. About 90 of the ICAO type designators, which were reported by Eurocontrol were not present in the ICAO DOC 8643. For those airplanes was performed a manual search in order to identify the exact type of airplane.

As a second step all 477 aircraft type designators were manually matched to the appropriate aircraft types from 2006 IPCC GL, Vol.2, Ch. 3, Table 3.6.9.

Since the IPCC guidelines provide information for only about 50 different aircraft types, the following correspondence table was used for the remaining aircrafts for which it was not possible to manually match the aircrafts based on their model:

Table 82 Correspondence between aircraft characteristics and generic aircraft types

WTC	Engine number	Engine type	Generic aircraft type	ICAO
L	1	Turboprop	King Air	BE30
L	1	Jet	Dornier 328 Jet	D328
L	2	Turboprop	BEECHCRAFT King Air	BE30
L	2	Jet	Dornier 328 Jet	D328
M	1	Jet	Gulfstream IV	G550
M	2	Turboprop	ATR72-500	ATR75
M	2	Jet	Fokker 100/70/28	F100
M	3	Turboprop	Dornier 328 Jet	D328
M	3	Jet	Yak-42M	YK42
M	4	Turboprop	BAE146	B463
M	4	Jet	BAE146	B463
H	2	Jet	Average fleet (B767)	B767
H	3	Jet	Lockheed Tristar	L1011
H	4	Jet	A340-300	A343
H	6	Jet	Old Fleet747-100	B741

The outcome of the updated Tier 2 methodology results in increase of the GHG emissions from jet kerosene by 0.5% for 2014.

3.3.12.2.5 Emission factors

The default Tier 2 emissions factors for jet kerosene from 2006 IPCC GL, Vol.2, Ch. 3, Table 3.6.9 were used.

3.3.12.2.6 Uncertainties

Since the default emission factors are used, the following default uncertainties are assumed (2006 IPCC GL):

AD: 5 %

EF CO_2: ±5 %

EF N_2O (for all fuel): -70 %/ +150 %

EF CH_4 (for all fuel): -57 % / +100 %

3.3.12.2.7 Source-specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, CO_2 emissions, emission factors and IEF (time series);
- Time series consistency;
- Plausibility checks of dips and jumps;
- Documentation and archiving of all information required in NIR, background documentation and archive;
- Comparison of Tier 1 and Tier 2 approach.

3.3.12.2.8 Source-specific recalculations

No recalculations have been performed for the 2014 submission.

3.3.12.2.9 Source-specific planned improvements

At this stage no improvements are planned for next submission.

3.3.12.3 CRF 1.A.3.b Road transport

3.3.12.3.1 Source description

The IPCC source category for road transport includes emissions from all types of vehicles, light-duty vehicles such as automobiles and light trucks, and heavy-duty vehicles such as tractor trailers and buses, and on-road motorcycles (including mopeds, scooters, and three-wheelers). Road transport emits significant amounts of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), as well as several other pollutants.

Road transport is defined as a key category, as a result of the considerable amount of CO_2 emissions from the use of diesel, gasoline, LPG presented below.

Special feature of Bulgarian vehicle fleet is its age structure. In 2014 more than 85% from the vehicles are above 10 years old, while new vehicles (1 to 5 years) are 4% from the total and 11% are 5 to 10 years old.

The total number of registered vehicles in Bulgaria for the period 1988 – 2014 is presented in the following table.

Table 83 Number of vehicles by type

Vehicle type	Passenger cars	LDV and HDV	Busses	Motor-cycles	Mopeds
1988	1 220 784	210 805	5 486	217 360	276 901
1989	1 269 958	219 092	6 466	221 416	279 077
1990	1 317 437	227 782	7 468	225 533	281 270

Vehicle type	Passenger cars	LDV and HDV	Busses	Motor-cycles	Mopeds
1991	1 358 976	240 487	9 396	226 853	282 137
1992	1 411 278	253 552	11 049	228 334	282 792
1993	1 505 451	270 129	13 375	230 635	283 963
1994	1 587 873	280 959	14 834	232 386	284 571
1995	1 647 571	289 430	15 371	233 365	285 901
1996	1 707 023	295 607	15 315	234 950	286 760
1997	1 730 506	298 210	15 029	236 260	288 690
1998	1 809 350	308 613	16 220	233 952	281 749
1999	1 908 392	318 003	16 830	235 181	284 031
2000	1 992 748	326 204	17 290	236 327	286 047
2001	2 085 730	336 942	17 978	237 756	288 290
2002	2 174 081	347 867	18 404	239 631	290 631
2003	2 309 343	362 540	19 042	242 441	293 228
2004	2 438 383	376 800	11 478	93 269	44 686
2005	2 544 198	393 565	12 761	97 754	48 667
2006*	1 767 310	255 868	16 213	42 877	33 372
2007	2 081 520	293 372	18 184	50 922	39 400
2008	2 366 200	333 188	20 164	60 114	46 801
2009	2 502 027	352 313	20 559	66 335	51 265
2010	2 602 461	368 195	20 457	70 394	54 983
2011	2 694 862	382 324	20 120	73 805	58 019
2012	2 806 814	402 648	20 040	77 972	61 840
2013	2 910 235	424 299	20 277	82 481	65 479
2014	3 013 863	449 458	20 685	88 035	68 982

**In 2006 there was a decrease of the number of officially registered vehicles due to the terminated registration of all vehicles, which did not pass the obligatory re-registration.*

Road transport has the biggest share in total fuel consumption in Transport subsector. In 2014 road transport consumed 94.5% from the total energy in the sector.

1.1.1.2.1 Emission trend

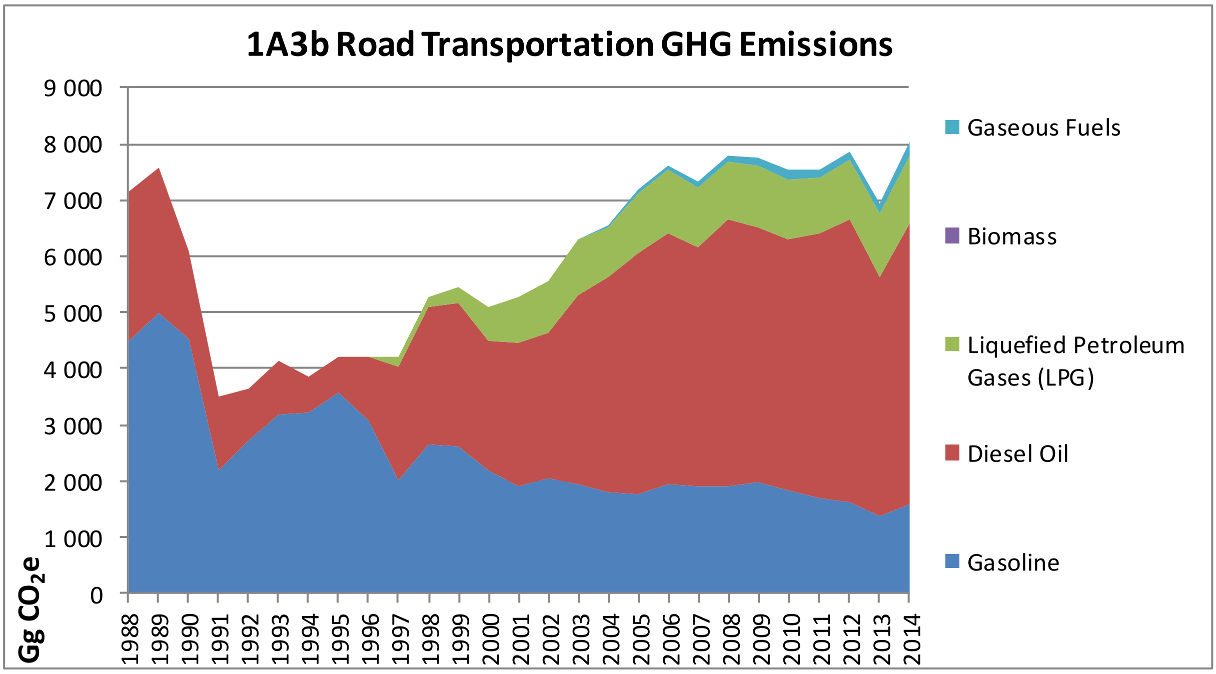

Figure 39 GHG emissions in CRF 1.A.3.b Road transport 1988 - 2014

Following a steep decline in 1989 as a result of the political and economic crisis, a distinct uptrend of GHG emissions could be noticed since 2000 to present. The change was a result of the economic recovery, preceded by the introduction of a currency board regime in 1997 and rigorous economic and political reforms. The main contributing gas is CO_2, followed by CH_4 and N_2O.The CO_2 emission trend is directly related to the fuel consumption and therefore shows a decrease in the period 1990-2000. However, with the reviving economy CO_2 emissions grew constantly to 2006. Afterwards, a period of stabilization began and continued to 2009 when there was a slight drop in the emissions mainly related to the economic crisis and the consequent decline in transportation. For 2013 there was again a drop in the fuel consumption (mostly for diesel fuel and gasoline), which resulted in decrease of the emissions, but the drop was compensated in 2014, reaching the highest ever consumption.

Overall, the GHG emissions from road transport increased by 12.4% compared to base year level of 7 152.9 Gg CO_2e and reached 8 042.6 Gg CO_2e in 2014.

The most significant contributor to GHG emissions are passenger cars, followed by heavy-duty vehicles, light-duty vehicles and motorcycles and mopeds. As it can be noticed from the following figure, in 2014, passenger cars account for 65.0%, light-duty vehicles are responsible for 13.3%, and heavy duty vehicles (incl. buses) account for 21.4% of total GHG CO_2e emissions, with the share of passenger cars increasing over the time series. The remaining 0.3% were shared among and mopeds and motorcycles.

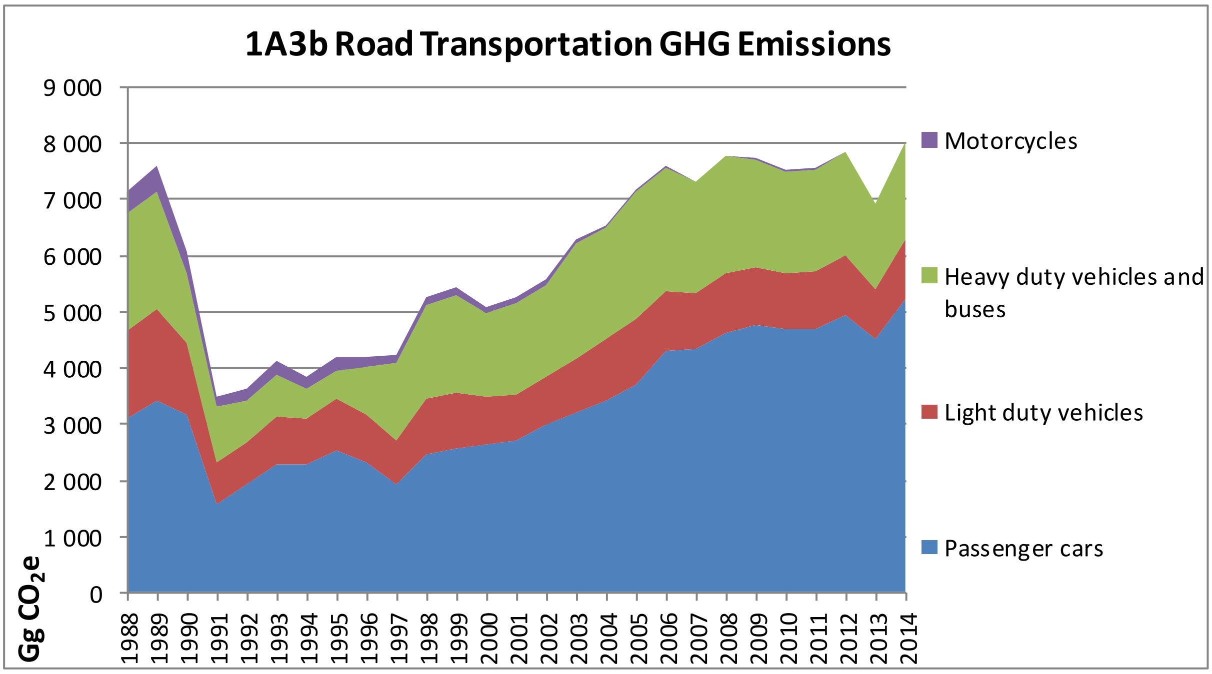

Figure 40 Emissions allocated to vehicle categories for the period 1988-2014

Whereas CO_2 emissions are closely linked to fuel consumption, CH_4 and N_2O emissions are considerably impacted by engine technology and do not follow the trend in the fuel consumption. As it can be observed in the following figure N_2O emissions and implied emission factors tend to fluctuate for the period of the inventory following the introduction to the market of different engine technologies implementing EURO emission standards and different fuel quality standards (e.g. lead and sulphur content). However, the trend is not always decreasing – for example there is an increase in the IEF for the years up to 2003, which is closely related to the gradual introduction of gasoline Euro 1 vehicles, a category which is known for its higher N_2O emissions. As the technology improves with time, there is a noticeable decrease moving from Euro 1 to Euro 3, which could be detected also clearly after 2004 with the introduction of fuels with lower sulphur content.

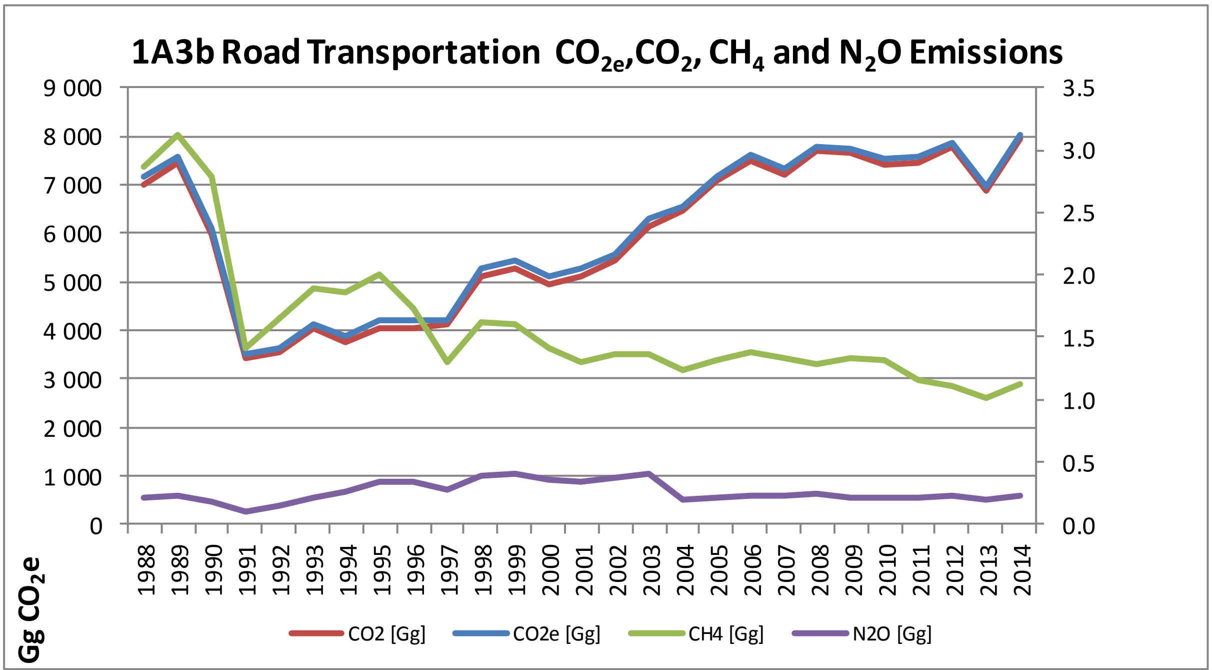

Figure 41 CO_2, CO_2e, CH_4 and N_2O emissions trends for the period 1998-2014

CH_4 emissions fall steeply following the gasoline consumption pattern, as the main source of those emissions proves to be pre-EURO gasoline passenger cars. After the crises in the beginning of the 90s, a slight increase during 1992 – 1995 can be observed, followed by downward trend. Compliance with strict Euro emission standards influences significantly the CH_4 emissions and thus results in decreased levels of methane.

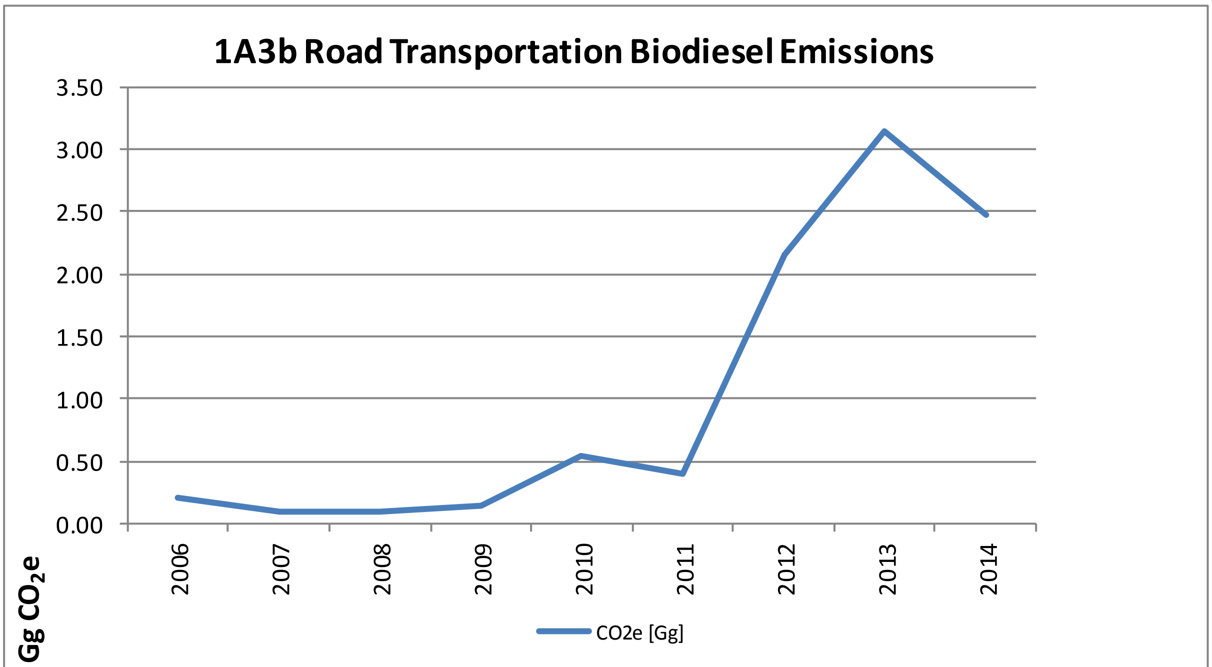

Figure 42 Emissions by biodiesel from Road Transport for the period 2006-2014

Transport diesel sold at the market contains a small percentage of biodiesel, which is also reported in the Energy balances as biodiesel for blending. The approach allocates the total emissions from transport diesel between mineral diesel and biodiesel. Since the EFs for biodiesel and diesel are assumed to be identical, the biomass fraction is calculated proportionally on the amounts of biodiesel and mineral diesel. A steep upward trend can be noticed due to an increase in biodiesel consumption by approximately eight times for the period 2011-2013, with a subsequent decrease in 2014.

3.3.12.3.2 Methods

The CO_2 emissions are best calculated based on the amount and type of fuel combusted and its carbon content. The emissions of CH_4 and N_2O are more difficult to be estimated accurately because emission factors depend on vehicle technology, fuel and operating characteristics.

Road transport as a source of CO_2 is a key category. With respect to the Review Report FCCC/ARR/2010/BGR, the emission calculations of road transport have been performed with the use of the COPERT computer model version 11 with subsequent adjustments, corresponding to Tier 2 methodology according to the 2006 IPCC GL. Country-specific technology based emission factors have been derived using the COPERT model, based on various country-specific and default parameters.

In the new version of COPERT there have been made a number of changes regarding new passenger cars subsectors and emissions update.

COPERT version 9 includes the same EURO 4 methane emission factor for EURO 5 and EURO 6 for Gasoline passenger cars. Hot methane emissions also differ, while COPERT deems that there are no CH_4 highway hot emissions while some studies show that highway methane emissions are in fact higher than urban and rural emissions. As a result, in version 10 hot emissions factors for CH_4 for EURO 4, 5 and 6 on urban, rural and highway have been updated with new values to reflect these findings. In COPERT version 11 there have been additional changes, which lead to the recalculation of the full time series, due to corrected cold emissions for diesel LDV CO, NOx, PM, VOC, CO_2, FC and fuel consumption related emissions, updated emission factors of regulated and non-regulated pollutants for EURO 5/V and EURO 6/VI vehicles, including CO, HC, NOx, PM, NH_3, N_2O, and NO_2.

In the COPERT model emissions are calculated through numerous input parameters like data on average daily trip distance, fuel Reid vapor pressure (RVP), monthly minimum and maximum temperatures, fuel consumption and fuel specifications, vehicle fleet categorized in sectors, subsectors and technologies, vehicle stock, annual mileage, speed, driving shares and others. Comparison of Tier 2 with Tier 1 is performed as a verification cross-check.

3.3.12.3.3 Activity data

Fuel consumption (liquid, gaseous and biofuels) is obtained from the Energy balance and converted into energy units using the country-specific NCV (as recommended by the ERT (FCCC/ARR/2013/BGR). As recommended by the ERT (FCCC/ARR/2011/BGR), CO_2 emissions are calculated based on total fuels sold in the country. The total amount of fuels sold is compared to the calculated amount of fuel according to the model, as the difference is used for mileage adjustment to correspond to the fuel quantities from the Energy balance, as explained under “Mileage” below.

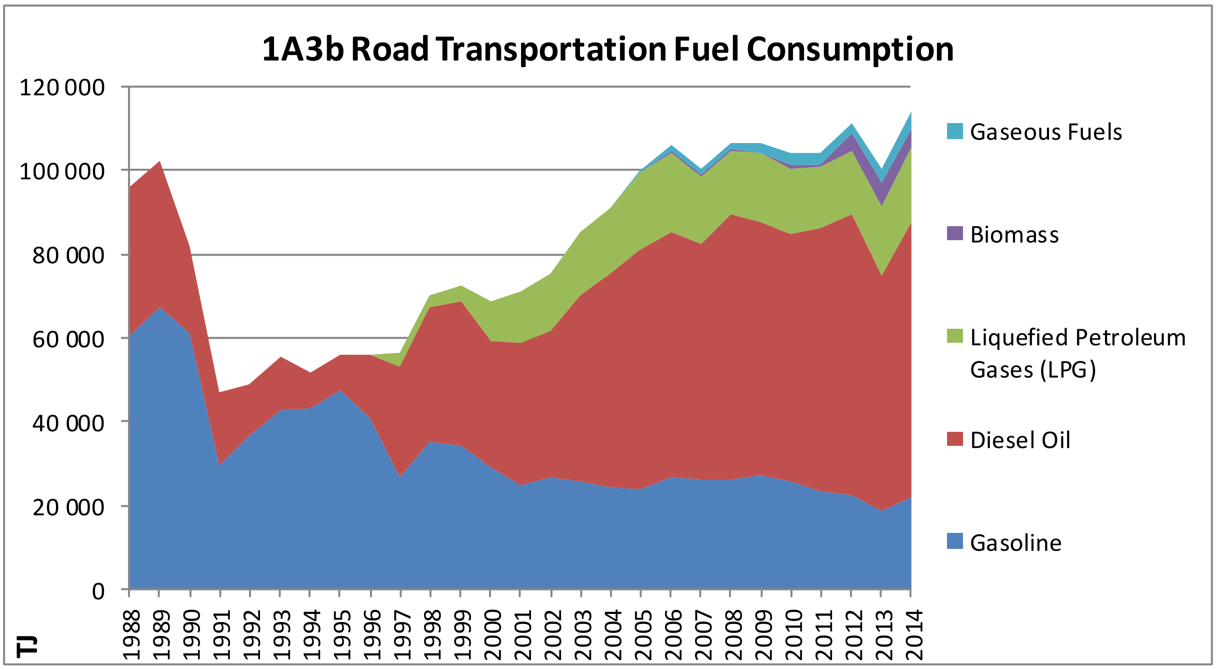

Figure 43 Fuel consumption in CRF 1.A.3.b Road transport (1988 - 2014)

Other data, necessary for implementation of model COPERT has been provided by national institutions and companies (National Statistical Institute, National Institute of Meteorology and Hydrology, Ministry of Internal affairs, Department Traffic police, Lukoil Neftohim oil refinery, State Agency for Metrological and Technical Surveillance). However, in some cases the completeness and quality of the information submitted was not of required detail. When directly related data was not available, surrogate data from various sources was used to fulfil the missing gaps and ensure the representativeness of the inputs to COPERT model. A degree of expert judgment was necessitating as well.

The following input data is compiled for the emission calculations with the use of COPERT 4:

Average daily trip distance

Average daily trip distance was calculated through www.bgmaps.com, one of the most popular websites for maps, routes, records and services to find individual addresses, locations and other information on the maps. Analysis of the major cities population and plausible daily journeys was performed and available data lead to an estimation of 15.1 km as average daily trip distance. Though, the average European value of 12.4 km (Samaras et al. 2000) is slightly lower, the calculated number seems to be more appropriate for the Bulgarian conditions and driving culture. Time trip duration is estimated at 0.42 hour.

Minimum and maximum temperatures

Complete, country-specific data on monthly average minimum and maximum temperatures for the whole period of 1988 to 2014 was compiled by the National Institute of Meteorology and Hydrology.

Fuel specifications

Fuel specifications of liquid fuels were provided by Lukoil Neftohim – Burgas, as the major part of the liquid fuels sold on the national market are produced by Lukoil, and by the State

Agency for Metrological and Technical Surveillance (SAMTS). The later organization performs the quality inspections of the liquid fuels placed on the market according to the national and European legislation requirements by using accredited laboratories. Since fuel sold at gas stations in the country is sampled regularly, SAMTS fuel quality data is considered representative for the fuel delivered to the final customer and utilized by the national fleet. Country specific data for diesel and gasoline for some of the fuel specifications is provided for the years 2005-2014 by Lukoil Neftohim – Burgas and the State Agency for Metrological and Technical Surveillance (SAMTS). Fuel quality data on LPG, biodiesel and CNG was not obtained. Hence, literature information and regulatory technical requirements were used instead. In some cases, default values provided by COPERT 4, version 11 were used and extrapolation of the existing numbers was applied to fill the gaps in the available data (Samaras 2000). It is important to be noted that since 2004 only unleaded gasoline is sold in Bulgaria (National Program to phase out lead in petrol). The years before, the percentage of leaded and unleaded gasoline varies as in 2003 the leaded gasoline share was only 2% (National Statistical Institute). An investigation of required fuel quality measurements showed that values for H:C and O:C ratios are not measured as a required fuel quality parameter in Bulgaria. Thus country specific data on H:C and O:C values cannot be obtained at this stage (FCCC/ARR/2013/BGR). Further, as fuels sold in Bulgaria comply with European fuel quality requirements it is assumed that default values are applicable.

Values for fuel volatility (RVP – Reid vapor pressure) are available for the period 2006-2014 provided by Lukoil Neftohim oil refinery. For the previous periods a summer and winter range is specified according to the technical requirements. Therefore, RVP data for the years 2000-2005 is estimated based on the available values and the legal requirements. RVP of 62 kPa (summer) and 67 kPa (winter) for the period 1988 -1999 is applied, based on the market average for 1996 (Samaras et al. et al. 2000) and the ratio of legal requirements to measured data, submitted for the recent years.

Speed

Infrastructure and vehicle stock differ significantly in different regions. Vehicle speed varies from big and small cities during the day, being quite low in the rush hours, especially in the densely populated areas. However, detailed data for speed variations is not available for the whole period. Krzywkowska et al. (2004) report approximate value of 24 km/h for mini buses in the urban region of Sofia. Additionally, a number of studies (André, 2006, Samaras et al. 2002, Coronas Metropolitanas 2006) document various average speeds for several European cities and private measurement of passenger cars average speed per day were considered. Further, average urban speed of 36.2 km/h was calculated via www.bgmaps.com, applying the same method as for average daily trip distance calculation. The latter value is preferred for the inventory, in relation to the traffic conditions in urban areas and literature research. A slightly higher value of 37 km/h is estimated for the period 1989-2000 regarding the traffic conditions in the past and fluctuation in bus speed.

Considering public transport, buses are the most developed mode of transport in Sofia (MottMacDonald 2009), as that is the case for the other large cities (e.g. Plovdiv, Varna). Trams and trolleybuses occupy the second and third place, as trams are used only in the capital and are not subject of road transport category. Bus transport remains the preferred method of public and for long-distance transportation as well. Average public transport speed for buses in Sofia is 19.4 km/h (Krzywkowska 2004), and for trolleybuses – 14.4 km/h (MottMacDonald 2009). These numbers vary back in the years as shows (Breshkov, 2005).

Table 84 Average operational speed (km/h)

Vehicle type/ Year	2009	2006	2002	1995	1989
Trolleybus	14.4		14	14	14
Urban bus	19.4	19.65	18.1	18.1	19.5

Since, bus lines are limited only to some areas, traffic jams frequently impede the free flow not only of private cars, but as well as of buses and trolleys. Nevertheless, the average speed of private cars is expected to be higher and thus making the car one of the most preferred ways of city transport.

Speed values for rural and highway roads depend not only on the vehicle type and purpose of the trip, but also on the road quality. In Bulgaria, there are four classes of road classification: Motorway, Class I, II and III, as the latter represents 60% of the total length and it is characterized with the highest poor quality percentage compared to the other classes. Hence, free flow speed variation in relation to the above mentioned classes is the following (AECOM 2010):

Table 85 Average free flow speed (km/h) per type of road class

Road Class	Average free flow speed (km/h)
Class I	79
Class II	70
Class III	55
Motorway (Highway)	110

Given these data, for the emission calculations average speed was estimated to be 68km/h for rural areas for all types of vehicles (except for mopeds) and 110 km/h for motorway, except for coaches. Whereas inappropriate and/or data was missing, the legal requirement speed limit was applied instead the above mentioned numbers. Moreover, a comparison of road classes for the years 2010-2002 revealed a negligible change in relation to rural speed variation. Therefore, identical value of 68 km/h was used for all years.

Driving share

The density of the Bulgarian road network is similar to the average density for the other EU member states, excluding highways. In terms of high speed roads and motorways the country lags far behind – 3.8 km/1000 km^2 compared to Austria - 19 km/1000 km^2 in Slovenia - 14 km/1000 km^2, and in Lithuania - 6 km/1000 km^2 (MRDPW 2010).

Due to lack of data for Bulgaria on mileage split between urban, rural and highway driving, literature survey of driving cycles (André, 2006) based on information from 80 representative European private cars in France, the UK, Germany and Greece was performed. Additionally, comparison of road statistics for Slovakia and Bulgaria shows a number of similarities related to road classes' ratio, length of network, geography and GDP trends. Taking into account the mentioned surveys, the driving share split for Slovakia was adopted. Where necessary data gaps for some years and categories were filled in by extrapolating the existing values.

Vehicle fleet

Corresponding to the COPERT methodology, detailed knowledge of the structure of the vehicle fleet is required in order to accurately estimate the emissions. Main sources of data on vehicle stock and classifications are National Statistical Institute and Ministry of Internal affairs. However, apart from the total numbers for the main vehicle categories, only partial data considering distribution into fuel, weight, technology classes and age was provided for this submission as well. Regardless of the data gaps, for this submission a country specific vehicle fleet matrix was developed, as described below (FCCC/ARR/2013/BGR).

Data regarding the total number of vehicle types by age is represented in 6 ranges from: 1 to more than 20 years old vehicles. This data is available for the period 2005 – 2014. Thus, new technology split for each vehicle category is proposed base on the age structure and EURO standard year of entry. This approach is applied to populate the vehicle numbers by sector and technology for the period 2005-2014. Additionally, data on vehicles by brand and expert judgment was used to estimate the full time series back to 1988.

Regarding the subsector, new split by fuel and engine volume has been introduced. National data on vehicle type per fuel type for the period 2005 – 2014 is applied in a model to generate the required subsector split. There are more than 10 vehicle categories by fuel (including bi-fuel combinations) according to national data, among which hybrids as well. In that case a conservative approach has been applied to apportion the vehicle numbers to the relevant COPERT vehicle groups. The resulting allocation by vehicle category is combined with data on engine volume extracted from TRACCS EU project. Since TRACCS provide data for 2005 to 2010, data gaps for the remaining years were fulfilled by extrapolation and expert judgement. Finally, total numbers for the national vehicle fleet were distributed in accordance with COPERT categories following the previously generated split by fuel, engine and EURO standard.

Mopeds classification to 2-sroke and 4-stroke engines is another area of change in COPERT 4, version 10.1. It is assumed, based on expert judgement, that 4-stroke mopeds are very rare and applicable for the matrix of some countries (e.g. Italy). Thus, this subsector is considered irrelevant in the current matrix.

Mileage

As only basic information on mileage per urban buses, coaches and heavy duty vehicles (>6t) was obtained from the National Statistics Institute, mileage for 2005 was estimated from the average for 16 European countries that provided such data (Ntziachristos et al. 2008). However, the average EU15 mileage data may lead to overestimations of emissions. A recommendation by Ntziachristos et al. (2008) to adjust the mileage values in order to better match the statistical fuel consumption (actual fuel sold) was followed. This was performed in relation to the fact that CO_2 emissions are calculated on the basis of fuel consumption (Ntziachristos et al., 2008) and that CO_2 emissions from road transport are indicated as a key category. The calibration procedure is aimed to exactly match the statistical with the calculated fuel consumption. The COPERT model run has been performed multiple times. The first run of the model was done with the actual vehicle numbers and mean European mileage per vehicle type. The resulting fuel consumption for each type of fuel was compared with that reported in the energy balance and then the mileage was corrected with an appropriate factor to reconcile the two estimates of fuel consumption. The calibration procedure ensures that CO_2 emission estimates are prepared based on the quantities of fuel sold, according to the IPCC guidelines.

For all other required parameters (e.g. fuel injection, evaporation control, evaporation distribution, slope factor, load factor) were used the default values provided by the COPERT model.

3.3.12.3.4 Emission factors

According to the IPCC guidelines, an emission factor is defined as the average emission rate of a given GHG for a given source, relative to units of activity. Whereas, an implied emission factor (IEF) is defined as emissions divided by the relevant measure of activity:

IEF = Emissions / Activity data

IEF are not equivalent to the emissions factors for emissions calculations. IEF are more as of results providing average values for complex categories such as road transport, where the emissions are dependent on many parameters related to the vehicle fleet distribution.

The emission factors used for the calculations of GHG emissions form road transport subsector are based on the algorithms of COPERT 4, version 11. The emission factors are internal parameters that depend both on the input data (e.g. average trip distance, driving and climatic conditions, etc.) and COPERT algorithms. However, COPERT model uses different emission factors for each vehicle category and technology. Thus, it is only possible to provide the implied emission factors which take into account the calculated emissions of greenhouse gases per fuel by the model related to the reported fuel consumption.

The decrease in the CH_4 implied emission factor (IEF) for gasoline and diesel fuel is a result of the gradual increase in the number of vehicles that meet the standards set out in the EU directive on emissions from motor vehicles (mostly EURO 2 and EURO 3 vehicles), which slowly replaced the older technologies. It has to be noted, that in Bulgaria are mostly sold second hand vehicles, imported from Western Europe, which leads to a delay of the introduction of each new vehicle technology by 4 to 7 years compared to other countries. It is also a bit more complex to model the vehicle distribution matrix, since it is influenced both by the sales of new vehicles and by the imports of second hand vehicles. At the same time there is still a very large number of very old vehicles –the average vehicle age is much higher than in the other European countries.

Table 86 Implied emission factors of CO_2, N_2O and CH_4 by fuel types

Fuel type	Gasoline			Diesel		
Emissions	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Year	t/TJ	kg/TJ	kg/TJ	t/TJ	kg/TJ	kg/TJ
1988	72.05	42.67	2.19	74.60	7.48	2.14
1989	72.04	42.48	2.19	74.60	7.51	2.13
1990	72.04	42.88	2.24	74.61	7.51	2.05
1991	72.04	43.05	2.27	74.61	7.50	1.97
1992	72.01	42.66	3.40	74.62	7.53	1.89
1993	71.98	41.87	4.52	74.62	7.54	1.81
1994	71.95	41.34	5.66	74.63	7.54	1.74
1995	71.92	40.74	6.71	74.63	7.52	1.68
1996	71.87	39.68	7.77	74.63	7.43	1.60
1997	71.83	38.93	8.73	74.63	7.35	1.53

1998	71.79	37.88	9.66	74.64	7.30	1.48
1999	71.75	37.07	10.34	74.64	7.23	1.44
2000	71.69	34.95	10.64	74.64	6.94	1.38
2001	71.64	33.56	11.06	74.64	6.72	1.35
2002	71.59	32.53	11.61	74.64	6.52	1.33
2003	71.54	30.93	12.15	74.64	6.39	1.32
2004	71.48	26.17	4.44	74.65	6.01	1.29
2005	71.43	24.62	4.49	74.64	5.70	1.31
2006	71.37	23.32	4.43	75.42	5.32	1.33
2007	71.25	22.06	4.45	74.65	4.85	1.32
2008	71.21	20.94	4.47	74.66	4.46	1.40
2009	71.17	19.98	3.02	74.66	4.21	1.47
2010	71.13	18.96	2.96	74.67	3.98	1.53
2011	71.10	18.09	2.87	74.67	3.75	1.58
2012	71.07	17.43	2.75	74.67	3.54	1.61
2013	71.85	17.01	2.66	75.16	3.35	1.67
2014	72.30	16.57	2.63	75.12	3.15	1.72

Table 87 Implied emission factors of CO_2, N_2O and CH_4 by fuel types

Fuel type	LPG			CNG		
Emissions	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Year	t/TJ	kg/TJ		t/TJ	kg/TJ	
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	65.98	20.47	0.79	NO	NO	NO
1998	65.98	20.42	0.93	NO	NO	NO
1999	65.98	20.36	1.08	NO	NO	NO
2000	65.98	20.02	1.24	NO	NO	NO
2001	65.98	19.73	1.40	NO	NO	NO
2002	65.97	19.33	1.57	NO	NO	NO
2003	65.97	18.97	1.77	NO	NO	NO
2004	58.08	16.45	1.74	57.20	151.05	0.21
2005	58.08	16.06	1.92	57.16	145.51	0.21
2006	58.08	15.66	2.13	57.10	139.61	0.22
2007	65.96	17.43	2.58	56.25	131.98	0.21
2008	65.96	17.05	2.74	56.61	126.26	0.21
2009	65.96	16.69	2.88	56.50	123.85	0.21
2010	65.96	16.30	3.00	56.48	120.55	0.21
2011	65.96	15.86	3.07	56.48	99.90	0.28
2012	65.95	15.31	2.97	56.42	82.92	0.33
2013	65.95	14.78	2.88	56.54	74.03	0.36
2014	65.95	14.37	2.88	56.60	68.95	0.38

As a result of the ERT recommendation (FCCC/ARR/2014/BGR) to conduct a Tier 2 estimate of CO_2 emissions from gasoline fuel based on country-specific EFs due to introduction of biofuels to road transportation, we adopted the following approach. Biofuels in transport are mostly consumed in the form of biodiesel blended with the diesel (biogasoline consumption started in 2013 in insignificant amounts). Thus, the consumption of biofuels cannot be linked to the decreasing trend of CO_2 IEF for gasoline. Regarding the recommendation to use a Tier 2 approach, we have approached our oil refinery in order to obtain country-specific values for carbon content of the produced liquid fuels, but the producer does not measure this fuel property. Moreover, Bulgaria also imports significant amounts of diesel and gasoline from neighboring countries, which makes the estimate of a country-specific emission factor highly uncertain.

The 2006 IPCC GL do allow the CO_2 emission factors to be adjusted to take account of un-oxidized carbon or carbon emitted as a non-CO_2 gas at higher tiers (Chapter 3.2.1.2). We consider the use of the COPERT model with all available country-specific parameters to effectively produce country-specific emission factors to the extent possible, even though some of the parameters are used with their default values.

During the emission estimates we do ensure that the activity data regarding fuel consumption used in the COPERT model matches exactly the amounts of fuel sold as reported by the national statistics. We believe that using the emission factor from the COPERT model, which is partly based on some default fuel properties according to EMEP/EEA air pollutant emission inventory guidebook is much more relevant than the default IPCC emission factors. The EMEP/EEA emission factors are also higher than the default IPCC factors, which does not lead to underestimate of the emissions from Road transport.

Additionally, the IEF of LPG for the period 2004-2006 is varying as a consequence to fluctuations in NCV provided by national statistics. Up to 2006 Bulgaria used the NCVs for liquid fuels provided by the producers/importers. Since IEA/Eurostat uses average NCVs for all liquid fuels, we were advised to use these values for the latter years, in order to harmonize our statistics with the EU. Previous conversations with our major liquid fuel producer revealed that NCVs are not measured by laboratory tests, since the process is too costly, instead they monitor other relevant characteristics to ensure that they comply with international standards. This was the reason to use the average European NCVs for the years after 2007. Regarding the implications of the NCVs, since the methodology we use adjusts the annual mileage in order to have an exact match with the reported fuel consumption in natural units (Gg) and the calculated fuel consumption by the COPERT model, we believe that the NCV difference does not influence the emission estimates, but only reflects the IEF.

3.3.12.3.5 Uncertainties

The following default uncertainties are assumed (IPCC 2006 GLs, Ch. 3.2.2 Uncertainty Assessment, page 3.29 – 3.30):

			EF CO_2	EF N_2O	EF CH_4
AD	+/-5 %	Motor Gasoline	5% / -3%	244% / -70%	233% / -71%
		Gas / Diesel Oil	1% / -2%	208% / -67%	144% / -59%
		LPG	4% / -2%	200% / -68%	238% / -70%

Except for the above mentioned uncertainty values, the inherited uncertainty of COPERT is associated with model formulation and input data. The main internal parameter is the emission factors, whose uncertainty comes from the experimental data. Information on the vehicle fleet and related data on vehicle movements are the most probable source of uncertainties with respect to inputs. Monte Carlo simulations reveal that 16 and 17 items of total 51 internal parameters and inputs variables are responsible for more than 90% of the total uncertainty in countries with good and poor statistics, respectively. In our case, as a country with relatively poor transport statistics, the most probable factors, according to this research, could be hot and cold-start emission factors, technology distribution, mileage, mean trip distance. Further, coefficient of variation for the following was estimated (Kioutsioukisa et al., 2010):

Parameter	Uncertainty for countries with poor transport statistics (%)
Fuel consumption and CO_2	<10
CH_4	>20
N_2O	>20

3.3.12.3.6 Source-specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, CO_2 emissions, emission factors and IEF (time series)
- Time series consistency
- Plausibility checks of dips and jumps (this is due to the Energy balance)
- Documentation and archiving of all information required in NIR, background documentation and archive.

3.3.12.3.7 Source-specific recalculations

Following a recommendation from FCCC/ARR/2010/BGR §79, a recalculation of the entire time series is undertaken due to implementation of higher tier method and incorporation of model COPERT, version 11 into the national road transport inventory.

Following a recommendation from FCCC/ARR/2010/BGR §76 is continued the allocation of the reported consumption of residual fuel oil in Road and Rail transport categories for the period 1991–1996 to Commercial and public services category.

Regarding recommendation from FCCC/ARR/2011/BGR §70, a detailed review of the activity data and parameters used in the COPERT model was undertaken. We came to the conclusion that the main cause for the decrease of the implied emission factor for gasoline is the gradual increase of EURO-standard vehicles (mostly Euro 2 and Euro 3) introduced in the country, which replaced the older Pre-ECE and ECE vehicles. As the CH_4 EF of the Pre-ECE and ECE vehicles is 5 times higher than the EURO vehicles, a significant drop in the IEF is observed. This is also the reason the generally stable downwards trend in the IEF.

For the 2015 submission a detailed investigation of the country specific parameters used in the COPERT model concerning the vehicle fleet and vehicle split was performed. As a result, a new vehicle distribution matrix was developed, which represents in a better way the national circumstances compared to the vehicle distribution matrix of Slovenia, which was previously used.

3.3.12.3.8 Source-specific planned improvements

No specific improvements are planned for the Road transport category.

3.3.12.4 Railways (CRF 1.A.3.c)

3.3.12.4.1 Source category description

GHG emissions from the Railways sector is not defined as a key source category. The main emission source is the use of gas-diesel oil.

3.3.12.4.2 Emission trend

Fuel consumption from Railway transport constitute 0.5% of the total Transport sector and thus, as a category does not contribute significantly to the total emissions from the Transport sector in Bulgaria. Railways related GHG emissions are quite low in Bulgaria, due to the decreased transport of passengers and freight and the fact that most of the locomotives in use are electricity-powered. A clear downwards trend of the GHG emissions in recent years is shown in following figures.

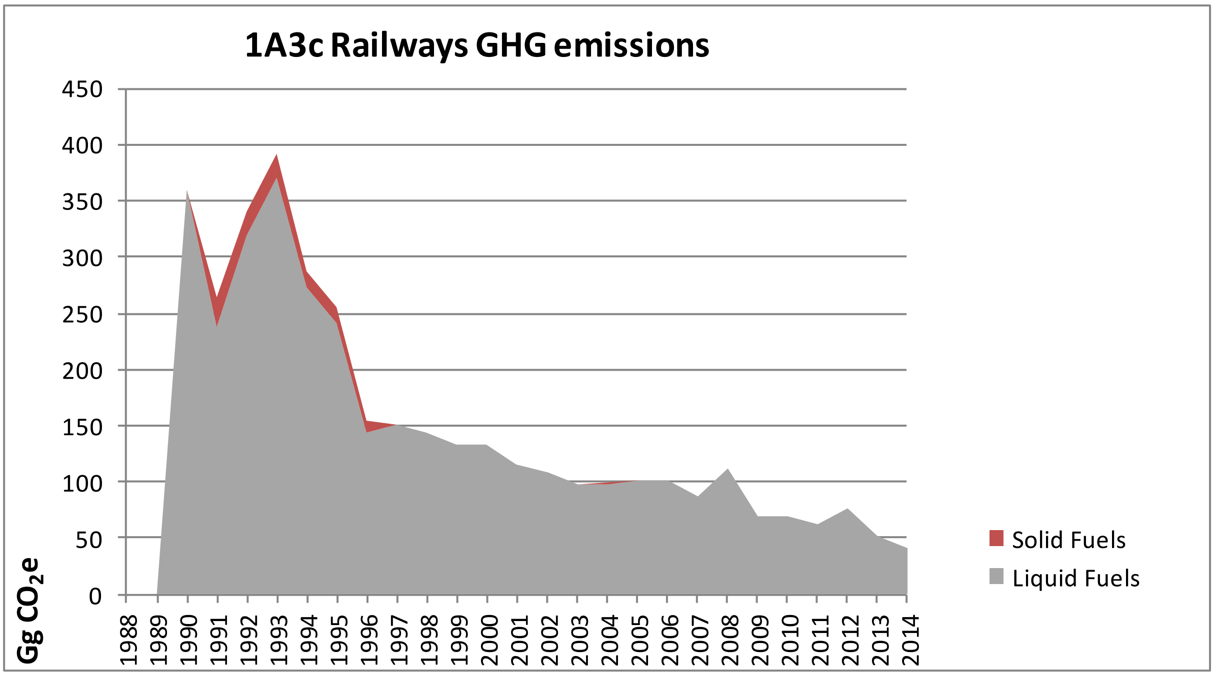

Figure 44 GHG emissions in CRF 1.A.3.c Railway transport (1988 - 2014)

As it can be observed from the figure above, emissions from Railway transport decreased steeply since 1993 with 89% to 2014. The emissions are mainly due to the consumption of liquid fuels (gas-diesel oil). As for the years 1988-1989, there are no quantities for fuels consumed in the Railways category reported, the data entries are marked as NO. However, it is assumed that the relevant quantities are reported under CRF 1.A.5 Other.

3.3.12.4.3 Methods

Following the recommendations of ERT set out in FCCC/ARR/2010/BGR §75 the emissions from Railway are calculated based on Revised 2006 IPCC GL and Tier 1 approach has been applied.

Equation 3.4.1 (GENERAL METHOD FOR EMISSIONS FROM LOCOMOTIVES) has been applied:

$$Emissions = \Sigma(Fuel_j \bullet EF_j)$$

Where:

Emissions = emissions (kg)

Fuel j = fuel type j consumed (as represented by fuel sold) in (TJ)

EF j = emission factor for fuel type j, (kg/TJ)

j = fuel type

For Tier 1, emissions are estimated using fuel-specific default emission factors, assuming that for each fuel type the total fuel is consumed by a single locomotive type.

3.3.12.4.4 Activity data

Fuel consumption (liquid and solid) is obtained from Eurostat Energy balance and converted into energy units using country-specific NCV. The energy balance provides activity data for consumption of residual fuel oil both in railways and road transport in the period 1991 – 1996. This is an improbable allocation and following the recommendations of ERT set out in FCCC/ARR/2010/BGR §76, quantities of this fuel reported under railways and road transport have been allocated to subcategory 1A4a Stationary combustion in Commercial/Institutional, as this fuel should have been used for heating purposes.

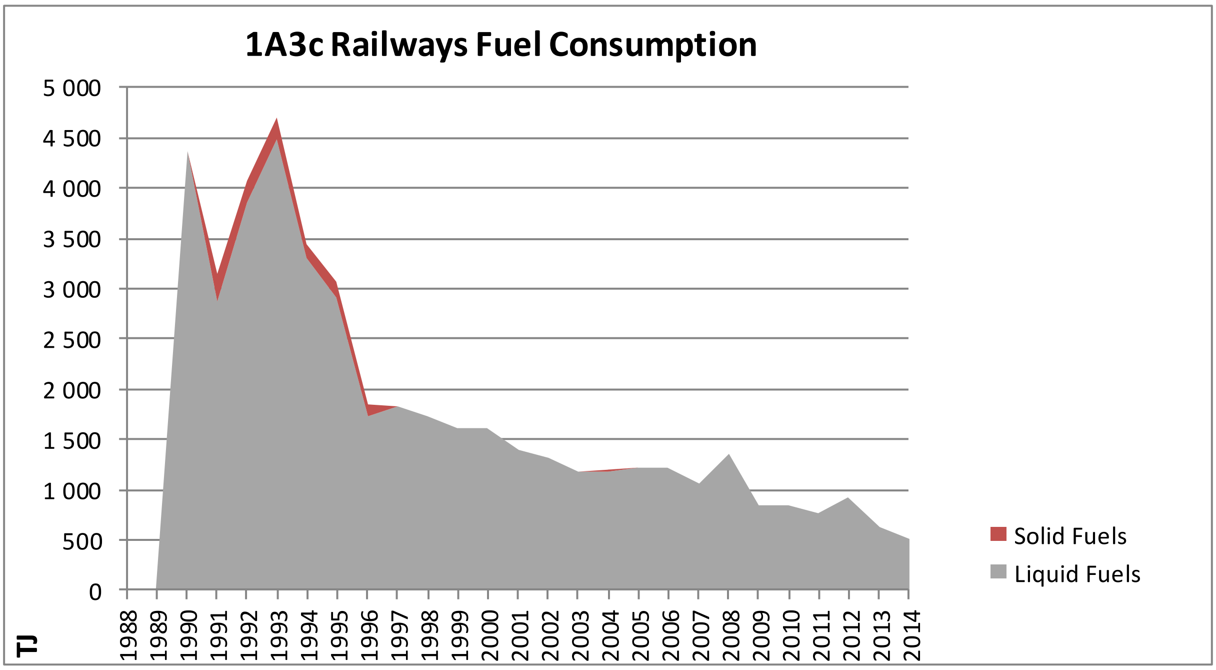

Figure 45 Fuel consumption in CRF 1.A.3.c Railway transport (1988 - 2014)

Table 88 Activity data for Gas-Diesel Oil, emissions and emission factors for subcategory 1A3c Railways

	Gas-Diesel Oil			EF* CO_2	CO_2 emission	EF* N_2O	N_2O emission	EF* CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	0	NO	42.6	74.10	NO	0.0286	NO	0.00415	NO
1989	0	NO	42.6	74.10	NO	0.0286	NO	0.00415	NO
1990	103	4 357	42.3	74.10	323	0.0286	0.125	0.00415	0.018
1991	68	2 876	42.3	74.10	213	0.0286	0.082	0.00415	0.012
1992	91	3 849	42.3	74.10	285	0.0286	0.110	0.00415	0.016
1993	106	4 484	42.3	74.10	332	0.0286	0.128	0.00415	0.019
1994	78	3 299	42.3	74.10	244	0.0286	0.094	0.00415	0.014
1995	69	2 919	42.3	74.10	216	0.0286	0.083	0.00415	0.012
1996	41	1 734	42.3	74.10	129	0.0286	0.050	0.00415	0.007
1997	43	1 819	42.3	74.10	135	0.0286	0.052	0.00415	0.008
1998	41	1 734	42.3	74.10	129	0.0286	0.050	0.00415	0.007
1999	38	1 607	42.3	74.10	119	0.0286	0.046	0.00415	0.007
2000	38	1 607	42.3	74.10	119	0.0286	0.046	0.00415	0.007
2001	33	1 396	42.3	74.10	103	0.0286	0.040	0.00415	0.006
2002	31	1 311	42.3	74.10	97	0.0286	0.038	0.00415	0.005
2003	28	1 184	42.3	74.10	88	0.0286	0.034	0.00415	0.005
2004	28	1 184	42.3	74.10	88	0.0286	0.034	0.00415	0.005
2005	29	1 227	42.3	74.10	91	0.0286	0.035	0.00415	0.005
2006	29	1 214	41.9	74.10	90	0.0286	0.035	0.00415	0.005
2007	25	1 058	42.3	74.10	78	0.0286	0.030	0.00415	0.004
2008	32	1 354	42.3	74.10	100	0.0286	0.039	0.00415	0.006
2009	20	846	42.3	74.10	63	0.0286	0.024	0.00415	0.004
2010	20	846	42.3	74.10	63	0.0286	0.024	0.00415	0.004
2011	18	761	42.3	74.10	56	0.0286	0.022	0.00415	0.003
2012	22	931	42.3	74.10	69	0.0286	0.027	0.00415	0.004
2013	15	630	42.0	74.10	47	0.0286	0.018	0.00415	0.003
2014	12	504	42.0	74.10	37	0.0286	0.014	0.00415	0.002

** 2006 IPCC Guidelines, Vol. 2, Ch. 3, Table 3.4.1*

3.3.12.4.5 Emission factors

The 2006 IPCC GL default GHG EFs for liquid and solid fuels have been applied.

3.3.12.4.6 Uncertainties

The following default uncertainties are assumed (2006 IPCC GL, Ch. 3.4.1.6 Uncertainty Assessment, page 3.45 – 3.46):

	EF CO_2	EF N_2O	EF CH_4
Diesel	1.5%	58%	60%
AD	+/-5 %		

3.3.12.4.7 Source-specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.

- Check of methodology, CO_2 emissions, emission factors and IEF (time series)
- Time series consistency
- Plausibility checks of dips and jumps (due to the Energy balance)
- Documentation and archiving of all information required in NIR, Background documentation and archive.

3.3.12.4.8 Source-specific recalculations

Following a recommendation made by FCCC/ARR/2013/BGR emissions from residual fuel oil in the railways subcategory are reallocated to the category commercial/institutional for the entire time series.

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

3.3.12.5.1 Source category description

GHG emissions from navigation are not defined as key source.

In Bulgaria navigation is used mostly for transportation of freights. However, the consumption patterns are unstable since 2000, as it can be observed from the figures below.

The previous assumption regarding residual fuel oil and gas/diesel oil consumed by navigation and marine transport was that it was reported in the industry sector, since there were some discussions regarding erroneously allocated fuel quantities. In addition, in the earlier years NSI reported in the energy balances all quantities of fuels loaded on Bulgarian ships regardless on the port the fuel was loaded on. This explains the large quantities reported for the years before 1997. Recently, it was clarified by the NSI that the marine vessels do not load at our ports because of the low fuel quality and higher prices.

Currently cargo is predominantly transported on international routes. Very limited amounts are transported within Bulgaria and this usually happens as part of an international route. Still, there is high uncertainty how the loading of fuel is accounted in this particular scenario – it is assumed that the logistic companies mainly prefer to load outside of Bulgaria – either in Romania or on their way to other countries.

3.3.12.5.2 Emission trend

Navigation is a very minor source of emissions for Bulgaria.

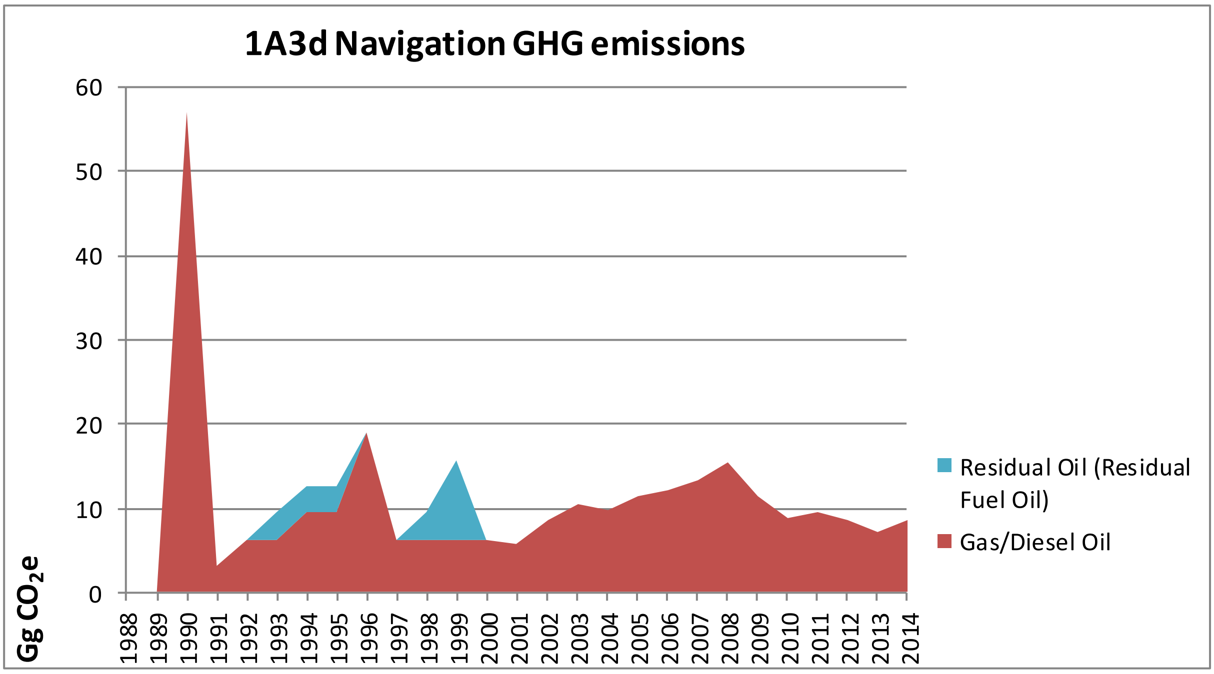

Figure 46 GHG emissions in CRF 1.A.3.d Navigation (1988 - 2014)

3.3.12.5.3 Methods

The 2006 IPCC Guidelines Tier 1 approach has been applied (Equation 3.5.1. Water-Borne Navigation Equation)

$$Emissions = \Sigma(Fuel\ Consumed_{ab} \bullet Emission\ Factor_{ab})$$

Where:

a = fuel type (diesel, gasoline, LPG, bunker, etc.)

b = water-borne navigation type (i.e., ship or boat, and possibly engine type.) (Only at Tier 2 is the fuel used differentiated by type of vessel so b can be ignored at Tier 1)

3.3.12.5.4 Activity data

Considering the fuel consumption fluctuations described above, in order to avoid underestimation of the emissions from navigation, the amount of fuel consumed is calculated based on the cargo transported inland (domestic transport of goods) for the period 2001-2014. Data on transported cargo inland is obtained from the National Statistics Institute (NSI) and Danube Commission (DC). Data on transported goods for previous years (1988 – 2000) is not available, thus the reported quantities of fuels sold are used for the emission estimates.

Average distance is calculated as 205 km based on the distance between western and eastern Bulgarian ports. Further, distance in tonne kilometers travelled goods (tkm) is derived from the average distance and weight of domestic goods transported.

Fuel economy for barge operation (kg/tkm) estimated as average European data from Ecoinvent 2.2 database is applied to calculate the tonnes of fuel consumed.

Table 89 Data on transported goods and fuel consumed for transportation

Year	Transported goods (DC)	Transported goods (NSI)	Transported goods (domestic)	Average distance	Distance	Fuel economy	Fuel consumed
Unit	1000t			km	tkm	kg diesel/tkm	t
2001	950	-	950	205	194647500	0.00939	1828
2002	1402	-	1402	205	287410000	0.00939	2699
2003	1731	-	1731	205	354855000	0.00939	3332
2004	1621	-	1621	205	332202500	0.00939	3119
2005	1741	1875	1875	205	384375000	0.00939	3609
2006	1001	2000	2000	205	410000000	0.00939	3850
2007	1130	2203	2203	205	451615000	0.00939	4241
2008	1392	2543	2543	205	521315000	0.00939	4895
2009	842	1864	1864	205	382120000	0.00939	3588
2010	390	1434	1434	205	293970000	0.00939	2760
2011	390	1563	1563	205	320415000	0.00939	3009
2012	-	1407	1407	205	288435000	0.00939	2708
2013	-	1190	1190	205	243950000	0.00939	2291
2014	-	1431	1431	205	293355000	0.00939	2755

3.3.12.5.5 Emission factors

The 2006 IPCC Guidelines default GHG EFs for Gas-Diesel Oil and Residual Fuel Oil have been applied (assuming an oxidation factor of 1). The emission factors are provided in the following tables:

Table 90 Activity data, emissions and emission factors for subcategory 1A3d Navigation

	Gas-Diesel Oil			EF* CO_2	CO_2 emission	EF* N_2O	N_2O emission	EF* CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	NO	NO	42.60	74.10	NO	0.002	NO	0.007	NO
1989	NO	NO	42.60	74.10	NO	0.002	NO	0.007	NO
1990	18	761.4	42.30	74.10	56.4	0.002	0.0015	0.007	0.0053
1991	1	42.3	42.30	74.10	3.1	0.002	0.0001	0.007	0.0003
1992	2	84.6	42.30	74.10	6.3	0.002	0.0002	0.007	0.0006
1993	2	84.6	42.30	74.10	6.3	0.002	0.0002	0.007	0.0006
1994	3	126.9	42.30	74.10	9.4	0.002	0.0003	0.007	0.0009
1995	3	126.9	42.30	74.10	9.4	0.002	0.0003	0.007	0.0009
1996	6	253.8	42.30	74.10	18.8	0.002	0.0005	0.007	0.0018
1997	2	84.6	42.30	74.10	6.3	0.002	0.0002	0.007	0.0006
1998	2	84.6	42.30	74.10	6.3	0.002	0.0002	0.007	0.0006

	Gas-Diesel Oil			EF* CO_2	CO_2 emission	EF* N_2O	N_2O emission	EF* CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1999	2	84.6	42.30	74.10	6.3	0.002	0.0002	0.007	0.0006
2000	2	84.6	42.30	74.10	6.3	0.002	0.0002	0.007	0.0006
2001	2	77.3	42.30	74.10	5.7	0.002	0.0002	0.007	0.0005
2002	3	114.2	42.30	74.10	8.5	0.002	0.0002	0.007	0.0008
2003	3	140.9	42.30	74.10	10.4	0.002	0.0003	0.007	0.0010
2004	3	131.9	42.30	74.10	9.8	0.002	0.0003	0.007	0.0009
2005	4	152.7	42.30	74.10	11.3	0.002	0.0003	0.007	0.0011
2006	4	161.2	41.87	74.10	11.9	0.002	0.0003	0.007	0.0011
2007	4	179.4	42.30	74.10	13.3	0.002	0.0004	0.007	0.0013
2008	5	207.1	42.30	74.10	15.3	0.002	0.0004	0.007	0.0014
2009	4	151.8	42.30	74.10	11.2	0.002	0.0003	0.007	0.0011
2010	3	116.8	42.30	74.10	8.7	0.002	0.0002	0.007	0.0008
2011	3	127.3	42.30	74.10	9.4	0.002	0.0003	0.007	0.0009
2012	3	114.6	42.30	74.10	8.5	0.002	0.0002	0.007	0.0008
2013	2	96.3	42.03	74.10	7.1	0.002	0.0002	0.007	0.0007
2014	3	115.8	42.05	74.10	8.6	0.002	0.0002	0.007	0.0008

Table 91 Activity data, emissions and emission factors for subcategory 1A3d Navigation

	Residual Fuel Oil			EF* CO_2	CO_2 emission	EF* N_2O	N_2O emission	EF* CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
1989	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
1990	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
1991	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
1992	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
1993	1	40	40	77.40	3.1	0.002	0.0001	0.007	0.0003
1994	1	40	40	77.40	3.1	0.002	0.0001	0.007	0.0003
1995	1	40	40	77.40	3.1	0.002	0.0001	0.007	0.0003
1996	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
1997	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
1998	1	40	40	77.40	3.1	0.002	0.0001	0.007	0.0003
1999	3	120	40	77.40	9.3	0.002	0.0002	0.007	0.0008
2000	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2001	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2002	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2003	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2004	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2005	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2006	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2007	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2008	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2009	NO	NO	40	77.40	NO	0.002	NO	0.007	NO

2010	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2011	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2012	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2013	NO	NO	40	77.40	NO	0.002	NO	0.007	NO
2014	NO	NO	40	77.40	NO	0.002	NO	0.007	NO

For N_2O *and* CH_4 *the default values from table 3.5.3 IPCC 2006 GL have been used.*

3.3.12.5.6 Uncertainties

The following default uncertainties are assumed (2006 IPCC GL, Ch. 3.5.1.7 Uncertainty Assessment, page 3.54):

	EF CO_2	EF N_2O	EF CH_4
Diesel	± -1.5%	-40%/+140%	±50%
Residual Fuel Oil	± -3%		
AD	+/-50%		

3.3.12.5.7 Source-specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, CO_2 emissions, emission factors and IEF (time series)
- Time series consistency
- Plausibility checks of dips and jumps (this is due to the Energy balance at this stage not possible / see trend description)
- Documentation and archiving of all information required in NIR, Background documentation and archive.

3.3.12.5.8 Source-specific planned improvements

No specific improvements for this subcategory are planned.

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

3.3.12.6.1 Source category description

The category (1.A.3.e) includes emissions from all remaining transport activities including pipeline transportation, related to the operation of compressor stations and maintenance of pipelines. This is a key category for 2014, mainly because of the significant volume of natural gas consumed for pipeline transport.

3.3.12.6.2 Emission trend

Some small quantities of liquid fuels are reported at the beginning of the time series, but in general natural gas remains the main source of emissions from this subcategory. Data regarding the consumption is provided in the Energy balance.

Table 92 Activity data, emissions and emission factors for gas-diesel oil

	Gas-Diesel Oil			EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1989	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1990	42	1 777	42.30	74.10	131.65	28.6	0.051	4.15	0.0074
1991	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1992	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1993	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1994	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1995	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1996	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1997	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1998	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
1999	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2000	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2001	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2002	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2003	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2004	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2005	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2006	NO	NO	41.87	74.10	NO	28.6	NO	4.15	NO
2007	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2008	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2009	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2010	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2011	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2012	NO	NO	42.30	74.10	NO	28.6	NO	4.15	NO
2013	NO	NO	42.03	74.10	NO	28.6	NO	4.15	NO
2014	NO	NO	42.05	74.10	NO	28.6	NO	5.15	NO

Table 93 Activity data, emissions and emission factors for residual fuel oil

	Residual fuel oil			EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	NO	NO	40.00	77.40	NO	2	NO	7	NO
1989	NO	NO	40.00	77.40	NO	2	NO	7	NO
1990	NO	NO	40.00	77.40	NO	2	NO	7	NO
1991	NO	NO	40.00	77.40	NO	2	NO	7	NO
1992	NO	NO	40.00	77.40	NO	2	NO	7	NO
1993	1	40	40.00	77.40	3.1	2	0.0001	7	0.0003
1994	1	40	40.00	77.40	3.1	2	0.0001	7	0.0003
1995	1	40	40.00	77.40	3.1	2	0.0001	7	0.0003
1996	1	40	40.00	77.40	3.1	2	0.0001	7	0.0003
1997	NO	NO	40.00	77.40	NO	2	NO	7	NO

	Residual fuel oil			EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	Gg	TJ	NCV GJ/t	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1998	NO	NO	40.00	77.40	NO	2	NO	7	NO
1999	2	80	40.00	77.40	6.2	2	0.0002	7	0.0006
2000	NO	NO	40.00	77.40	NO	2	NO	7	NO
2001	NO	NO	40.00	77.40	NO	2	NO	7	NO
2002	NO	NO	40.00	77.40	NO	2	NO	7	NO
2003	NO	NO	40.00	77.40	NO	2	NO	7	NO
2004	NO	NO	40.00	77.40	NO	2	NO	7	NO
2005	NO	NO	40.00	77.40	NO	2	NO	7	NO
2006	NO	NO	39.77	77.40	NO	2	NO	7	NO
2007	NO	NO	40.00	77.40	NO	2	NO	7	NO
2008	NO	NO	40.00	77.40	NO	2	NO	7	NO
2009	NO	NO	40.00	77.40	NO	2	NO	7	NO
2010	NO	NO	40.00	77.40	NO	2	NO	7	NO
2011	NO	NO	40.00	77.40	NO	2	NO	7	NO
2012	NO	NO	40.00	77.40	NO	2	NO	7	NO
2013	NO	NO	40.00	77.40	NO	2	NO	7	NO
2014	NO	NO	40.00	77.40	NO	2	NO	7	NO

Table 94 Activity data, emissions and emission factors for natural gas

	Natural gas	EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	TJ	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
1988	NO	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO	NO
1997	471.6	55.20	26.0	0.10	0.000	1.0	0.000
1998	3718.8	55.20	205.3	0.10	0.000	1.0	0.004
1999	3215.7	55.20	177.5	0.10	0.000	1.0	0.003
2000	6886.8	55.20	380.2	0.10	0.001	1.0	0.007
2001	5777.1	55.20	318.9	0.10	0.001	1.0	0.006
2002	5821.2	55.20	321.4	0.10	0.001	1.0	0.006
2003	3664.8	55.20	202.3	0.10	0.000	1.0	0.004
2004	5631.3	55.20	310.9	0.10	0.001	1.0	0.006
2005	9042.3	55.20	499.2	0.10	0.001	1.0	0.009
2006	9538.2	55.20	526.6	0.10	0.001	1.0	0.010
2007	10973.7	55.18	605.6	0.10	0.001	1.0	0.011
2008	10808.1	55.18	596.3	0.10	0.001	1.0	0.011

	Natural gas	EF CO_2	CO_2 emission	EF N_2O	N_2O emission	EF CH_4	CH_4 emission
	TJ	t/TJ	Gg	kg/TJ	Gg	kg/TJ	Gg
2009	5845.5	55.24	322.9	0.10	0.001	1.0	0.006
2010	5895.9	55.24	325.7	0.10	0.001	1.0	0.006
2011	8527.5	55.26	471.3	0.10	0.001	1.0	0.009
2012	8518.5	55.20	470.2	0.10	0.001	1.0	0.009
2013	7607.7	55.37	421.2	0.10	0.001	1.0	0.008
2014	7031.7	55.43	389.8	0.10	0.001	1.0	0.007

3.3.12.6.3 Methods

The 2006 IPCC Guidelines Tier 2 approach has been applied for gaseous fuels, Tier 1 for liquid fuels.

3.3.12.6.4 Activity data

The National energy balances have been used to obtain the fuel consumption and net calorific values.

3.3.12.6.5 Emission factors

The default EFs from the 2006 IPCC Guidelines for Gas-Diesel Oil and Residual Fuel Oil has been applied. For the calculation of pipeline transport emissions are used the country-specific emission factors.

3.3.12.6.6 Uncertainties

Greenhouse gas emissions from other transport sources are typically much smaller than those from road transportation, but activities in this category are diverse and are thus typically associated with higher uncertainties because of the additional uncertainty in activity data.

The types of equipment and their operating conditions are typically more diverse than that for road transportation, and this may give rise to a larger variation in emission factors and thus to larger uncertainties. However, the uncertainty estimate is likely to be dominated by the activity data for natural gas, and so it is reasonable to assume as a default that the values for gaseous fuels apply.

Uncertainty in activity data is determined by the accuracy of the surveys or bottom-up models on which the estimates of fuel usage by off-road source and fuel type are based. This will be very case-specific, but factor of 2 uncertainties are certainly possible, unless if there is evidence to the contrary from the survey design.

The following default uncertainties are assumed based on the lower and higher values of the EFs (2006 IPCC GL, Ch. 3, Table 3.2.2 Uncertainty Assessment):

AD	+/-5 %		EF CO_2	EF N_2O	EF CH_4
		Natural gas	1% / -2%	208% / -67%	144% /-59%

3.3.12.6.7 Source specific QA/QC and verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, CO_2 emissions, emission factors and IEF (time series)
- Time series consistency
- Plausibility checks of dips and jumps (this is due to the Energy balance at this stage not possible / see trend description)
- Documentation and archiving of all information required in NIR, background documentation and archive.

There are some variations of the IEF for liquid fuels for some of the years - for 1990 the value is lower (74.10 t/TJ) than the rest of the time series (77.40 t/TJ). This is due to the fuel mix in this category - some quantities of Gas/Diesel Oil reported as Not elsewhere specified (Transport) in the National Energy Balance, which has an EF of 74.1 t/TJ. For the period 1993-1996 and 1999 the value of the IEF (77.4 t/TJ) is higher than the rest of the time series. This is due to some quantities of Residual Fuel Oil reported as Not elsewhere specified (Transport) in the National Energy Balance, which has an EF of 77.4 t/TJ.

3.3.13 OTHER SECTORS (CRF 1.A.4)

Other sectors include the following subcategories:

- Commercial / Institutional (1.A.4.a);
- Residential (1.A.4.b);
- Agriculture / Forestry / Fisheries (1.A.4.c);

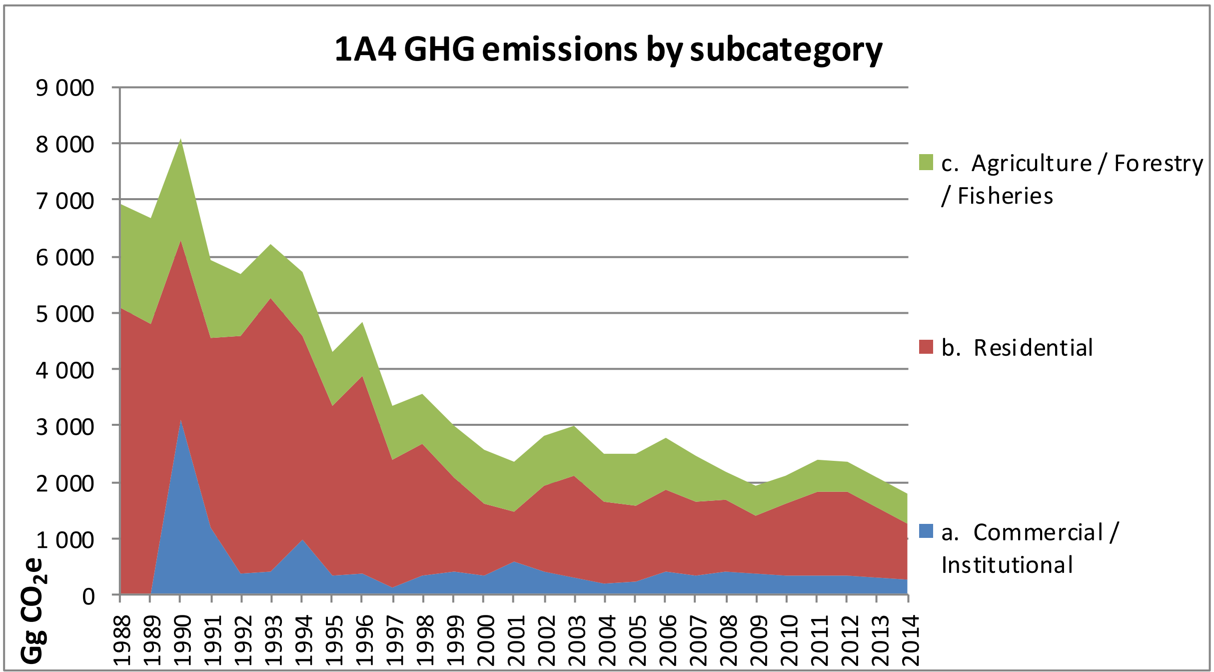

Figure 47 Total GHG emissions from 1.A.4 Other Sectors

The general trend in CRF category 1.A.4 is a decrease of 74.4% compared to base year and a decrease of 14.8% compared to last year.

3.3.13.1 Commercial/Institutional (CRF 1.A.4.a.)

Category 1.A.4.a. Commercial/Institutional covers emissions from fuel combustion in the commercial and Institutional sectors.

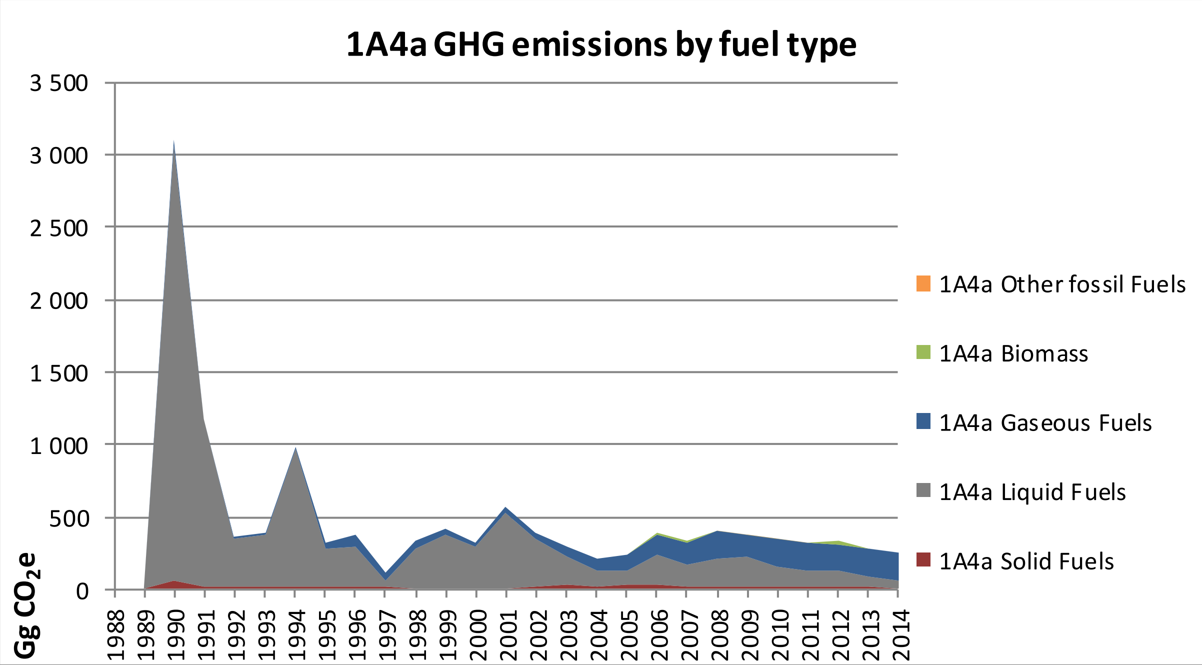

Figure 48 GHG emissions from CRF 1.A.4.a. Commercial/Institutional

The share of this subcategory from sector 1.A is 0.6% for 2014, while the share from the total GHG emissions is 0.4%.

For the years before 1990 no consumption is reported in this subcategory, instead it is reported under category 1.A.5.

Table 95 CO_2 emissions in CRF 1.A.4.a. Commercial/Institutional

CO_2 (Gg)	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	3 084.74	2 985.60	60.19	38.95	NO	NO
1991	1 167.83	1 140.88	21.54	5.42	4.4800	NO
1992	353.74	325.37	22.26	6.11	18.8160	NO
1993	387.22	362.17	17.00	8.05	12.8800	NO
1994	971.04	950.30	12.30	8.45	13.6640	NO
1995	320.92	268.64	14.32	37.96	13.3280	NO
1996	368.31	278.35	17.12	72.84	12.5440	NO
1997	109.46	52.79	12.30	44.37	NO	NO
1998	329.75	278.00	5.24	46.50	NO	NO
1999	416.41	374.71	4.64	37.06	63.9520	NO
2000	318.86	290.54	NO	28.32	45.4720	NO
2001	568.83	528.29	NO	40.54	NO	NO
2002	388.92	331.44	11.42	46.06	NO	NO
2003	288.10	196.70	26.61	64.79	60.7040	NO
2004	206.10	115.10	18.67	72.34	NO	NO
2005	230.79	105.40	24.68	100.71	63.5040	NO
2006	381.09	206.74	25.25	149.10	85.3440	NO

CO_2 (Gg)	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2007	324.12	149.88	12.09	162.16	70.0000	NO
2008	400.91	190.55	22.76	187.61	99.5680	NO
2009	375.00	203.32	18.97	152.72	70.5516	NO
2010	342.37	139.62	17.40	185.35	50.7290	NO
2011	318.57	108.01	19.52	191.04	52.1136	NO
2012	310.23	106.73	14.77	188.73	231.2226	NO
2013	273.25	73.15	19.31	180.78	129.5672	NO
2014	248.56	45.84	9.69	193.03	28.5838	NO
Decrease 1988-2014	-	-	-	-	-	-
Decrease 1990-2014	91.9%	98.5%	83.9%	-395.6%	-	-
Decrease 2013-2014	9.0%	37.3%	49.8%	-6.8%	77.9%	-

Table 96 CH_4 emissions in CRF 1.A.4.a. Commercial/Institutional

CH_4 (Gg)	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	0.4072	0.3977	0.0060	0.0035	NO	NO
1991	0.1642	0.1496	0.0022	0.0005	0.0120	NO
1992	0.0968	0.0436	0.0023	0.0006	0.0504	NO
1993	0.0851	0.0482	0.0017	0.0007	0.0345	NO
1994	0.1627	0.1241	0.0012	0.0008	0.0366	NO
1995	0.0764	0.0358	0.0015	0.0034	0.0357	NO
1996	0.0792	0.0373	0.0017	0.0066	0.0336	NO
1997	0.0121	0.0069	0.0012	0.0040	NO	NO
1998	0.0418	0.0370	0.0005	0.0042	NO	NO
1999	0.2250	0.0499	0.0005	0.0034	0.1713	NO
2000	0.1631	0.0387	NO	0.0026	0.1218	NO
2001	0.0741	0.0704	NO	0.0037	NO	NO
2002	0.0496	0.0443	0.0011	0.0042	NO	NO
2003	0.1973	0.0261	0.0027	0.0059	0.1626	NO
2004	0.0234	0.0149	0.0019	0.0066	NO	NO
2005	0.1957	0.0140	0.0025	0.0091	0.1701	NO
2006	0.2718	0.0271	0.0026	0.0135	0.2286	NO
2007	0.2234	0.0200	0.0012	0.0147	0.1875	NO
2008	0.2904	0.0254	0.0023	0.0170	0.2457	NO
2009	0.2131	0.0272	0.0019	0.0138	0.1701	NO
2010	0.1570	0.0179	0.0018	0.0168	0.1205	NO
2011	0.1584	0.0135	0.0020	0.0173	0.1257	NO
2012	0.6382	0.0124	0.0015	0.0171	0.6072	NO
2013	0.3602	0.0085	0.0020	0.0163	0.3334	NO
2014	0.0881	0.0054	0.0010	0.0174	0.0643	NO
Decrease 1988-2014	-	-	-	-	-	-
Decrease 1990-2014	78.4%	98.6%	83.3%	-393.5%	-	-
Decrease 2013-2014	75.5%	36.9%	50.1%	-6.6%	80.7%	-

Table 97 N_2O emissions in CRF 1.A.4.a. Commercial/Institutional

N_2O (Gg)	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	0.0248	0.0238	0.0009	0.0001	NO	NO
1991	0.0095	0.0090	0.0003	0.0000	0.0002	NO
1992	0.0036	0.0026	0.0003	0.0000	0.0007	NO
1993	0.0036	0.0029	0.0003	0.0000	0.0005	NO
1994	0.0081	0.0074	0.0002	0.0000	0.0005	NO
1995	0.0029	0.0021	0.0002	0.0001	0.0005	NO
1996	0.0031	0.0022	0.0003	0.0001	0.0004	NO
1997	0.0007	0.0004	0.0002	0.0001	NO	NO
1998	0.0024	0.0022	0.0001	0.0001	NO	NO
1999	0.0054	0.0030	0.0001	0.0001	0.0023	NO
2000	0.0040	0.0023	NO	0.0001	0.0016	NO
2001	0.0043	0.0042	NO	0.0001	NO	NO
2002	0.0029	0.0026	0.0002	0.0001	NO	NO
2003	0.0042	0.0016	0.0004	0.0001	0.0022	NO
2004	0.0013	0.0009	0.0003	0.0001	NO	NO
2005	0.0037	0.0008	0.0004	0.0002	0.0023	NO
2006	0.0053	0.0016	0.0004	0.0003	0.0030	NO
2007	0.0042	0.0012	0.0002	0.0003	0.0025	NO
2008	0.0051	0.0015	0.0003	0.0003	0.0029	NO
2009	0.0042	0.0016	0.0003	0.0003	0.0020	NO
2010	0.0031	0.0010	0.0003	0.0003	0.0015	NO
2011	0.0030	0.0008	0.0003	0.0003	0.0016	NO
2012	0.0091	0.0006	0.0002	0.0003	0.0079	NO
2013	0.0053	0.0004	0.0003	0.0003	0.0042	NO
2014	0.0015	0.0003	0.0001	0.0003	0.0007	NO
Decrease 1988-2014	-	-	-	-	-	-
Decrease 1990-2014	94.0%	98.8%	83.3%	-393.5%	-	-
Decrease 2013-2014	72.1%	36.8%	50.1%	-6.6%	83.3%	-

Table 98 GHG emissions in CRF 1.A.4.a. Commercial/Institutional

GHG (Gg)	TJ	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	NO	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO	NO
1990	41 122.92	3 102.32	3 002.65	60.61	39.06	NO	NO
1991	15 313.66	1 174.76	1 147.30	21.69	5.43	0.3477	NO
1992	4 867.14	357.24	327.24	22.42	6.13	1.4603	NO
1993	5 271.79	390.42	364.23	17.12	8.07	0.9996	NO
1994	12 832.11	977.53	955.61	12.39	8.47	1.0604	NO
1995	4 534.36	323.70	270.17	14.42	38.06	1.0343	NO
1996	5 332.80	371.21	279.95	17.25	73.04	0.9735	NO
1997	1 615.93	109.96	53.08	12.39	44.49	NO	NO
1998	4 620.85	331.50	279.59	5.28	46.63	NO	NO
1999	6 295.98	423.65	376.84	4.67	37.17	4.9631	NO

GHG (Gg)	TJ	CRF 1.A.4.a.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2000	4 812.90	324.13	292.20	NO	28.40	3.5290	NO
2001	7 868.00	571.96	531.30	NO	40.66	NO	NO
2002	5 400.48	391.02	333.34	11.50	46.19	NO	NO
2003	4 620.54	294.30	197.82	26.80	64.97	4.7111	NO
2004	3 046.52	207.07	115.73	18.80	72.54	NO	NO
2005	4 042.48	236.78	106.00	24.86	100.99	4.9284	NO
2006	6 430.04	389.47	207.90	25.43	149.52	6.6233	NO
2007	5 681.36	330.95	150.73	12.17	162.61	5.4325	NO
2008	7 061.22	409.70	191.64	22.92	188.14	7.0144	NO
2009	6 313.79	381.57	204.48	19.10	153.15	4.8399	NO
2010	5 916.11	347.22	140.38	17.53	185.86	3.4478	NO
2011	5 636.14	323.42	108.57	19.66	191.57	3.6121	NO
2012	7 130.77	328.90	107.23	14.88	189.26	17.5332	NO
2013	5 664.80	283.84	73.50	19.45	181.29	9.5991	NO
2014	4 501.61	251.20	46.06	9.76	193.57	1.8189	NO
Decrease 1988-2014	-	-	-	-	-	-	-
Decrease 1990-2014	89.1%	91.9%	98.5%	83.9%	-395.5%	-	-
Decrease 2013-2014	20.5%	11.5%	37.3%	49.8%	-6.8%	81.1%	-

3.3.13.2 Residential (CRF 1.A.4.b.)

Category 1.A.4.b. Residential covers emissions from fuel combustion in the residential sector.

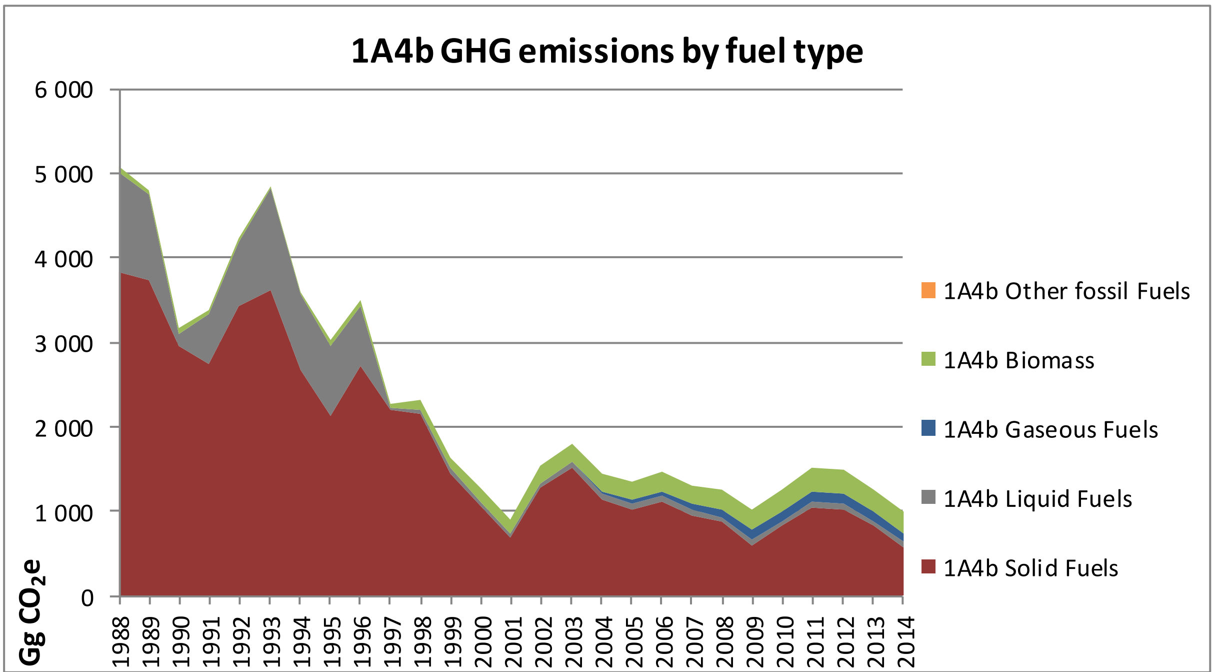

Figure 49 GHG emissions from CRF 1.A.4.b. Residential

The share of this subcategory from sector 1.A is 2.4% for 2014, while the share from the total GHG emissions is 1.8%. The emissions from this category decreased by 80.1% compared to base year. There are two separate trends contributing to this decrease – at the beginning of the period due to economic reasons occurred a transition from liquid fuels, which were previously used for heating, to electricity. Some social groups also drastically reduced the energy for heating due to their very low income. The second trend is the increase of the use of biomass – in 2014 was used 4 times more biomass by the residential sector compared to 1988. This trend is also complimented by the increasing gasification of the households, although by a much smaller extent.

Table 99 CO_2 emissions in CRF 1.A.4.b. Residential

CO_2 (Gg)	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	4 715.89	1 167.81	3 548.08	NO	889.3920	NO
1989	4 463.53	1 003.57	3 459.96	NO	850.7520	NO
1990	2 891.37	157.69	2 733.68	NO	808.7520	NO
1991	3 134.09	600.51	2 533.58	NO	469.2800	NO
1992	3 937.16	752.93	3 184.24	NO	480.1440	NO
1993	4 544.51	1 194.07	3 350.43	NO	440.4960	NO
1994	3 358.21	892.83	2 465.38	NO	506.5760	NO
1995	2 801.77	825.89	1 975.88	NO	674.9120	NO
1996	3 224.71	704.57	2 520.14	NO	805.3920	NO
1997	2 055.40	20.32	2 035.09	NO	741.6640	NO
1998	2 042.34	39.12	2 003.22	NO	1 581.6640	NO
1999	1 400.03	50.50	1 349.53	NO	1 604.4000	NO
2000	1 034.19	44.47	989.28	0.45	2 292.0800	NO
2001	685.05	47.14	636.07	1.84	2 212.7840	NO
2002	1 235.82	52.94	1 179.95	2.93	2 667.1680	NO
2003	1 482.11	67.46	1 407.50	7.15	2 752.7360	NO
2004	1 145.27	75.25	1 056.71	13.32	2 880.6400	NO
2005	1 055.70	69.04	954.11	32.54	2 812.4320	NO
2006	1 155.68	75.44	1 023.70	56.54	2 977.7440	NO
2007	1 022.59	66.99	879.91	75.69	2 846.4800	NO
2008	960.09	61.19	809.02	89.88	2 998.1280	NO
2009	745.24	70.13	557.64	117.47	3 062.6400	NO
2010	939.08	61.42	763.56	114.10	3 334.1280	NO
2011	1 166.33	72.80	964.07	129.46	3 502.6880	NO
2012	1 137.61	66.99	947.11	123.50	3 557.9040	NO
2013	933.84	63.86	765.79	104.19	3 515.2320	NO
2014	699.19	64.09	530.23	104.87	3 438.6240	NO
Decrease 1988-2014	85.2%	94.5%	85.1%	-	-286.6%	-
Decrease 1990-2014	75.8%	59.4%	80.6%	-	-325.2%	-
Decrease 2013-2014	25.1%	-0.4%	30.8%	-0.7%	2.2%	-

Table 100 CH_4 emissions in CRF 1.A.4.b. Residential

CH_4 (Gg)	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	13.2877	0.1332	10.7722	NO	2.3823	NO
1989	12.9080	0.1101	10.5191	NO	2.2788	NO
1990	10.4734	0.0134	8.2936	NO	2.1663	NO
1991	9.1018	0.0615	7.7833	NO	1.2570	NO
1992	11.1487	0.0977	9.7649	NO	1.2861	NO

CH_4 (Gg)	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1993	11.6203	0.1545	10.2859	NO	1.1799	NO
1994	9.0406	0.1114	7.5722	NO	1.3569	NO
1995	7.9831	0.1016	6.0737	NO	1.8078	NO
1996	9.9921	0.0859	7.7490	NO	2.1573	NO
1997	8.1727	0.0016	6.1844	NO	1.9866	NO
1998	10.3468	0.0041	6.1060	NO	4.2366	NO
1999	8.4039	0.0049	4.1015	NO	4.2975	NO
2000	9.1482	0.0042	3.0045	0.0000	6.1395	NO
2001	7.8613	0.0043	1.9298	0.0002	5.9271	NO
2002	10.7387	0.0047	3.5895	0.0003	7.1442	NO
2003	11.6622	0.0059	4.2822	0.0006	7.3734	NO
2004	10.9704	0.0065	3.2467	0.0012	7.7160	NO
2005	10.4843	0.0056	2.9424	0.0029	7.5333	NO
2006	11.1394	0.0063	3.1519	0.0051	7.9761	NO
2007	10.3166	0.0055	2.6797	0.0069	7.6245	NO
2008	10.5372	0.0050	2.4933	0.0081	8.0307	NO
2009	9.9417	0.0059	1.7217	0.0106	8.2035	NO
2010	11.3488	0.0052	2.4026	0.0103	8.9307	NO
2011	12.3939	0.0059	2.9941	0.0117	9.3822	NO
2012	12.4494	0.0055	2.9026	0.0112	9.5301	NO
2013	11.8037	0.0051	2.3735	0.0094	9.4158	NO
2014	10.8808	0.0053	1.6555	0.0095	9.2106	NO
Decrease 1988-2014	18.1%	96.1%	84.6%	-	-286.6%	-
Decrease 1990-2014	-3.9%	60.9%	80.0%	-	-325.2%	-
Decrease 2013-2014	7.8%	-3.8%	30.3%	-0.5%	2.2%	-

Table 101 N_2O emissions in CRF 1.A.4.b. Residential

N_2O (Gg)	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0921	0.0064	0.0539	NO	0.0318	NO
1989	0.0880	0.0050	0.0526	NO	0.0304	NO
1990	0.0707	0.0004	0.0415	NO	0.0289	NO
1991	0.0582	0.0025	0.0389	NO	0.0168	NO
1992	0.0716	0.0056	0.0488	NO	0.0171	NO
1993	0.0761	0.0089	0.0514	NO	0.0157	NO
1994	0.0621	0.0062	0.0379	NO	0.0181	NO
1995	0.0600	0.0055	0.0304	NO	0.0241	NO
1996	0.0721	0.0046	0.0387	NO	0.0288	NO
1997	0.0574	0.0000	0.0309	NO	0.0265	NO
1998	0.0872	0.0002	0.0305	NO	0.0565	NO
1999	0.0780	0.0002	0.0205	NO	0.0573	NO
2000	0.0970	0.0002	0.0150	0.0000	0.0819	NO
2001	0.0888	0.0001	0.0096	0.0000	0.0790	NO
2002	0.1134	0.0001	0.0179	0.0000	0.0953	NO
2003	0.1199	0.0002	0.0214	0.0000	0.0983	NO
2004	0.1193	0.0002	0.0162	0.0000	0.1029	NO
2005	0.1153	0.0001	0.0147	0.0001	0.1004	NO

N_2O (Gg)	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2006	0.1224	0.0002	0.0158	0.0001	0.1063	NO
2007	0.1153	0.0001	0.0134	0.0001	0.1017	NO
2008	0.1198	0.0001	0.0125	0.0002	0.1071	NO
2009	0.1184	0.0002	0.0086	0.0002	0.1094	NO
2010	0.1314	0.0001	0.0120	0.0002	0.1191	NO
2011	0.1404	0.0001	0.0150	0.0002	0.1251	NO
2012	0.1419	0.0001	0.0145	0.0002	0.1271	NO
2013	0.1377	0.0001	0.0119	0.0002	0.1255	NO
2014	0.1314	0.0001	0.0083	0.0002	0.1228	NO
Decrease 1988-2014	-42.7%	98.1%	84.6%	-	-286.6%	-
Decrease 1990-2014	-85.8%	65.6%	80.0%	-	-325.2%	-
Decrease 2013-2014	4.6%	-20.5%	30.3%	-0.5%	2.2%	-

Table 102 GHG emissions in CRF 1.A.4.b. Residential

GHG (Gg)	TJ	CRF 1.A.4.b.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	61 036.20	5 075.52	1 173.06	3 833.43	NO	69.0232	NO
1989	57 574.80	4 812.46	1 007.83	3 738.61	NO	66.0244	NO
1990	37 335.50	3 174.28	158.13	2 953.38	NO	62.7649	NO
1991	39 201.46	3 378.98	602.79	2 739.76	NO	36.4195	NO
1992	47 162.73	4 237.22	757.05	3 442.91	NO	37.2626	NO
1993	54 614.84	4 857.68	1 200.59	3 622.91	NO	34.1856	NO
1994	42 196.30	3 602.73	897.45	2 665.97	NO	39.3139	NO
1995	37 833.80	3 019.23	830.07	2 136.77	NO	52.3780	NO
1996	42 918.43	3 496.01	708.10	2 725.41	NO	62.5042	NO
1997	27 558.82	2 276.84	20.37	2 198.91	NO	57.5584	NO
1998	35 051.27	2 327.00	39.28	2 164.97	NO	122.7484	NO
1999	28 760.27	1 633.37	50.68	1 458.18	NO	124.5129	NO
2000	31 163.18	1 291.81	44.62	1 068.86	0.45	177.8818	NO
2001	26 947.85	908.05	47.28	687.19	1.84	171.7278	NO
2002	36 649.13	1 538.07	53.10	1 275.03	2.94	206.9913	NO
2003	40 028.66	1 809.39	67.65	1 520.93	7.17	213.6320	NO
2004	37 954.10	1 455.09	75.46	1 142.72	13.35	223.5582	NO
2005	36 595.41	1 352.18	69.22	1 032.06	32.63	218.2648	NO
2006	39 298.38	1 470.63	75.65	1 107.19	56.70	231.0942	NO
2007	36 773.38	1 314.87	67.17	950.89	75.90	220.9072	NO
2008	37 671.27	1 259.23	61.35	875.07	90.13	232.6761	NO
2009	36 307.24	1 029.05	70.32	603.25	117.80	237.6827	NO
2010	40 801.64	1 261.97	61.59	827.21	114.42	258.7521	NO
2011	44 743.19	1 518.03	72.99	1 043.38	129.83	271.8336	NO
2012	44 734.15	1 491.14	67.17	1 024.00	123.85	276.1188	NO
2013	42 191.49	1 269.96	64.01	828.66	104.48	272.8071	NO
2014	39 120.33	1 010.36	64.26	574.08	105.16	266.8618	NO
Decrease 1988-2014	35.9%	80.1%	94.5%	85.0%	-	-286.6%	-
Decrease 1990-2014	-4.8%	68.2%	59.4%	80.6%	-	-325.2%	-
Decrease 2013-2014	7.3%	20.4%	-0.4%	30.7%	-0.7%	2.2%	-

3.3.13.3 Agriculture/Forestry/Fisheries (CRF 1.A.4.c.)

Category 1.A.4.c. Agriculture/Forestry/Fisheries covers emissions from fuel combustion in the agriculture, forestry and fisheries sectors.

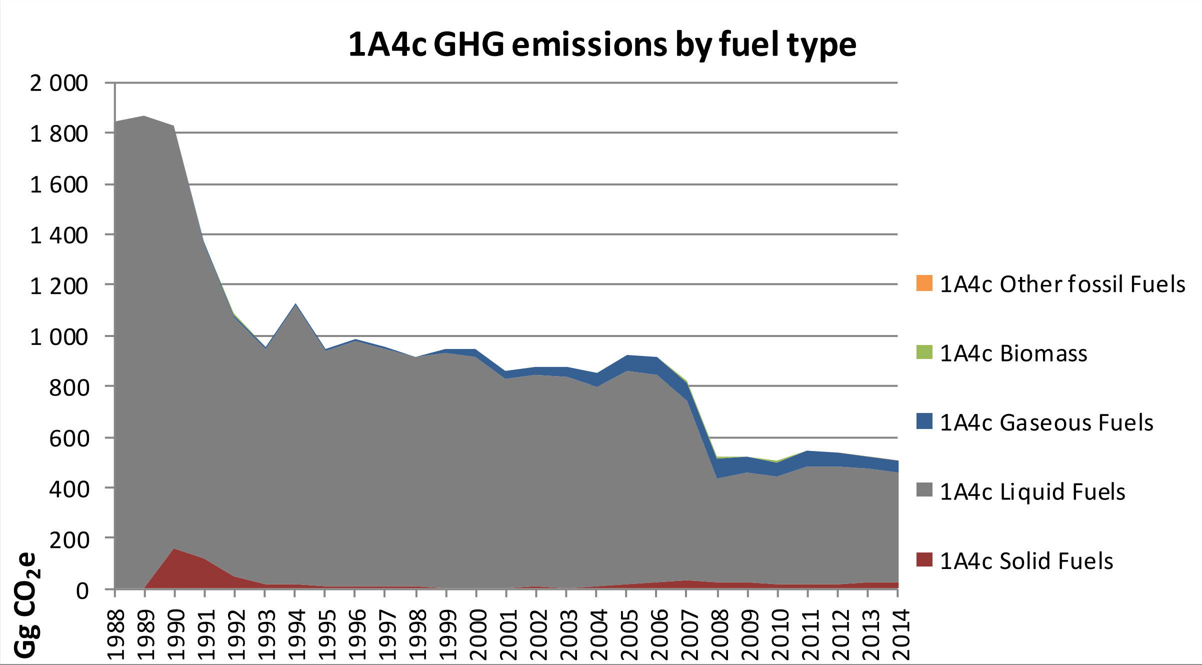

Figure 50 GHG emissions from CRF 1.A.4.c. Agriculture/Forestry/Fisheries

The share of this subcategory from sector 1.A is 1.2% for 2014, while the share from the total GHG emissions is 0.9%.

Table 103 CO_2 emissions in CRF 1.A.4.c. Agriculture/Forestry/Fisheries

CO_2 (Gg)	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	1 657.25	1 657.25	NO	NO,IE	NO,IE	NO
1989	1 682.50	1 682.50	NO	NO,IE	NO,IE	NO
1990	1 652.94	1 498.15	151.51	3.28	NO,IE	NO
1991	1 235.54	1 115.86	113.57	6.11	16.8000	NO
1992	981.76	924.04	47.83	9.89	32.2560	NO
1993	868.29	845.53	15.36	7.40	4.3680	NO
1994	1 034.38	1 009.77	16.06	8.55	17.2480	NO
1995	862.92	845.22	9.20	8.50	4.1440	NO
1996	889.75	871.06	10.14	8.55	10.3040	NO
1997	863.73	848.55	11.91	3.28	25.0880	NO
1998	830.26	820.64	6.34	3.28	4.7040	NO
1999	857.41	839.18	4.82	13.41	52.8640	NO
2000	860.24	826.57	3.86	29.81	68.4320	NO
2001	784.77	748.40	3.18	33.19	7.2800	NO
2002	795.07	751.69	8.71	34.68	11.3120	NO
2003	797.73	754.51	4.81	38.41	14.7840	NO
2004	774.02	713.45	10.88	49.68	15.9040	NO
2005	841.02	760.55	19.11	61.36	24.8640	NO
2006	834.12	735.47	24.67	73.98	14.1120	NO
2007	743.66	635.56	33.16	74.95	10.9760	NO
2008	475.64	368.90	26.50	80.25	10.0800	NO
2009	474.49	393.60	20.84	60.05	17.1360	NO

CO_2 (Gg)	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2010	457.08	384.40	16.00	56.68	15.6800	NO
2011	498.91	415.76	19.39	63.76	16.8000	NO
2012	487.23	417.36	17.76	52.11	18.7040	NO
2013	475.53	401.03	27.06	47.44	25.8720	NO
2014	462.21	388.93	23.94	49.34	32.2560	NO
Decrease 1988-2014	72.1%	76.5%	-	-	-	-
Decrease 1990-2014	72.0%	74.0%	84.2%	-1404.7%	-	-
Decrease 2013-2014	2.8%	3.0%	11.5%	-4.0%	-24.7%	-

Table 104 CH_4 emissions in CRF 1.A.4.c. Agriculture/Forestry/Fisheries

CH_4 (Gg)	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.0987	0.0987	NO	NO,IE	NO,IE	NO
1989	0.1002	0.1002	NO	NO,IE	NO,IE	NO
1990	0.5499	0.0897	0.4599	0.0003	NO,IE	NO
1991	0.4599	0.0664	0.3479	0.0006	0.0450	NO
1992	0.2926	0.0585	0.1468	0.0009	0.0864	NO
1993	0.1143	0.0547	0.0473	0.0007	0.0117	NO
1994	0.1715	0.0750	0.0495	0.0008	0.0462	NO
1995	0.0965	0.0564	0.0283	0.0008	0.0111	NO
1996	0.1132	0.0536	0.0312	0.0008	0.0276	NO
1997	0.1592	0.0555	0.0362	0.0003	0.0672	NO
1998	0.0842	0.0521	0.0193	0.0003	0.0126	NO
1999	0.2120	0.0547	0.0145	0.0012	0.1416	NO
2000	0.2513	0.0537	0.0117	0.0027	0.1833	NO
2001	0.0793	0.0474	0.0094	0.0030	0.0195	NO
2002	0.1056	0.0467	0.0255	0.0031	0.0303	NO
2003	0.1046	0.0471	0.0144	0.0035	0.0396	NO
2004	0.1263	0.0455	0.0337	0.0045	0.0426	NO
2005	0.1798	0.0486	0.0591	0.0056	0.0666	NO
2006	0.1657	0.0446	0.0766	0.0067	0.0378	NO
2007	0.1749	0.0376	0.1012	0.0068	0.0294	NO
2008	0.1385	0.0225	0.0818	0.0073	0.0270	NO
2009	0.1385	0.0231	0.0640	0.0054	0.0459	NO
2010	0.1194	0.0222	0.0501	0.0051	0.0420	NO
2011	0.1355	0.0242	0.0605	0.0058	0.0450	NO
2012	0.1340	0.0243	0.0550	0.0047	0.0501	NO
2013	0.1812	0.0236	0.0840	0.0043	0.0693	NO
2014	0.1887	0.0230	0.0748	0.0045	0.0864	NO
Decrease 1988-2014	-91.2%	76.7%	-	-	-	-
Decrease 1990-2014	65.7%	74.4%	83.7%	-1398.5%	-	-
Decrease 2013-2014	-4.1%	2.6%	10.9%	-3.9%	-24.7%	-

Table 105 N_2O emissions in CRF 1.A.4.c. Agriculture/Forestry/Fisheries

N_2O (Gg)	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	0.6116	0.6116	NO	NO,IE	NO,IE	NO
1989	0.6210	0.6210	NO	NO,IE	NO,IE	NO
1990	0.5530	0.5507	0.0023	0.0000	NO,IE	NO
1991	0.4142	0.4118	0.0017	0.0000	0.0006	NO
1992	0.3250	0.3231	0.0007	0.0000	0.0012	NO
1993	0.2901	0.2897	0.0002	0.0000	0.0002	NO
1994	0.2964	0.2955	0.0002	0.0000	0.0006	NO
1995	0.2809	0.2806	0.0001	0.0000	0.0001	NO
1996	0.3131	0.3125	0.0002	0.0000	0.0004	NO
1997	0.2885	0.2874	0.0002	0.0000	0.0009	NO
1998	0.2864	0.2861	0.0001	0.0000	0.0002	NO
1999	0.2871	0.2851	0.0001	0.0000	0.0019	NO
2000	0.2840	0.2814	0.0001	0.0001	0.0024	NO
2001	0.2610	0.2607	0.0000	0.0001	0.0003	NO
2002	0.2672	0.2666	0.0001	0.0001	0.0004	NO
2003	0.2661	0.2654	0.0001	0.0001	0.0005	NO
2004	0.2481	0.2473	0.0002	0.0001	0.0006	NO
2005	0.2618	0.2605	0.0003	0.0001	0.0009	NO
2006	0.2660	0.2650	0.0004	0.0001	0.0005	NO
2007	0.2347	0.2337	0.0005	0.0001	0.0004	NO
2008	0.1317	0.1308	0.0004	0.0001	0.0004	NO
2009	0.1438	0.1428	0.0003	0.0001	0.0006	NO
2010	0.1436	0.1426	0.0003	0.0001	0.0006	NO
2011	0.1546	0.1536	0.0003	0.0001	0.0006	NO
2012	0.1563	0.1553	0.0003	0.0001	0.0007	NO
2013	0.1493	0.1478	0.0004	0.0001	0.0009	NO
2014	0.1436	0.1420	0.0004	0.0001	0.0012	NO
Decrease 1988-2014	76.5%	76.8%	-	-	-	-
Decrease 1990-2014	74.0%	74.2%	83.7%	-1398.5%	-	-
Decrease 2013-2014	3.8%	3.9%	10.9%	-3.9%	-24.7%	-

Table 106 GHG emissions in CRF 1.A.4.c. Agriculture/Forestry/Fisheries

GHG (Gg)	TJ	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
1988	22 365.00	1 841.98	1 841.98	NO	NO	NO	NO
1989	22 705.80	1 870.05	1 870.05	NO	NO	NO	NO
1990	21 815.07	1 831.48	1 664.50	163.70	3.29	NO	NO
1991	16 479.06	1 370.46	1 240.24	122.79	6.13	1.3038	NO
1992	13 398.16	1 085.93	1 021.80	51.72	9.91	2.5033	NO
1993	11 705.68	957.60	933.22	16.61	7.42	0.3390	NO
1994	13 978.14	1 126.98	1 099.70	17.37	8.57	1.3386	NO
1995	11 641.80	949.05	930.25	9.95	8.52	0.3216	NO
1996	12 091.92	985.88	965.54	10.97	8.57	0.7997	NO
1997	11 814.54	953.69	935.59	12.87	3.29	1.9470	NO
1998	11 213.70	917.71	907.20	6.85	3.29	0.3651	NO
1999	12 049.00	948.27	925.51	5.20	13.45	4.1026	NO

GHG (Gg)	TJ	CRF 1.A.4.c.	Liquid Fuels	Solid Fuels	Gaseous Fuels	Biomass	Other Fuels
2000	12 319.45	951.15	911.78	4.17	29.89	5.3108	NO
2001	10 781.05	864.54	827.26	3.43	33.28	0.5650	NO
2002	10 949.05	877.34	832.31	9.38	34.78	0.8779	NO
2003	11 052.14	879.64	834.79	5.19	38.51	1.1473	NO
2004	10 754.06	851.10	788.27	11.77	49.82	1.2343	NO
2005	11 781.97	923.52	839.38	20.68	61.53	1.9296	NO
2006	11 648.14	917.53	815.55	26.70	74.19	1.0952	NO
2007	10 371.47	817.98	706.14	35.83	75.16	0.8518	NO
2008	6 805.18	518.36	408.44	28.66	80.47	0.7823	NO
2009	6 797.71	520.82	436.73	22.53	60.22	1.3299	NO
2010	6 540.96	502.85	427.47	17.33	56.84	1.2169	NO
2011	7 136.82	548.37	462.13	21.00	63.94	1.3038	NO
2012	6 940.35	537.17	464.25	19.22	52.26	1.4516	NO
2013	6 793.46	524.53	445.67	29.28	47.57	2.0079	NO
2014	6 696.76	509.73	431.83	25.92	49.48	2.5033	NO
Decrease 1988-2014	70.1%	72.3%	76.6%	-	-	-	-
Decrease 1990-2014	69.3%	72.2%	74.1%	84.2%	-1404.7%	-	-
Decrease 2013-2014	1.4%	2.8%	3.1%	11.5%	-4.0%	-24.7%	-

3.4 FUGITIVE EMISSIONS FROM SOLID FUELS AND OIL AND NATURAL GAS (CRF 1.B)

Fugitive emissions from fuels are responsible for 1.8% of total GHG emissions for 2014. The fugitive emissions from gas and oil have a share of approx. 0.4% of total GHG emissions, while the fugitive emissions from solid fuels are approx. 1.5% of total GHG emissions.

3.4.1 COAL MINING (CRF 1.B.1)

This category includes fugitive methane emissions from coal mining and handling activities in underground and surface mines as well as emissions from solid fuel transformation.

The coal mining in Bulgaria is being carried out by both surface mining and underground mining. The main domestic solid fuels are lignite and sub-bituminous coal and they are mined mostly by surface mining in the Maritza Iztok mining complex. At the beginning of the time series the quantities of coal produced trough underground mining were equal to about 12% of the total production of coal, but since many of the mines were subsequently closed down, the percentage dropped down to about 2% in 2014. The annual production amounts to 31.3 million tons in 2014, of which 472 thousand tons were produced by underground mining.

Solid fuel transformation is also a source of fugitive emissions, although the IPCC guidelines are not very explicit regarding this subcategory. In Bulgaria until 2008 the operation of coke ovens was a source of fugitive emissions, while the annual amount of coking coal was varying between 1.4 Mt at the beginning of the time series and 434 kt at the end. For the 2014 submission was identified an additional source of fugitive emissions – charcoal production and the emissions were estimated for the full time series. The indigenous production of charcoal decreases from 18 kt at the beginning of the time series to 6 kt in 2014. The activity data and the emission estimates are presented in Table 107.

3.4.2 EXTRACTION, REFINING, TRANSPORTATION AND DISTRIBUTION OF OIL AND NATURAL GAS (CRF 1.B.2)

Unlike fugitive emissions from coal mining, the emissions from Oil and Gas are a lot more complex because of the various sources involved and different types of activity data. The emission estimates for this category cover methane, carbon dioxide and nitrous oxide fugitive emissions from exploration, production and processing, refining and storage, transport, transmission and distribution of oil and natural gas.

The trends of methane fugitive emissions from oil and gas systems are presented in Table 108 and Table 109.

The natural gas consumption was reduced almost twice in 2014, compared to 1988, due to the collapse of the industrial sector (mainly in fertilizer production and iron & steel industries), which decline had not been compensated by the increasing gas consumption of commercial and residential sectors in the latest years.

Natural gas production in Bulgaria peaked in the interval 2005-2006, following the development of the new field (Galata), which was expended in 2009. Since 2010 there are new fields which are developed (Kaliakra and Kavarna), which have again increased the domestic production of natural gas and are expected to be developed until 2017. As a requirement from the National Statistics Institute, due to the limited number of oil and natural gas production companies in the country, the indigenous production data is notated as confidential and not presented in this report.

The CH_4 and CO_2 fugitive emissions from the transmission and distribution gas networks in the industry and households are estimated based on the quantity of natural gas sold. This is a change from the previously used approach, which was based on the length of the network. In general, the distribution network length is growing steadily due to the increasing gasification of municipalities in Bulgaria, while the transmission network stays constant.

The production of crude oil in Bulgaria is in very small amounts equal to 0.5% of the total consumption in 2014, with only one production company. Generally, there is a decreasing trend in the local production of crude oil.

Table 107 Activity data and CH_4 emissions from CRF 1.B.1 Coal mining and Handling

Year	1.B.1.a Coal Mining and Handling						1.B.1.b Solid Fuel Transformation			
	i. Underground Mines			ii. Surface Mines			Coking coal		Charcoal	
	AD	Post-mining emissions	Mining emissions	AD	Post-mining emissions	Mining emissions	AD	Emissions	AD	Emissions
	kt	Gg	Gg	kt	Gg	Gg	kt	Gg	kt	Gg
1988	4098	6.86	49.42	30049	2.01	24.16	1400	0.07	18	0.48
1989	4116	6.89	49.64	30182	2.02	24.27	1208	0.06	19	0.48
1990	3848	6.45	46.41	27827	1.86	22.37	1854	0.09	20	0.52
1991	3159	5.29	38.10	25231	1.69	20.29	1004	0.05	21	0.54
1992	3589	6.01	43.28	26735	1.79	21.49	1161	0.06	23	0.59
1993	3682	6.17	44.40	25350	1.70	20.38	1295	0.06	23	0.59
1994	3328	5.57	40.14	25429	1.70	20.44	1519	0.07	21	0.54
1995	3381	5.66	40.77	27449	1.84	22.07	1693	0.08	20	0.52
1996	3198	5.36	38.57	28104	1.88	22.60	1491	0.07	21	0.54
1997	2779	4.65	33.51	26929	1.80	21.65	1656	0.08	21	0.55
1998	1970	3.30	23.76	28141	1.89	22.63	1189	0.06	3	0.08
1999	1458	2.44	17.58	23840	1.60	19.17	1090	0.05	3	0.08
2000	1621	2.72	19.55	24811	1.66	19.95	1325	0.06	8	0.21
2001	1248	2.09	15.05	25363	1.70	20.39	1148	0.06	21	0.55
2002	1354	2.27	16.33	24664	1.65	19.83	1072	0.05	25	0.65
2003	1560	2.61	18.81	25739	1.72	20.69	1188	0.06	25	0.65
2004	383	0.64	4.62	26102	1.75	20.99	1174	0.06	24	0.62
2005	585	0.98	7.06	24110	1.62	19.38	1051	0.05	24	0.62
2006	161	0.27	1.94	25517	1.71	20.52	947	0.05	43	1.12
2007	475	0.80	5.73	27978	1.87	22.49	751	0.04	25	0.65
2008	556	0.93	6.71	28233	1.89	22.70	434	0.02	17	0.44
2009	698	1.17	8.42	26488	1.77	21.30	0	0.00	16	0.42
2010	744	1.25	8.97	28649	1.92	23.03	0	0.00	17	0.44
2011	872	1.46	10.52	36250	2.43	29.15	0	0.00	16	0.42
2012	688	1.15	8.30	32732	2.19	26.32	0	0.00	4	0.10
2013	550	0.92	6.63	28071	1.88	22.57	0	0.00	5	0.13
2014	472	0.79	5.69	30796	2.06	24.76	0	0.00	6	0.16

Table 108 Activity data from oil and gas

Year	1. B. 2. a. Oil			1. B. 2. b. Natural Gas					1. B. 2. c. Venting and Flaring			
									1. B. 2. c. 1 Venting		1. B. 2. c. 2 Flaring	
	1. Exploration	2. Production	4. Refining / Storage	2. Production / Processing	4. Transmission		5. Distribution		i. Oil	ii. Gas	i. Oil	ii. Gas
	10^3m^3	10^3m^3	10^3m^3	10^6m^3	10^6m^3	km	10^6m^3	km	10^3m^3	10^6m^3	10^3m^3	10^6m^3
1988	C	C	15319.3	C	6442.2	1234	6152.2	50	C	C	C	C
1989	C	C	15319.3	C	8633.1	1350	6333.2	50	C	C	C	C
1990	C	C	9666.7	C	8789.5	1469	6717.0	50	C	C	C	C
1991	C	C	5249.4	C	8633.1	1619	5661.0	50	C	C	C	C
1992	C	C	2935.9	C	8372.2	1644	5012.0	50	C	C	C	C
1993	C	C	6637.5	C	8554.8	1769	4670.0	50	C	C	C	C
1994	C	C	8110.7	C	8580.9	1919	4674.0	50	C	C	C	C
1995	C	C	9314.7	C	9937.1	2044	5638.0	50	C	C	C	C
1996	C	C	8104.9	C	10015.4	2205	5761.0	50	C	C	C	C
1997	C	C	6951.0	C	10041.5	2370	4599.0	60	C	C	C	C
1998	C	C	6474.4	C	10171.9	2410	3848.0	100	C	C	C	C
1999	C	C	6586.2	C	12128.0	2540	3322.0	200	C	C	C	C
2000	C	C	6193.5	C	13588.6	2645	3616.0	300	C	C	C	C
2001	C	C	6236.6	C	12700.0	2645	3361.0	500	C	C	C	C
2002	C	C	6085.1	C	13500.0	2645	2935.0	700	C	C	C	C
2003	C	C	5870.6	C	13600.0	2645	3058.0	911	C	C	C	C
2004	C	C	6157.3	C	13500.0	2645	3092.0	1268	C	C	C	C
2005	C	C	7207.5	C	15500.0	2645	3466.0	1577	C	C	C	C
2006	C	C	8286.7	C	15200.0	2645	3539.0	1870	C	C	C	C
2007	C	C	8270.4	C	17190.0	2645	3582.0	2290	C	C	C	C
2008	C	C	8328.7	C	16680.0	2645	3508.0	2710	C	C	C	C
2009	C	C	7280.9	C	12310.0	2645	2609.0	3164	C	C	C	C
2010	C	C	6381.1	C	12160.0	2645	2795.0	3493	C	C	C	C
2011	C	C	5924.2	C	15060.0	2645	3188.0	3656	C	C	C	C
2012	C	C	6869.5	C	15000.0	2645	2970.0	3873	C	C	C	C
2013	C	C	6552.4	C	15810.0	2645	2883.0	4035	C	C	C	C

2014	C	C	6007.0	C	14816.2	2645	2860.0	4224	C	C	C	C

Table 109 CH_4 fugitive emissions from oil and gas (Gg)

Year	1. B. 2. a. Oil				1. B. 2. b. Natural Gas				1. B. 2. c. Venting and Flaring			
									1. B. 2. c. 1 Venting		1. B. 2. c. 2 Flaring	
	1. Exploration	2. Production	3. Transport	4. Refining / Storage	2. Production	3. Processing	4. Transmission	5. Distribution	i. Oil	ii. Gas	i. Oil	ii. Gas
1988	0.0181	0.2051	0.0023	0.3340	0.0140	0.0061	1.7587	6.7674	0.8112	0.0019	0.0020	0.0000
1989	0.0181	0.2051	0.0023	0.3340	0.0111	0.0049	2.3568	6.9666	0.8112	0.0015	0.0020	0.0000
1990	0.0136	0.1538	0.0017	0.2107	0.0188	0.0083	2.3995	7.3887	0.6084	0.0025	0.0015	0.0000
1991	0.0131	0.1487	0.0017	0.1144	0.0134	0.0059	2.3568	6.2271	0.5881	0.0018	0.0014	0.0000
1992	0.0120	0.1359	0.0015	0.0640	0.0496	0.0218	2.2856	5.5132	0.5374	0.0067	0.0013	0.0001
1993	0.0097	0.1103	0.0013	0.1447	0.0911	0.0401	2.3355	5.1370	0.4360	0.0124	0.0011	0.0002
1994	0.0081	0.0923	0.0010	0.1768	0.0750	0.0330	2.3426	5.1414	0.3650	0.0102	0.0009	0.0002
1995	0.0097	0.1103	0.0013	0.2031	0.0670	0.0295	2.7128	6.2018	0.4360	0.0091	0.0011	0.0001
1996	0.0072	0.0821	0.0009	0.1767	0.0563	0.0248	2.7342	6.3371	0.3245	0.0076	0.0008	0.0001
1997	0.0063	0.0718	0.0008	0.1515	0.0469	0.0207	2.7413	5.0589	0.2839	0.0064	0.0007	0.0001
1998	0.0075	0.0846	0.0010	0.1411	0.0389	0.0171	2.7769	4.2328	0.3346	0.0053	0.0008	0.0001
1999	0.0090	0.1026	0.0012	0.1436	0.0362	0.0159	3.3109	3.6542	0.4056	0.0049	0.0010	0.0001
2000	0.0095	0.1077	0.0012	0.1350	0.0201	0.0089	3.7097	3.9776	0.4259	0.0027	0.0010	0.0000
2001	0.0077	0.0872	0.0010	0.1360	0.0308	0.0136	3.4671	3.6971	0.3448	0.0042	0.0008	0.0001
2002	0.0084	0.0949	0.0011	0.1327	0.0268	0.0118	3.6855	3.2285	0.3752	0.0036	0.0009	0.0001
2003	0.0068	0.0769	0.0009	0.1280	0.0214	0.0094	3.7128	3.3638	0.3042	0.0029	0.0007	0.0000
2004	0.0068	0.0769	0.0009	0.1342	0.4422	0.1947	3.6855	3.4012	0.3042	0.0601	0.0007	0.0009
2005	0.0068	0.0769	0.0009	0.1571	0.7048	0.3103	4.2315	3.8126	0.3042	0.0957	0.0007	0.0015
2006	0.0063	0.0718	0.0008	0.1807	0.6834	0.3009	4.1496	3.8929	0.2839	0.0928	0.0007	0.0014
2007	0.0059	0.0667	0.0008	0.1803	0.3886	0.1711	4.6929	3.9402	0.2636	0.0528	0.0006	0.0008
2008	0.0054	0.0615	0.0007	0.1816	0.2868	0.1263	4.5536	3.8588	0.2434	0.0389	0.0006	0.0006
2009	0.0057	0.0641	0.0007	0.1587	0.0228	0.0100	3.3606	2.8699	0.2535	0.0031	0.0006	0.0000
2010	0.0052	0.0590	0.0007	0.1391	0.0978	0.0431	3.3197	3.0745	0.2332	0.0133	0.0006	0.0002
2011	0.0050	0.0564	0.0006	0.1291	0.5842	0.2572	4.1114	3.5068	0.2231	0.0794	0.0005	0.0012
2012	0.0054	0.0615	0.0007	0.1498	0.5132	0.2260	4.0950	3.2670	0.2434	0.0697	0.0006	0.0011

2013	0.0063	0.0718	0.0008	0.1428	0.3886	0.1711	4.3161	3.1713	0.2839	0.0528	0.0007	0.0008
2014	0.0059	0.0667	0.0008	0.1310	0.2640	0.1162	4.0448	3.1460	0.2636	0.0359	0.0006	0.0005

3.4.3 METHODOLOGICAL ISSUES

Fugitive emissions from coal mining were estimated by Tier 1 method.

Equations 4.1.1 and 4.1.7 from the 2006 IPCC Guidelines, Vol. 2, Ch. 4 have been applied:

Emissions = Raw coal production ● Emission Factor ● Units conversion factor

Relevant values of the emission factors from 2006 IPCC Guidelines were chosen considering that the underground mines have average depth not more than 400 m, and the surface mines for lignite coals have depth more than 25 m.

The estimate of the CO_2, CH_4 and N_2O fugitive emissions from gas and oil systems was performed by Tier 1 methodology applying Equation 4.2.1 from the 2006 IPCC Guidelines, Vol. 2, Ch. 4.

$$Emissions_{\text{gas, industry segment}} = Activity\ data_{\text{industry segment}} \cdot EF_{\text{gas, industry segment}}$$

The appropriate EFs from 2006 IPCC Guidelines, Vol. 2, Ch. 4.2.2.3, Table 4.2.4 were applied:

1. B. 2. a. Oil			
i. Exploration		**iii. Transport**	
AD	National Energy Balance	AD	National Energy Balance
EF	CH_4: 0.000194 Gg/10^3m^3 CO_2: 0.0091019 Gg/10^3m^3 2006 IPCC Guidelines	EF	CH_4: 0.000025 Gg/10^3m^3 CO_2: 0.0000023 Gg/10^3m^3 2006 IPCC Guidelines
ii. Production		**iv. Refining / Storage**	
AD	National Energy Balance	AD	National Energy Balance
EF	CH_4: 0.0022 Gg/10^3m^3 CO_2: 0.00028 Gg/10^3m^3 2006 IPCC Guidelines	EF	CH_4: 0.0000218 Gg/10^3m^3 2006 IPCC Guidelines

1. B. 2. b. Natural Gas			
ii. Production		**iv. Transmission**	
AD	National Energy Balance	AD	Bulgartransgaz
EF	CH_4: 0.00134 Gg/10^6m^3 CO_2: 0.000048 Gg/10^6m^3 2006 IPCC Guidelines	EF	CH_4: 0.000273 Gg/10^6m^3 CO_2: 0.00000088 Gg/10^6m^3 2006 IPCC Guidelines
iii. Processing		**v. Distribution**	
AD	National Energy Balance	AD	National Energy Balance
EF	CH_4: 0.00059 Gg/10^6m^3 CO_2: 0.000166 Gg/10^6m^3 2006 IPCC Guidelines	EF	CH_4: 0.0011 Gg/10^6m^3 CO_2: 0.000051 Gg/10^6m^3 2006 IPCC Guidelines

1. B. 2. c. Venting and Flaring			
1. B. 2. c. 1 Venting		**1. B. 2. c. 2 Flaring**	
i. Oil		**i. Oil**	
AD	National Energy Balance	AD	National Energy Balance

EF	CH_4: 0.0087 Gg/10^3m^3 CO_2: 0.0018 Gg/10^3m^3 2006 IPCC Guidelines	EF	CH_4: 0.000021 Gg/10^3m^3 CO_2: 0.034 Gg/10^3m^3 2006 IPCC Guidelines
ii. Gas		**ii. Gas**	
AD	National Energy Balance	AD	National Energy Balance
EF	CH_4: 0.000182 Gg/10^6m^3 CO_2: 0.04 Gg/10^6m^3 2006 IPCC Guidelines	EF	CH_4: 2.76E-06 Gg/10^6m^3 CO_2: 4.20E-03 Gg/10^6m^3 2006 IPCC Guidelines

1.B.1.a Coal Mining and Handling	
i. Underground Mines	
AD	National Energy Balance
EF	Mining CH_4: 18 m^3/t Post-Mining CH_4: 2.5 m^3/t 2006 IPCC Guidelines
ii. Surface Mines	
AD	National Energy Balance
EF	Mining CH_4: 1.2 m^3/t Post-Mining CH_4: 0.1 m^3/t 2006 IPCC Guidelines
1.B.1.b Solid Fuel Transformation	
AD	National Energy Balance, FAO (Charcoal)
EF	Coking coal CH_4: 0.049 kg/t Charcoal CH_4: 1 t/TJ (1996 IPCC Guidelines)

Activity data for crude oil and natural gas has been taken from the Energy balance and Bulgartransgaz.

3.4.4 UNCERTAINTIES

The uncertainty of this emission source category was estimated as follows:

- 200% for coal mining;
- 50% for oil and natural gas systems.

3.4.5 SOURCE-SPECIFIC QA/QC AND VERIFICATION

All activities regarding QC as described in QA/QC System have been undertaken.

3.4.6 SOURCE-SPECIFIC RECALCULATIONS, INCLUDING CHANGES MADE IN RESPONSE TO THE REVIEW PROCESS

For category 1.B.1.a.2.1 Fugitive emissions from surface mines, the previous emission factor of 1.2 m^3/t was changed to 1.5 m^3/t (IPCC GPG 2000, p.2.75), following a recommendation of the ERT during the Centralized review in 2012. For the 2014 submission the EF was changed back to 1.2 m^3/t following the adoption of the 2006 IPCC Guidelines.

For category 1.B.2.b.4 Fugitive emissions from gas transmission, the previous emission factor of 1340 kgCH_4/km was changed to 2500 kgCH_4/km (IPCC GPG 2000, Table 2.16, p.2.86), following a recommendation of the ERT during the Centralized review in 2012. For the latest submission the calculation approach was changed to rely on transited gas quantities following the adoption of the 2006 IPCC Guidelines.

As a result of ERT recommendation during the 2013 review cycle, the emission inventory was improved by adding emission estimates for category 1.B.2.a.iii. Oil transport.

3.4.7 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

No specific improvements are planned.

4 INDUSTRIAL PROCESSES AND PRODUCT USE (CRF SECTOR 2)

4.1 OVERVIEW OF SECTOR

This chapter includes information on and descriptions of methodologies used for estimating greenhouse gas emissions as well as references for activity data and emission factors reported under IPCC Category 2 Industrial Processes and Product Use (IPPU) for the period from 1988 to 2014.

Emissions from this category comprise emissions from the following sub categories:

- 2.A Mineral Industry
- 2.B Chemical Industry
- 2.C Metal Industry
- 2.D Non-energy Products from Fuels and Solvent Use
- 2.E Electronics Industry
- 2.F Product Uses as Substitutes for ODS
- 2.G Other Product Manufacture and Use
- 2.H Other

Only process related emissions are considered in this sector.

Emission Trends

This section briefly describes the emission trends from 1988 to 2014 for each of the IPCC Categories under CRF Sector 2 for which GHG emissions are reported

Industrial process emissions include emissions from industrial installations and from consumption of Solvent Use and halocarbons and SF_6 (the fluorinated gases or F-gases).

In 2014 the most important emitting category is Mineral Industry (90.0% of which are from clinker/cement production (46.2%), lime stone used for DeSOx installation of LCP/TPP (33.6%) and quick lime production (10.2%)) which share in the total IPPU emissions is 42.2%. The second category by share is Chemical Industry (ammonia and nitric acid production) with 33.8%, followed by Product uses as ODS substitutes (Consumption of Halocarbons) with 21.6% and followed by others subcategory.

These results are presented in the following table:

Table 110 GHG Emission trends in CRF 2 IPPU, 1988 - 2014

IPCC category	Emissions [Gg CO_2 eq]		Share [%]		Trend 1988 – 2014 [%]
	Base year*	2014	Base year*	2014	
2 Industrial processes	11643.80	4710.19	100.00	100.00	-59.55
2.A Mineral Industry	3736.03	1986.35	32.09	42.17	-46.83
2.B Chemical Industry	3195.65	1592.36	27.45	33.81	-50.17
2.C Metal Industry	3771.09	40.29	32.39	0.86	-98.93
2.D Non-energy Products from Fuels and Solvent Use	866.20	31.13	7.44	0.66	-96.41
2.E Electronics Industry	NO	NO	0.00	0.00	0.00

2.F Product Uses as Substitutes for ODS	0.00	1017.43	0.00	21.60	0.00
2.G Other Product Manufacture and Use	67.99	37.70	0.58	0.80	-44.55
2.H Other	6.85	4.93	0.06	0.10	-28.01

* Base year 1988

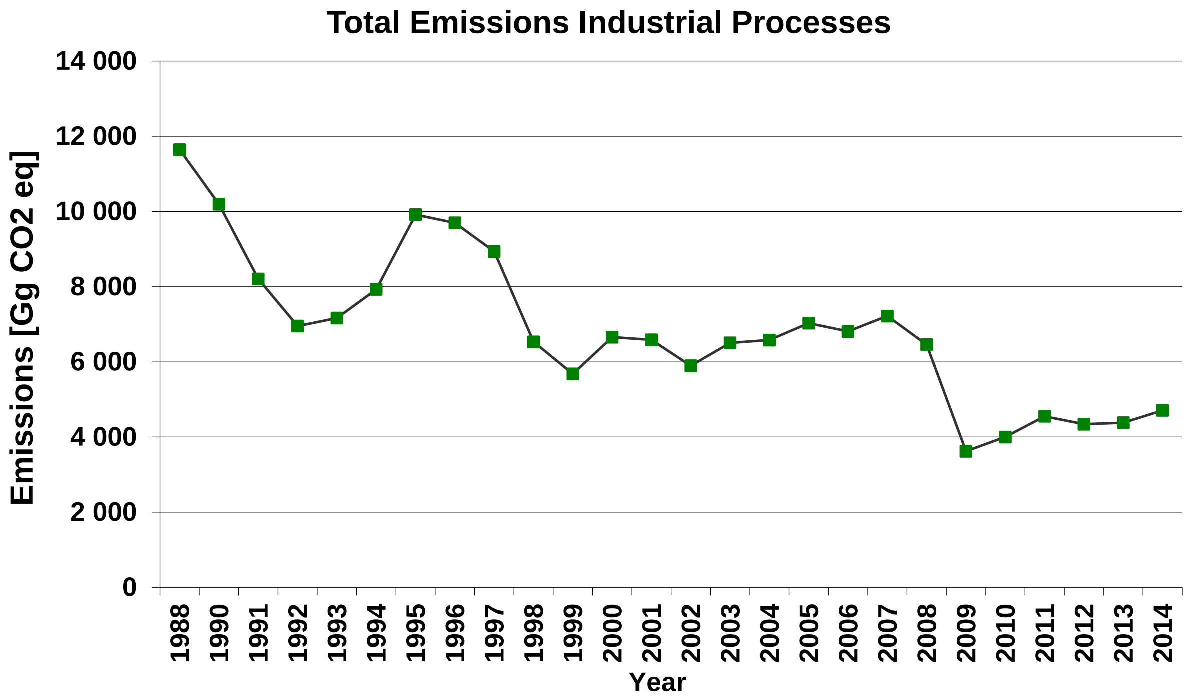

Figure 51 CO_2 Emission trends for CRF Sector 2 IPPU for 1988-2014

In the year 2014, 10.21% of national total greenhouse gas emissions (without LULUCF) originated from industrial processes and product use, compared to 11.66% in the base year 1988. In 2014, greenhouse gas emissions from Category 2 IPPU are 4710.19 Gg CO_2 equivalent compared to 11643.80 Gg in the base year.

Greenhouse gas emissions from the IPPU sector fluctuate during the period and reach a minimum in 2009. The reduction for the whole sector is 59.55% in 2014 while the biggest reduction (compared to the base year) is in Metal Industry category – 98.93% and on-energy Products from Fuels and Solvent Use category – 96.41%.

This is mainly due to economic crisis and in particular the world economic crisis in 2009. The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation. From 2009 onwards the market had recovered.

The general reduction in the emissions in the later years of the time period is influenced also by the starting introduction of better technologies on plant level.

Emission trends by gas

The following table presents greenhouse gas emissions of the IPPU sector as well as their share in total greenhouse gas emissions from that sector in the base year and in 2014.

Table 111 GHG emissions from CRF 2 IPPU by gas in 1988 and 2014

GHG	Base year*	2014	Base year*	2014
	CO_2 equivalent [Gg CO_2 eq]		[%]	
Total	11643.80	4710.19	100.00	100.00
CO_2	9635.39	3337.38	82.75	70.85
CH_4	41.19	0.00	0.35	0.00
N_2O	1963.92	124.53	16.87	2.64
HFCs	0.00	898.62	0.00	19.08
PFCs	0.00	0.05	0.00	0.001
SF_6	3.30	19.72	0.03	0.42

*1988 for: CO_2, CH_4, N_2O and SF_6.

*1995 for: HFCs and PFCs.

The most important GHG of the IPPU sector is CO_2 with 75.4% of the total emissions from this category in 2014, followed by HFCs with 21.6%, N_2O with 2.6 %, SF_6 with 0.33%, PFCs with 0,001% and finally CH_4 with 0.00003%.

Table 112 GHG Emissions from CRF 2 IPPU by gases 1988 - 2014

GHG emissions [Gg CO_2 eq]							
Year	Total	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
1988	11 643.80	9 635.39	41.19	1 963.92	0.00	0.00	3.30
1990	10 194.23	8 479.42	31.80	1 679.32	0.00	0.00	3.69
1991	8 207.48	7 013.84	25.48	1 164.26	0.00	0.00	3.91
1992	6 953.60	5 940.22	22.99	986.26	0.00	0.00	4.13
1993	7 165.25	6 261.24	26.71	872.91	0.01	0.00	4.37
1994	7 928.39	6 944.10	37.84	940.74	1.08	0.00	4.63
1995	9 915.72	8 483.77	41.57	1 382.50	2.99	0.00	4.90
1996	9 699.67	8 226.96	39.78	1 422.58	5.17	0.00	5.18
1997	8 933.88	7 804.73	43.12	1 072.40	8.14	0.00	5.48
1998	6 534.05	5 818.13	36.36	660.40	13.36	0.00	5.80
1999	5 679.70	5 071.34	30.40	551.87	19.95	0.00	6.14
2000	6 656.96	5 775.14	31.27	818.44	25.62	0.00	6.49
2001	6 586.39	5 690.03	31.07	821.10	37.33	0.00	6.87
2002	5 896.16	5 126.10	27.67	682.85	52.27	0.00	7.27
2003	6 505.09	5 683.03	35.27	708.75	70.35	0.00	7.69
2004	6 580.45	5 597.47	29.95	840.87	104.03	0.00	8.13
2005	7 029.75	5 931.35	28.60	904.19	157.45	0.00	8.16
2006	6 810.71	6 056.44	29.53	495.89	220.37	0.00	8.48
2007	7 219.86	6 274.47	27.98	606.05	302.55	0.00	8.81
2008	6 458.54	5 356.42	13.18	582.43	497.35	0.00	9.16
2009	3 620.47	2 763.55	1.67	284.35	561.37	0.02	9.52
2010	4 001.06	3 111.67	0.02	276.54	600.31	0.06	12.47
2011	4 551.53	3 636.07	0.00	243.64	657.56	0.06	14.19
2012	4 341.16	3 426.57	0.00	143.35	751.88	0.06	19.29
2013	4 380.30	3 337.38	0.00	124.53	898.62	0.05	19.72
2014	4 710.19	3 552.34	0.00	124.81	1017.39	0.04	15.62

The emission trends of the three GHG – CO_2, CH_4 and N_2O, are presented on the following figure.

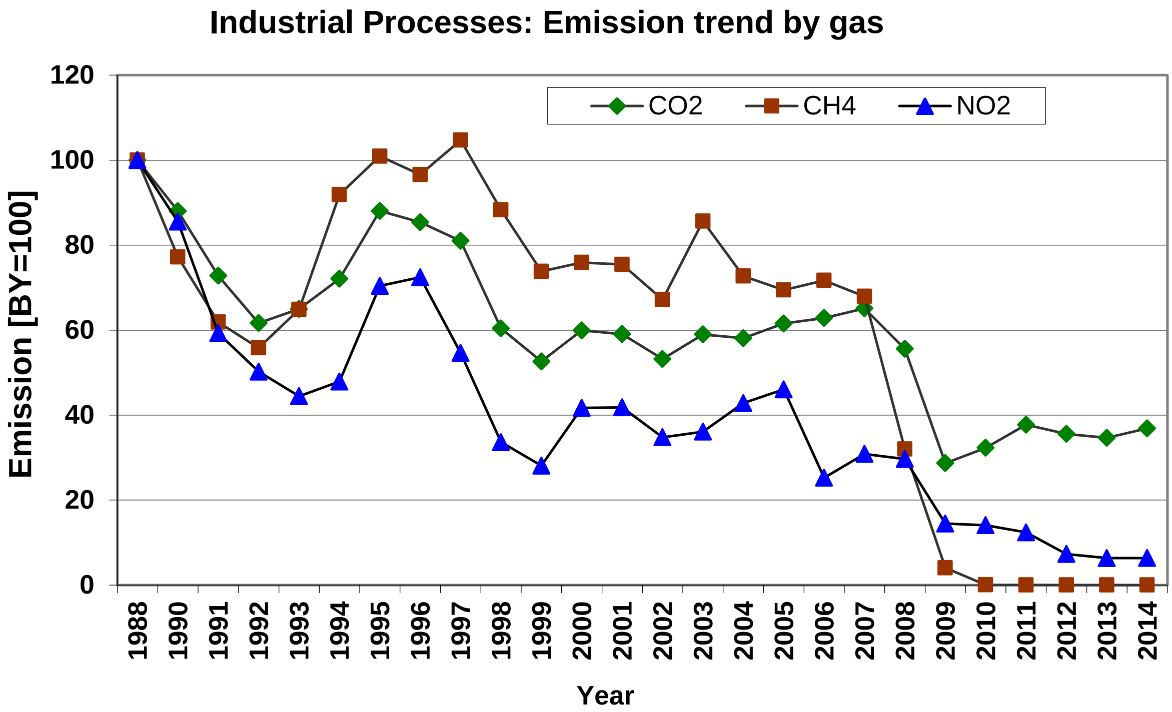

Figure 52 IPPU: Emission trend by gas – CO_2, N_2O, CH_4

Emission trends by sources

The main sources of greenhouse gas emissions in the IPPU sector are Mineral Industry and Chemical Industry, which cause about 42.2% and 33.8%, respectively, of the emissions from this sector in 2014. There has been an increase over 20% in the past year in CO_2 eq. emissions from the F-gases use (sector 2.F).

Table 113 GHG Emissions from CRF 2 IPPU by sector 1988 to 2014

GHG emissions [Gg CO_2 eq]							
Year	2.A Mineral Industry	2.B Chemical Industry	2.C Metal Industry	2.D Non-energy Products from Fuels and Solvent Use	2.F Product Uses as Substitutes for ODS	2.G Other Product Manufacture and Use	2.H Other
1988	3736.03	3195.65	3771.09	866.20	0.00	67.99	6.85
1990	3276.13	4541.34	1439.36	864.05	0.00	67.82	5.53
1991	2068.09	3658.46	1555.82	852.99	0.00	67.91	4.22
1992	1751.83	2831.09	1443.03	854.60	0.00	67.94	5.11
1993	1773.91	2594.56	1933.61	800.75	0.01	56.43	5.99
1994	2096.55	2905.20	2766.10	57.41	1.08	96.46	5.60
1995	2720.26	3874.43	3188.10	37.10	2.99	85.30	7.54
1996	2677.55	4026.06	2866.49	29.85	5.17	88.22	6.33
1997	2103.59	3325.46	3386.17	22.13	8.14	82.24	6.16
1998	1541.68	2127.48	2753.11	28.07	13.36	66.22	4.13
1999	1437.64	1617.22	2513.40	25.66	19.95	61.81	4.03
2000	1611.72	2499.05	2417.47	22.77	25.62	76.28	4.06

GHG emissions [Gg CO_2 eq]							
Year	2.A Mineral Industry	2.B Chemical Industry	2.C Metal Industry	2.D Non-energy Products from Fuels and Solvent Use	2.F Product Uses as Substitutes for ODS	2.G Other Product Manufacture and Use	2.H Other
2001	1636.50	2523.63	2299.18	24.13	37.33	62.08	3.54
2002	1704.13	1948.12	2097.57	23.26	52.27	68.12	2.69
2003	1738.47	1984.92	2613.20	34.47	70.35	60.62	3.06
2004	1966.83	2324.35	2098.13	26.94	104.03	57.46	2.72
2005	2171.13	2486.95	2123.57	32.13	157.45	55.26	3.27
2006	2307.82	1859.23	2328.39	35.60	220.37	56.02	3.28
2007	2796.29	2014.97	2014.56	31.20	302.55	57.03	3.26
2008	2789.21	2044.17	1034.21	31.23	497.35	59.18	3.17
2009	1730.23	1156.17	82.05	28.89	561.39	55.50	6.25
2010	1790.67	1464.04	55.84	29.89	600.36	56.38	3.89
2011	1923.71	1813.47	68.59	29.43	657.62	55.15	3.55
2012	2033.16	1411.95	50.41	29.84	751.94	60.04	3.82
2013	1922.95	1452.53	32.73	27.34	898.67	41.45	4.63
2014	1986.35	1592.36	40.29	31.13	1017.43	37.70	4.93

The following figure presents greenhouse gas emissions from IPCC Category 2 IPPU by sub category for the years 1988 to 2014.

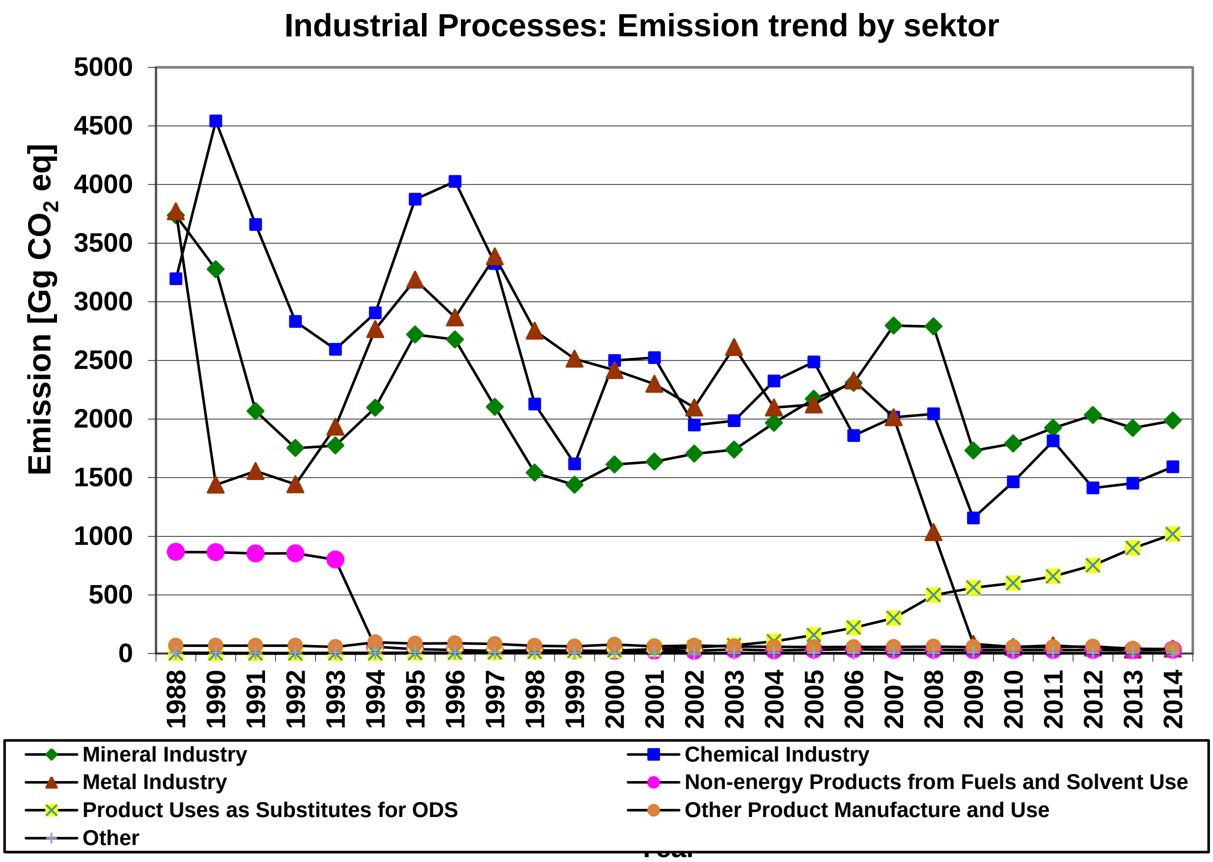

Figure 53 CRF 2 IPPU: Emission trend by sector – [Gg CO_2 eq]

The emissions reduction during the whole time period from 1988 to 2014 is due to mainly economic reasons (economic crisis). There are another two such periods – around 1989 - 1991 and 1997 – 1999. The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

The general reduction in the emissions in the later years of the time period is influenced also by the starting introduction of better technologies on plant level.

Greenhouse gas emissions from the IPPU sector fluctuate during the period and reach a minimum in 2009. The reduction for the whole sector is 59.55% in 2014 while the biggest reduction (compared to the base year) is in Metal Industry category – 98.93%, followed by Non-energy Products from Fuels and Solvent Use with 96.41, Chemical Industry with 50.17%, Mineral Industry with 46.83% and Other Product Manufacture and Use - 44.55%

One of the most important factors leading to emission reduction in Metal Industry sector is that the biggest plant from this sector (which share in the steel production before 2008 was more than 50%) ceased operation of its pig iron and the following steel making in BOF in November 2008. The total reduction in the sector production comparing the years of 2008 and 2014 is more than 50%.

Ceased operation of existing ammonia and nitric acid plants is the main reason for the emission reduction in Chemical Industry category, too. That led to a reduction of the emissions in the period 1999/2002 for the Chemical Industry as a whole. In 2014 the market was recovered.

In 2014 a slight increase in emissions is observed for the entire IPPU sector. This is mainly due to increase in Mineral Industry category. There is a slight increase in the Chemical Industry category, which indicates that the chemical plants start to recover from the effects of the world economic crisis in 2008-2009. In 2014 there is some increase observed in all categories.

Methodology

The general method for estimating emissions for the IPPU sector, as recommended by the IPCC, involves multiplying production data for each process by an emission factor per unit of production. For some sub-sectors (for example ammonia production, nitric acid production, etc.) higher tier, i.e. tier 2 or tier 3, are used.

In some categories emission and production data were reported directly by industry or EU ETS, IPPC and/or E-PRTR reports thus represent plant and country specific data. Methodologies are described for all IPCC categories.

Detailed information on the methodology can be found in the corresponding subchapters.

Emission data reported under the European Emission Trading Scheme - EU ETS

Verified CO_2 emissions reported under the EU ETS were available for the years 2007-2014. These emissions have been incorporated in the inventory as far as possible (see respective subchapters for more information). Furthermore the background data for the emission calculations under the EU ETS were used for further QA/QC checks.

Uncertainty Assessment

For the sector IPPU uncertainties are estimated taking into account the recommendations of the 2006 IPCC Guidelines.

For all the sub-sectors uncertainties for the emission factors and activity data as well as combined uncertainty are estimated. When doing so the methods for obtaining the activity data and estimating the emission factors (plant specific, country specific, national statistics) were considered.

Quality Assurance and Quality Control (QA/ QC)

Emission estimations as well as activity data and emission factors are compared with verified EU ETS emission reports, IPPC reports as well as E-PRTR reports where available.

The availability of quality management systems, such as ISO 9001, ISO 14001 and EMAS, are available for is also taken into account that.

Monitoring data are used in some emissions estimation.

Planned Improvements

All planned improvements (described in the following sub-chapters) have been implemented in this sector.

4.2 MINERAL INDUSTRY (CRF 2.A)

4.2.1 CEMENT PRODUCTION (CRF 2.A.1)

4.2.1.1 Source category description

In the period 1988 to 2014, there are 6 existing/operational cement plants in Bulgaria. One of these (6th) installations was operational from 1988 till 1996 and decommissioned finally during that last year. One from the 5th existing/operational installation was the decrease substantially its production during 2010. In 2011 this factory completely ceases operation and all equipment is decommissioned. In 2013 one more installation ceases operation. At present there are only 3 operating plants. All 3 plants are covered by the EU ETS and the IPPC Directive and have been modernized accordingly during the last 10 years. In addition all plant sites are certified at present according to ISO 9001 and 14 001 standards. During 2014 cement produced 98.8% are Portland cement, i.e. the other types of cement are only 1.2% from the total annual national production. All types of produced cements are according to BSS EN 197-1[25].

[25] Cement. Composition, specifications and conformity criteria for low heat common cements

Additional information on the above installations (operators) may be obtained through the Bulgarian Association of Cement Industry (BACI) at www.bacibg.org and/or their own internet sites.

4.2.1.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

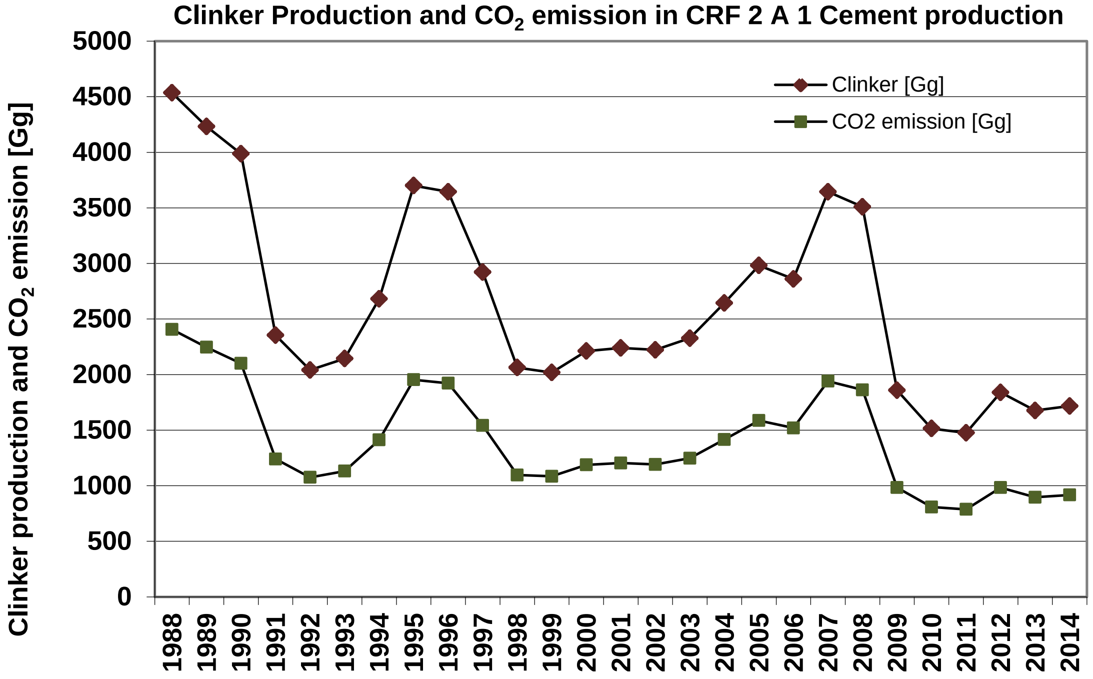

Figure 54 Clinker Production and CO_2 emission in CRF 2 A 1 Cement production

4.2.1.3 Methodological issues

4.2.1.3.1 Method

The GHG emissions from the sector are calculated by using a clinker production data and a country specific method, similar to a Tier 2 Method according to item 2.2.1.1 from the 2006 IPCC GL. The aggregated national clinker production (CP) data in t/y are provided by the NSI. Clinker production data was taken from the annual reports under the IPPC permits. In addition, information on the content of calcium and magnesium oxide in the clinker is required from the plants.

The emission calculations and the applied emission factor are respectively according to equation 2.2 on pages 2.9 from item 2.2.1.1 (2006 IPCC GL):

$$\textbf{Emissions} = \textbf{EF}_{\textbf{clinker}} \bullet \textbf{CP} \bullet \textbf{CKD Correction Factor}$$

$$EF_{clinker} = \sum M \bullet C_{(MeO)}$$

$$C_{(MeO)} = ((\sum Cn_{(MeO)}) \bullet CPn) / CP)/100$$

Where:

CKD Correction Factor = 1.00

M - Molecular Weight CO_2/ Molecular Weight Me-oxide

$C_{(MeO)}$ – Content (Weight Fraction) in Clinker [%]

CP – clinker production [Gg]

Me – Ca, Mg, other

n – Cement plants (1-5)

The above assumption for the CKD Correction Factor is based on the modern status of cement plants and the total (100%) recycling of their CKD as a raw material.

4.2.1.3.2 Emission factor

In addition, the above calculations are based on the conservative assumption that all of the lime (MeO) comes from a carbonate sources (e.g. limestone/$MeCO_3$) in the lack of reliable data on the use of non-carbonate sources, i.e. assuming 100% calcinations of the carbonate sources present in the raw materials mixture.

Taking into account the above, the final equation is as follows:

Emissions = 0,534 • CP • 1.00 = 0,534 • CP (for 2014)

The CO_2 emissions for 2014 are taken from the operators EU ETS reports. In their reports $CaCO_3$, $MgCO_3$ and other carbonates content in the raw materials used is taken into account.

4.2.1.3.3 Activity data

The aggregated national clinker production (CP) data provided by the NSI and plants cover the period from 1988 to 2014. They are presented in the table below together with the relevant coefficients and the calculated CO_2 emissions:

Table 114 Clinker production, weight fraction and CO_2 emission

Clinker Production Data		Molecular Weight Fraction CO_2/CaO	CaO Weight Fraction	Molecular Weight Fraction CO_2/MgO	MgO Weight Fraction	CO_2 Emissions [kt/y]	Other CO_2 Emissions [kt/y]
Year	[kt/y]						
1988	4535,24	0,785	0,659	1,092	0,012	2406.34	-
1989	4232,71	0,785	0,659	1,092	0,012	2245.81	-
1990	3986,62	0,785	0,655	1,092	0,012	2100.41	-
1991	2354,10	0,785	0,655	1,092	0,012	1239.97	-
1992	2041,10	0,785	0,656	1,092	0,011	1075.59	-
1993	2143,81	0,785	0,655	1,092	0,012	1131.18	-

Clinker Production Data		Molecular Weight Fraction CO_2/CaO	CaO Weight Fraction	Molecular Weight Fraction CO_2/MgO	MgO Weight Fraction	CO_2 Emissions [kt/y]	Other CO_2 Emissions [kt/y]
Year	[kt/y]						
1994	2680,61	0,785	0,654	1,092	0,012	1412.44	-
1995	3700,60	0,785	0,656	1,092	0,012	1953.59	-
1996	3645,10	0,785	0,655	1,092	0,012	1922.08	-
1997	2921,99	0,785	0,656	1,092	0,012	1542.17	-
1998	2063,45	0,785	0,660	1,092	0,012	1096.50	-
1999	2018,72	0,785	0,666	1,092	0,013	1084.76	-
2000	2211,23	0,785	0,668	1,092	0,012	1187.81	-
2001	2239,65	0,785	0,668	1,092	0,012	1204.32	-
2002	2222,32	0,785	0,666	1,092	0,012	1190.90	-
2003	2327,30	0,785	0,665	1,092	0,013	1247.57	-
2004	2644,37	0,785	0,664	1,092	0,013	1415.94	-
2005	2981,62	0,785	0,660	1,092	0,013	1586.36	-
2006	2859,79	0,785	0,659	1,092	0,013	1519.30	-
2007	3644,85	0,785	0,660	1,092	0,013	1940.55	-
2008	3509,82	0,785	0,658	1,092	0,013	1862.44	-
2009	1858,85	0,785	0,657	1,092	0,012	982.96	0.05
2010	1514,55	0,785	0,660	1,092	0,012	804.41	3.44
2011	1475,70	0,785	0,659	1,092	0,012	783.61	3.71
2012	1839,27	0,785	0,660	1,092	0,013	977.94	5.01
2013	1676.33	0.785	0.660	1.092	0.013	891.30	4.57
2014	1716.92	0.785	0.660	1.092	0.013	912.86	4.20
Plant specific data		Statistical data					

4.2.1.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

AD = 1-2 %

CaO Weight Fraction = 1-2%

MgO Weight Fraction = 1-2%

Quantitative uncertainty estimates are provided in Annex 2.

4.2.1.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.

As a part from the QA activities the aggregated national clinker production data provided by the NSI were compared with the production data reported by the cement plants in the annual reports for compliance with their IPPC permits (EPRTR data), as well as in their verified EU ETS emission reports .

All verification EU ETS reports are public available at: http://eea.government.bg/bg/r-r/r-te/verifitsirani-dokladi-16/dokladi-1r

The following improvements were undertaken

Improvements with regard to TACCC of method, EF and relevant other parameters used to estimate these emissions were made.

4.2.1.6 Source specific recalculations

CO_2 emissions from usage of feedstocks, used for supplemental purification of waste gases, are added. Emissions are calculated on the base of the quantity of the consumed substance and a stoichiometric correlation.

4.2.1.7 Source specific planned improvements

Letters of inquiry about the percentage content of CaO and MgO for the period 2010-2015 (separately for each year) will be sent to the relevant plants, as an averaged percentage content for the past period 2000-2009 have been used.

4.2.2 LIME PRODUCTION (CRF 2.A.2)

4.2.2.1 Source category description

The production of lime involves a series of steps comparable to those used in the production of Portland cement clinker. These include quarrying the raw materials, crushing and sizing, calcining (i.e., high temperature heat processing ~ 1100°C) the raw materials to produce lime, hydrating the lime to calcium hydroxide followed by miscellaneous transfer, storage and handling operations.

Calcium oxide (CaO or quicklime) is formed by heating limestone to decompose the carbonates. This is usually done in shaft or rotary kilns at high temperatures and the process releases CO_2. Depending on the product requirements (e.g., metallurgy, pulp and paper, construction materials, effluent treatment, water softening, pH control, and soil stabilisation), primarily high calcium limestone (calcite) is utilized in accordance with the following reaction (2006 IPCC Guidelines):

$CaCO_3$ (high-purity limestone) + heat = CaO (quicklime) + CO_2

Currently there are 5 lime producing plants in Bulgaria which fall under the IPPC and the EU ETS. They produce high calcium quicklime. After the largest metallurgic plant ceases operation in 2008 there is virtually no production of dolomitic lime. In 2013 letters were sent to all quicklime producing plants (including the ones producing quicklimes for their own needs) and all of them declared that they do not produce dolomitic lime.

4.2.2.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

The reduction in 2009 is ceased operation (in November 2008) of one of the lime producers (integrated steel making plant), reduction in the construction works and other quicklime consuming production processes and world economic crises.

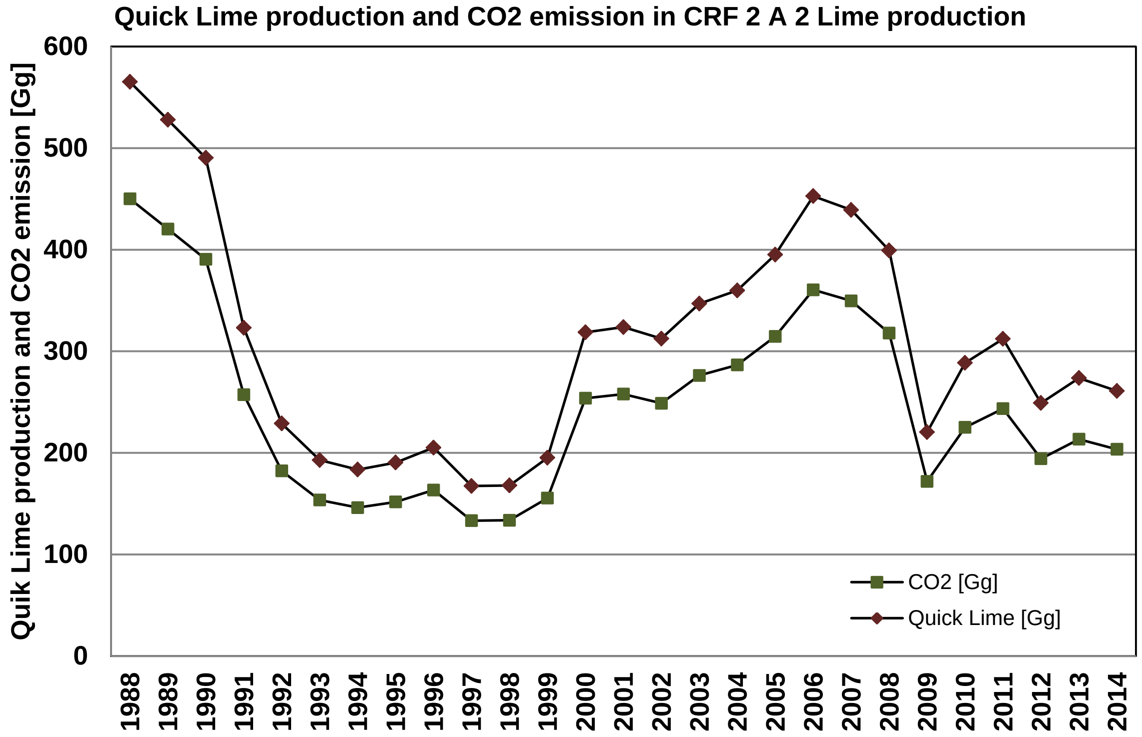

Figure 55 Lime Production and CO_2 emission in CRF 2.A.2 Lime production

4.2.2.3 Methodological issues

4.2.2.3.1 Method

The emissions from the sector are calculated using country specific data on the total amount of lime produced provided by NSI. Default emission factor is applied.

The emissions are estimated following the general approach and using the following equation similar to equation 2.6, p.2.21 (2006 IPCC Guidelines):

$$\mathbf{CO_2\ Emissions = \sum (EF_{Lime,i} \bullet M_{Lime,i} \bullet CF_{LKD,I})}$$

Where:

CO_2 Emissions = emissions of CO_2 from lime production, tonnes

$EF_{Lime,i}$ = emission factor for lime of type i, tonnes CO_2/tonne lime

$M_{Lime,i}$ = lime production of type i, tonnes

$CF_{LKD,I}$ = correction factor for LKD for lime of type i, dimensionless = 1.02

The following is taken into account:

2006 IPCC Guidelines (Table 2.4, p. 2.22) recommend a default emission factor of 0.785 tonnes CO_2/tonne quicklime produced and 0.913 tonnes CO_2/tonne dolomitic lime produced.

It is assumed that the whole quantity of $CaCO_3$, $MgCO_3$, и $CaMg(CO_3)_2$ is carbonised to CaO и MgO – 100% and the ratio of high-calcium lime to Dolomitic lime is: 85% High-calcium lime to 15% Dolomitic lime.

$$M_{\text{Lime}} = 0.85 \cdot M_{\text{high calciumlime}} + 0.15 \cdot M_{\text{dolomitic lime}}$$

Thus an approach in line with Tier 2 method (2006 IPCC Guidelines, p.2.21) is used to estimate CO_2 emissions from lime production.

4.2.2.3.2 Emission factor

To estimate the emission factors are used the following equations:

EQUATION 3.5A

$$EF_{\text{high calciumlime}} = \text{Stoichiometric ratio } (CO_2 / CaO) \cdot \text{CaO content} + \text{Stoichiometric ratio } (CO_2 / MgO) \cdot \text{MgO content}$$

Where: $EF_{\text{high calciumlime}}$ = emission factor for quicklime

EQUATION 3.5B

$$EF_{\text{dolomitic lime}} = \text{Stoichiometric ratio } (CO_2 / CaO{\cdot}MgO) \cdot (CaO{\cdot}MgO) \text{ content (Stoichiometric ratio } (CO_2 / CaO) \cdot \text{CaO content} + \text{Stoichiometric ratio } (CO_2 / MgO) \cdot \text{MgO content)}$$

Where: $EF_{\text{dolomitic lime}}$ = emission factor for dolomitic quicklime

The above equations are used to estimate the emission factor.

4.2.2.3.3 Activity data

Country specific data on the total lime production (quicklime) are provided by NSI.

The following is taken into consideration: It is good practice to assess the available national statistics for completeness, and for the ratio of limestone to dolomite used in lime production (2006 IPCC Guidelines).

Thus statistical data on total amount of lime produced are used to estimate the emissions of CO_2 from lime production.

Issues of double counting:

CO_2 emissions from Lime production are reported in this chapter and are not included in Limestone and dolomite use chapter.

Table 115 Lime production and CO_2 emissions

Year	Lime Production [kt/y]	IEF (with LKD) [kt CO_2/ kt production]	CO_2 Emissions [kt CO_2]
1988	565.21	0.796	450.07
1989	527.93	0.796	420.38
1990	490.39	0.796	390.49
1991	323.18	0.796	257.34

Year	Lime Production [kt/y]	IEF (with LKD) [kt CO_2/ kt production]	CO_2 Emissions [kt CO_2]
1992	228.88	0.796	182.26
1993	192.93	0.796	153.62
1994	183.49	0.796	146.11
1995	190.48	0.796	151.67
1996	205.21	0.796	163.40
1997	167.39	0.796	133.29
1998	167.90	0.796	133.70
1999	195.22	0.796	155.45
2000	318.70	0.796	253.78
2001	323.84	0.796	257.87
2002	312.45	0.796	248.80
2003	346.88	0.796	276.21
2004	359.90	0.796	286.59
2005	395.12	0.796	314.63
2006	452.75	0.796	360.52
2007	439.09	0.796	349.64
2008	399.27	0.796	317.93
2009	220.38	0.780	171.91
2010	288.60	0.780	225.13
2011	312.25	0.780	243.58
2012	249.03	0.780	194.26
2013	273.62	0.780	213.45
2014	260.94	0.780	203.55

4.2.2.3.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

AD	1-2 %
EF	2%

Uncertainty for AD:

The following is taken into account (2006 IPCC GL, p. 2.25, see also Table 2.5):

The uncertainty for the activity data is likely to be much higher than for the emission factors, based on experience in gathering lime data.

Uncertainty for EF:

The following is taken into account (2006 IPCC GL, p. 2.25, see also Table 2.5):

In Tier 2 and Tier 1, the stoichiometric ratio is an exact number and therefore the uncertainty of the emission factor is the uncertainty of lime composition.

There is uncertainty associated with determining the CaO content and/or the CaO•MgO content of the lime produced.

Quantitative uncertainty estimates are provided in Annex 2.

4.2.2.4 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.

4.2.2.5 Source specific recalculations

Data for the CaO and MgO content in quicklime are changed as average scopes from the 2006 IPCC are taken.

	Lime	Dolomit
Range of CaO Content [%]	95.5	56
Range of MgO Content [%]	1.4	39.5

Additionally a correlation factor of 1,02 LKD is applied in emissions calculation.

4.2.2.6 Source specific planned improvements

Letters of inquiry about the treatment of captured emissions of dust will be sent to relevant plants.

4.2.3 GLASS PRODUCTION (CRF 2.A.3)

4.2.3.1 Source category description

Currently there are six glass plants in Bulgaria mainly producing flat, container and domestic glass. All of them fall under the IPPCD and the EU ETS.

According to the information given in the Reference Document on Best Available Techniques in the Glass Manufacturing Industry, December 2001, the general description of the main types of glass produced in the country are:

Container glass

The forming process is carried out in two stages, the initial forming of the blank either by pressing with a plunger, or by blowing with compressed air, and the final moulding operation by blowing to obtain the finished hollow shape. These two processes are thus respectively termed "press and blow" and "blow and blow". Container production is almost exclusively by IS (Individual Section) machines.

Flat glass

Flat glass is produced almost exclusively with cross-fired regenerative furnaces. The basic principle of the float process is to pour the molten glass onto a bath of molten tin, and to form a ribbon with the upper and lower surfaces becoming parallel under the influence of gravity and surface tension. From the exit of the float bath the glass ribbon is passed through the annealing lehr, gradually cooling the glass to reduce residual stresses. On-line coatings can be applied to improve the performance of the product (e.g. low emissivity glazing).

Domestic glass

Domestic glass is a diverse sector involving a wide range of products and processes. Ranging from intricate handmade lead crystal, to high volume, mechanised methods used for mass produced tableware.

The forming processes are automatic processing, hand made or semi-automatic processing, and following production the basic items can be subjected to cold finishing operations (e.g. lead crystal is often cut and polished).

4.2.3.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

One of the glass producing plants is new and has started working in the period 2005/2006. Another one had reduced capacity, operational time, during 2008 – 2009 and had stopped in 2010.

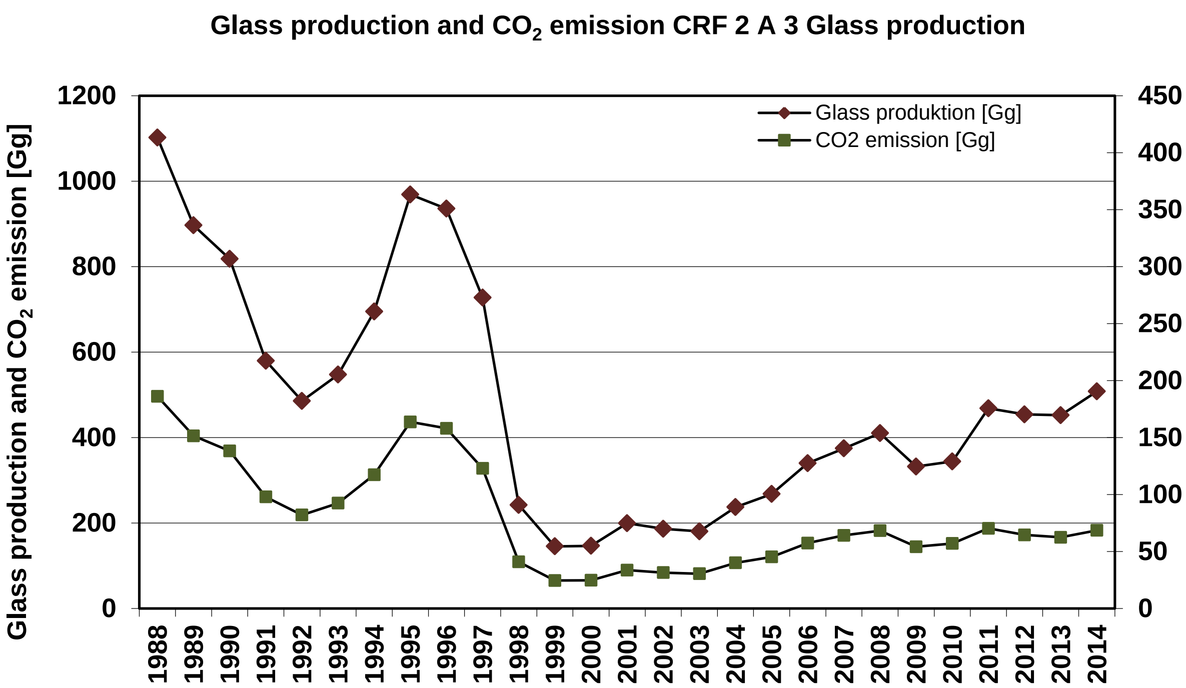

Figure 56 Glass Production and CO_2 emission in CRF 2.A.3 Glass production

4.2.3.3 Methodological issues

4.2.3.3.1 Method

Emissions are estimated based on the carbonate used from data presented in verified reports, it is similar to equation 2.12, page 2.28, 2006 IPCC GL. This section does not report emissions from soda ash use, they are reported in the sub-sector 2A4b Other uses of Soda Ash.

The emissions were estimated using the following equation:

Emissions CO_2 = Emission factor • Glass production

For the period 2007 - 2014 plant specific emissions and production data were used based on the data reported by operators under the EU ETS (except one plant) and the IPPC. Thus plants specific emission factors were obtained which from an implied emission factor was delivered.

4.2.3.3.2 CO_2 Emission factor

For the period 2007 - 2008 plant specific (for five plants) emission factors were calculated on the basis of data from the IPPCD and the EU ETS reports (see Table 116). These emission factors were used to calculate an implied emission factor which was further used to recalculate the emissions for the rest of the time series.

4.2.3.3.3 Activity data

Plant specific data from the IPPCD and the EU ETS reports are available for the years 2007 - 2014. For the time series 1988 – 2014 statistical activity data were used. The quantity of glass produced was recalculated by NSI in tones due to differences in the measurement units reported.

Issue of double counting:

Only the emissions from the use of lime stone in the glass production process are estimated in this category. The quantities of soda ash and fuel used are reported under Soda ash use and Energy Chapter respectively.

Table 116 Glass production and CO_2 emission in CRF 2.A.3 Glass production

Year	Glass Production (GP) [kt/y]	Emission Factor (EF CO_2) [kt CO_2/kt GP]	CO_2 Emissions [kt CO_2]
1988	1102.09	0.169	186.24
1989	896.74	0.169	151.54
1990	818.04	0.169	138.24
1991	579.65	0.169	97.96
1992	485.66	0.169	82.07
1993	547.33	0.169	92.49
1994	694.82	0.169	117.42
1995	968.79	0.169	163.72
1996	935.62	0.169	158.11
1997	727.54	0.169	122.95
1998	242.41	0.169	40.97
1999	145.54	0.169	24.60
2000	146.66	0.169	24.78
2001	199.59	0.169	33.73
2002	186.58	0.169	31.53
2003	180.62	0.169	30.52
2004	237.31	0.169	40.10
2005	267.94	0.169	45.28

Year	Glass Production (GP) [kt/y]	Emission Factor (EF CO_2) [kt CO_2/kt GP]	CO_2 Emissions [kt CO_2]
2006	340.01	0.169	57.46
2007	374.65	0.171	64.21
2008	410.19	0.167	68.33
2009	332.20	0.163	54.21
2010	344.16	0.166	57.11
2011	468.41	0.150	70.35
2012	454.32	0.142	64.62
2013	452.32	0.138	62.54
2014	508.00	0.135	68.64

4.2.3.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	60.3 %
AD	±6 %
EF	60%

Uncertainty for AD:

"Glass production data are typically measured fairly accurately (+/-5 percent) for Tier 1 and Tier 2. As mentioned above, inventory compilers should be cautious where activity data are not originally available in mass, but rather as a unit (e.g., bottle) or area (e.g., m2). If activity data have to be converted to mass, this may result in additional uncertainty." (2006 IPCC GL, p. 2.31)

Taking the above into account the uncertainty of the emission factor was assumed as ±6 %.

Uncertainty for EF:

Uncertainty associated with use of the Tier 1 emission factor and cullet ratio is significantly higher, and may be on the order of +/- 60 percent.

Quantitative uncertainty estimates are provided in Annex 2.

4.2.3.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.
Revision of the activity data by using IPPCD and EU ETS reports as well as statistical data.
Development of country specific emission factor for glass production based on IPPCD and EU ETS data.
ISO 9001 and 14 001 standards.

4.2.3.6 Source specific recalculations

There are no source specific recalculations for this category.

4.2.3.7 Source specific planned improvements

No source specific improvements are planned

4.2.4 OTHER PROCESS USES OF CARBONATES (CRF 2.A.4): CERAMICS PRODUCTION (CRF 2.A.4.A)

4.2.4.1 Source category description

According to the Reference Document on Best Available Techniques in the Ceramic Manufacturing Industry, August 2007, the fundamental methods and steps in the production processes hardly differ in the manufacture of the various ceramic products, besides the fact that, for the manufacture of, e.g. wall and floor tiles, table - and ornamentalware (household ceramics), sanitaryware and also technical ceramics, often a multiple stage firing process is used.

The manufacture of ceramic products takes place in different types of kilns, with a wide range of raw materials and in numerous shapes, sizes and colours. The general process of manufacturing ceramic products, however, is rather uniform, besides the fact that, for the manufacture of wall and floor tiles, table- and ornamentalware (household ceramics), sanitaryware and also technical ceramics, often a multiple stage firing process is used. In general, raw materials are mixed and cast, pressed or extruded into shape. Water is regularly used for a thorough mixing and shaping. This water is evaporated in dryers and the products are either placed by hand in the kiln (especially in the case of periodically operated kilns) or placed onto carriages that are transferred through continuously operated kilns. In most cases, the kilns are heated with natural gas, but liquefied petroleum gas, fuel oil, coal, petroleum coke, biogas/biomass or electricity are also used.

The currently operating ceramic plants in Bulgaria are producing mostly bricks, roof and wall tiles and other ceramic products. Those of them which cover the capacity criteria according to the IPPC Directive have IPPC permits as well as ETS permits.

4.2.4.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

A relatively stable production amount is observed for the period after the world economic crisis. This level is stable but significantly lower than the previous years. The production in this sector is highly dependent on the construction business. As this business flourishes in 2004-2005 there is also a great increase in the production of ceramics. After 2009 the demand is considerably lower and the market is oversaturated with goods which brings the production of a collapse in 2009.

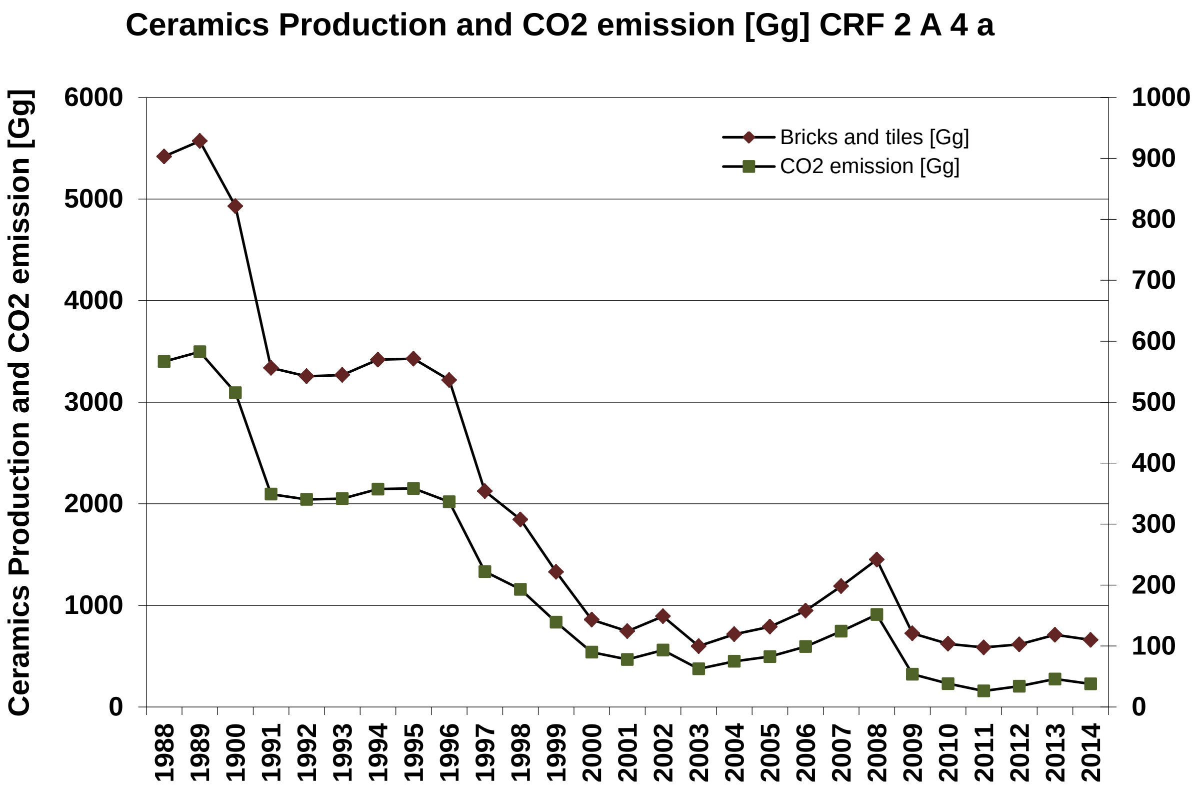

Figure 57 Ceramics Production and CO_2 emission in 2A4a "Other Process Uses of Carbonates"

4.2.4.3 Methodological issues

4.2.4.3.1 Method

The CO_2 emissions from the verified ETS reports are used. These emissions are estimated taking into account the CaO and MgO content in the products. The CO_2 emissions in the ETS reports are calculated using the following equation:

Emissions CO_2 **= ∑ (Activity data • Emission factor MeO • Conversion coefficient)**

Where:

Activity data = Ceramics production, tones

MeO = CaO, MgO

Emission factor $_{MeO}$:

Emission factor $_{CaO}$ = 0.785,

Emission factor $_{MgO}$ = 1.092

Conversion coefficient = 1.

The emissions estimated by the above equation are used together with the respective EU ETS production data for 2008 to obtain country specific emission factor.

For the rest of the time series NSI data were used. Since these data were expressed in different measurement units (for example: m^3, units) a conversion factor was applied in order to obtain the production in tones. To convert the production from units to tones a local conversion factor was obtained.

4.2.4.3.2 CO_2 Emission factor

Country specific emission factor was calculated on the basis of data from EU ETS and IPPC reports of the operators (see Table 117). The EU ETS data used to estimate the EF take into account the $CaCO_3$, $MgCO_3$ in the used in the raw materials (clay).

4.2.4.3.3 Activity data

Statistical data on production are used for the whole time series. Conversion of the production data (from m^3 and units) was performed in order to obtain them in tones.

Issue of double counting:

In order to avoid double counting, the quantity fuel used is reported under Energy Chapter respectively.

Table 117 Ceramic production and CO_2 emission in CRF 2.A.4.a

Year	Ceramic Production (CP) [kt/y]	Emission Factor [kt CO_2/kt CP]	CO_2 Emissions [kt CO_2]
1988	5419.1	0.105	566.79
1989	5571.2	0.105	582.70
1990	4929.8	0.105	515.61
1991	3338.5	0.105	349.18
1992	3255.7	0.105	340.52
1993	3268.1	0.105	341.82
1994	3418.3	0.105	357.52
1995	3428.1	0.105	358.55
1996	3218.1	0.105	336.58
1997	2124.1	0.105	222.16
1998	1845.2	0.105	193.00
1999	1329.3	0.105	139.04
2000	859.7	0.105	89.92
2001	745.7	0.105	77.99
2002	892.5	0.105	93.35
2003	598.3	0.105	62.58
2004	716.1	0.105	74.90
2005	790.0	0.105	82.63
2006	947.8	0.105	99.13
2007	1189.0	0.105	124.36
2008	1450.2	0.105	151.68
2009	725.0	0.074	53.75
2010	621.63	0.062	38.25
2011	585.70	0.045	26.39
2012	615.71	0.055	34.04
2013	710.42	0.065	45.86
2014	660.14	0.057	37.94

* Ceramic Production = Bricks and Tiles

4.2.4.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	5.8 %
AD	3 %
EF	5%

Uncertainty for AD:

The following is relevant (2006 IPCC GL, p. 2.39)

Assuming that carbonate consumption is allocated to the appropriate consuming sectors/industries, the uncertainty associated with weighing or proportioning the carbonates for any given industry is 1-3 percent. The uncertainty of the overall chemical analysis pertaining to carbonate content and identity also is 1-3 percent.

Uncertainty for EF:

The following is relevant (2006 IPCC GL, p. 2.39)

Assuming that the activity data are collected correctly, and thus the correct emission factor is applied, there is negligible uncertainty associated with the emission factor. There may be some uncertainty associated with assuming a fractional purity of limestone and dolomite in cases where only carbonate rock data are available (+/- 1-5 percent).

Quantitative uncertainty estimates are provided in Annex 6.

4.2.4.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.

Check with IPPC reports on the activity data used.
EU ETS CO_2 emissions used for the emission factor estimation and recalculations.

4.2.4.6 Source specific recalculations

Emission factor for the period before 2008 is changed as a mistake has been found during the check of data for 2008.

4.2.4.7 Source specific planned improvements

The option of application of the emission factor for 2009 back in time is considered, as 2008 is the first year for reporting and there is less probability data from operators to be incorrect. Also operators who reports in 2008 are significantly fewer.

4.2.5 OTHER PROCESS USES OF CARBONATES (CRF 2.A.4): SODA ASH USE (CRF 2.A.4.B)

4.2.5.1 Source category description

In this category CO_2 emissions from soda ash use in glass production and non-ferrous metal processing are considered and other industries.

4.2.5.2 Trend description

The use of soda ash depends mainly on production where it is used, as most strongly is influenced by the glass industry (glass production), because there is used about 80-90% of the total quantity use in the country.

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production. Third period with major fluctuations is worldwide economic crisis in 2009-2010.

There was a peak in 2006 which is due to approach to calculate the amounts of soda ash used in the country as = production + export – import, and not on the actual use amounts. This approach is assumed in order to avoid underestimation of emissions, because all enterprises using soda ash in manufacturing processes cannot be covered (approximately 5-6% lower than reported). This peak is due to approximately 100 000 t less quantities exported than previous years, approximately the same amount of output and about 2000 t more imported quantity compared to 2005.

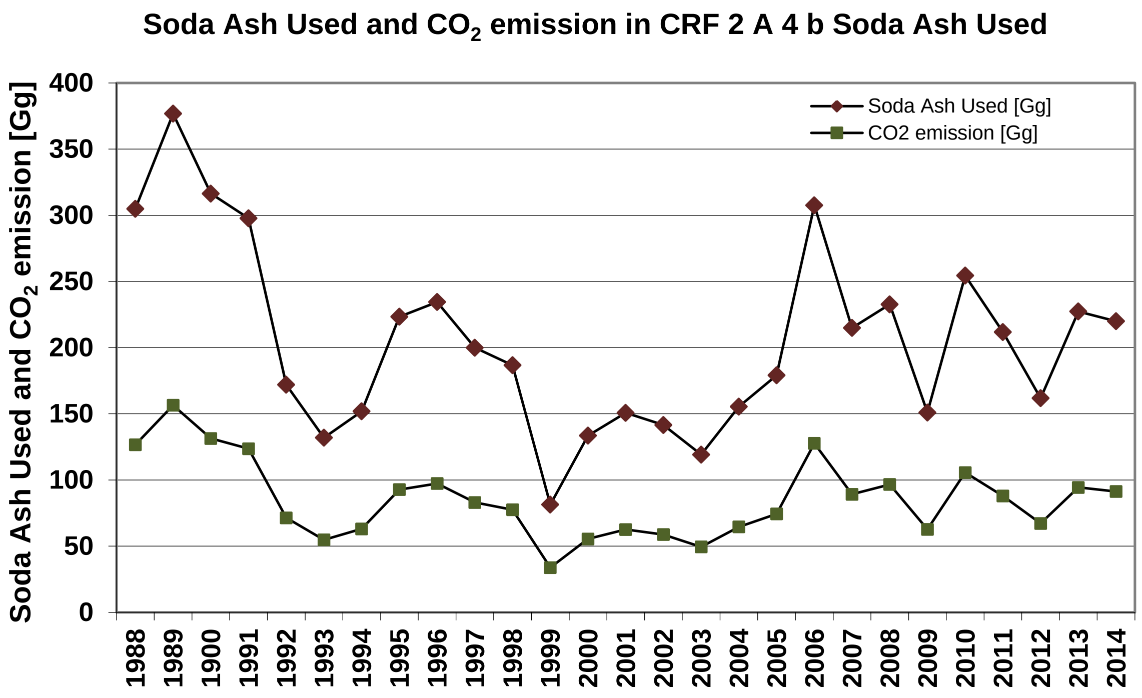

Figure 58 Soda ash used and CO_2 emission in CRF 2.A.4.b "Other Process Uses of Carbonates"

4.2.5.3 Methodological issues

For the period 1988 - 2009 a recalculation of the emissions from soda ash use is made. The following is taken into account: Statistics on soda ash production, imports and exports are obtained from NSI. Based on that a balance is made to obtain the quantity of soda ash used. This quantity is further used as AD for the calculations of the emissions from category 2.A.4.b. The EF for these recalculations is estimated stoichiometrically from Na_2CO_3.

In order to avoid double counting emissions from soda ash used in Glass productions are reported only here under 2.A.4.b and are not considered under Glass production (2.A.3).

4.2.5.3.1 Method

Emissions of CO_2 from Soda ash use are estimated using the methodology described in recommendations of the 2006 IPCC Guidelines and a default emission factor from the same guidelines (415.229 kg CO_2/t soda). Plant specific and country specific data were used to estimate CO_2 emissions from Soda ash use.

In emissions estimations the general approach is applied using the following equation:

$$\textbf{TOTAL } CO_2 = AD \bullet EF$$

where:

TOTAL = the process emission (tonnes) of CO_2

AD = soda ash used (tonnes/yr) – it is assumed that the pure substance is 100% (in fact it is in the range of 99.75-99.85%, a slight overestimation of emissions by 0.2%)

EF = the emission factor for CO_2 (EF = 415.229 kg CO_2/t soda)

4.2.5.3.2 CO_2 Emission factor

Default emission factor (stoichiometry) of 415.229 kg CO_2/t soda ash used for the whole time series was used as described in the 2006 IPCC Guidelines

4.2.5.3.3 Activity data

The activity data is calculated based on the material balance for the production, import and export of soda ash in the country, according to the recommendation of the ERT during 2012.

Table 118 Soda ash used and CO_2 emission in CRF 2.A.4 b

Year	Soda ash used [kt/y]	CO_2 EF [t CO_2/kt soda]	CO_2 Emissions [Gg CO_2]
1988	304.86	415.229	126.58
1989	376.79	415.229	156.45
1990	316.39	415.229	131.37
1991	297.79	415.229	123.65
1992	171.96	415.229	71.40
1993	131.96	415.229	54.79
1994	151.86	415.229	63.06

Year	Soda ash used [kt/y]	CO_2 EF [t CO_2/kt soda]	CO_2 Emissions [Gg CO_2]
1995	223.34	415.229	92.74
1996	234.48	415.229	97.36
1997	199.95	415.229	83.03
1998	186.70	415.229	77.53
1999	81.41	415.229	33.80
2000	133.50	415.229	55.43
2001	150.73	415.229	62.59
2002	141.56	415.229	58.78
2003	119.17	415.229	49.48
2004	155.47	415.229	64.55
2005	179.07	415.229	74.35
2006	307.56	415.229	127.71
2007	214.85	415.229	89.21
2008	232.72	415.229	96.63
2009	150.95	415.229	62.68
2010	254.47	415.229	105.66
2011	211.72	415.229	87.91
2012	161.80	415.229	67.18
2013	227.35	415.229	94.40
2014	219.94	415.229	91.33

4.2.5.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	2.4 %
AD	2 %
EF	+/-1 %

Uncertainty for AD:

The two following aspects are relevant (2006 IPCC GL, Chapter 2.5.2)

Assuming that carbonate consumption is allocated to the appropriate consuming sectors/industries, the uncertainty associated with weighing or proportioning the carbonates for any given industry is 1-3 percent.
The uncertainty of the overall chemical analysis pertaining to carbonate content and identity also is 1-3 percent.
Taking the above into account as well as that for the part of the time series statistical (and not plant specific) data were used an uncertainty of 2 % for activity data is assumed.

Uncertainty for EF:

The following is taken into account:

In theory the uncertainty associated with the emission factor for this source category should be relatively low, as the emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon calcination of the carbonate. In practice, there are uncertainties due, in part, to variations in the chemical composition of the limestone and other carbonates. For example, in addition to calcium carbonate, limestone may contain smaller amounts of magnesia, silica and sulphur. Assuming that the activity data are collected correctly, and thus the correct emission factor is applied, there is negligible uncertainty associated with the emission factor. There may be some uncertainty associated with assuming a fractional purity of limestone and dolomite in cases where only carbonate rock data are available (+/- 1-5 percent) (2006 IPCC GL, Chapter 2.5.2).

On the basis of the above as well as taking into account that for the part of the time series statistical (and not plant specific) data were used the emission factor uncertainty is assumed as ± 1 % - stoichiometric ratio.

Quantitative uncertainty estimates are provided in Annex 6.

4.2.5.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.

Revised the emission estimation method, by using soda ash mass balance
ISO 9001 and 14 001 standards.
EU ETS reports - emission from soda ash used in glass production (calculated by plants in the reports) and using the mass balance approach are compared.

4.2.5.6 Source specific recalculations

There are no source specific recalculations for this category

4.2.5.7 Source specific planned improvements

No source specific improvements are planned

4.2.6 OTHER PROCESS USES OF CARBONATES (CRF 2.A.4): DESULPHURISATION CRF 2.A.4.D

4.2.6.1 Source category description

Flue gas desulphurization (FGD) is a technology used to remove sulphur dioxide (SO_2) from the exhaust flue gas if fossil fuels power plants. Fossil fuels such as coal, peat and oil contain varying amounts of sulphur. To avoid high emissions of sulphur dioxide to the atmosphere, large combustion plants (in particular plants over 100 MWth) are usually equipped with FGD.

Nowadays there are many different ways of reducing the SO_2 emissions generated by the combustion of fossil fuels. In Bulgaria two following desulphurization techniques are applied:

<u>Use of adsorbents in fluidised bed combustion systems</u>

This is a primary measure to reduce the sulphur oxide emissions. The use of adsorbents in fluidised bed combustion systems are integrated desulphurisation systems. This limits the combustion temperature to about 850°C. The adsorbent utilised is typically CaO, $Ca(OH)_2$ or $CaCO_3$. The reaction needs a surplus of adsorbent with a stoichiometric ratio (fuel/adsorbent) of 1.5 to 7 depending on the fuel. Due to chlorine corrosion effects, the desulphurisation rate is limited by 75%. This technique is mainly utilised in coalfired LCPs and is described in Chapter 4. (LCP BREF, p. 65).

Wet scrubbers

This is a secondary measure to reduce sulphur oxide emissions. Wet scrubbers, especially the limestone-gypsum processes, are the leading FGD technologies. They are used in large utility boilers. This is due to their high SO_2 removal efficiency and their high reliability. Limestone is used in most cases as the sorbent, as it is available in large amounts in many countries and is cheaper to process than other sorbents. By-products are either gypsum or a mixture of calcium sulphate/sulphite, depending on the oxidation mode. (LCP BREF, p. 66 - 67).

Limestone and quicklime are used for desulphurisation in the large combustion plants (LCP) in Bulgaria. CO_2 emissions in this sector are estimated only for these LCP's which use limestone for desulphurisation. Currently there are five LCP in Bulgaria applying desulphurization for the flue gas cleaning with lime stone. Four of them have desulphurization installations applying wet scrubbing process and the fifth one is using fluidized bed combustion system where the desulphurisation is incorporated into the combustion process.

4.2.6.2 Trend description

The first desulphurization installation started its operation in 2002. The next desulphurization installations started operation in 2006 - 2012.

In 2005 there was only one plant with such instillations and during that year its boilers with desulphurization installations had reduced capacity.

There is a reduced demand for electrical energy in 2012 compared to 2011, due to which the emissions are lower despite the fact that one of the installations switched from quick lime to limestone.

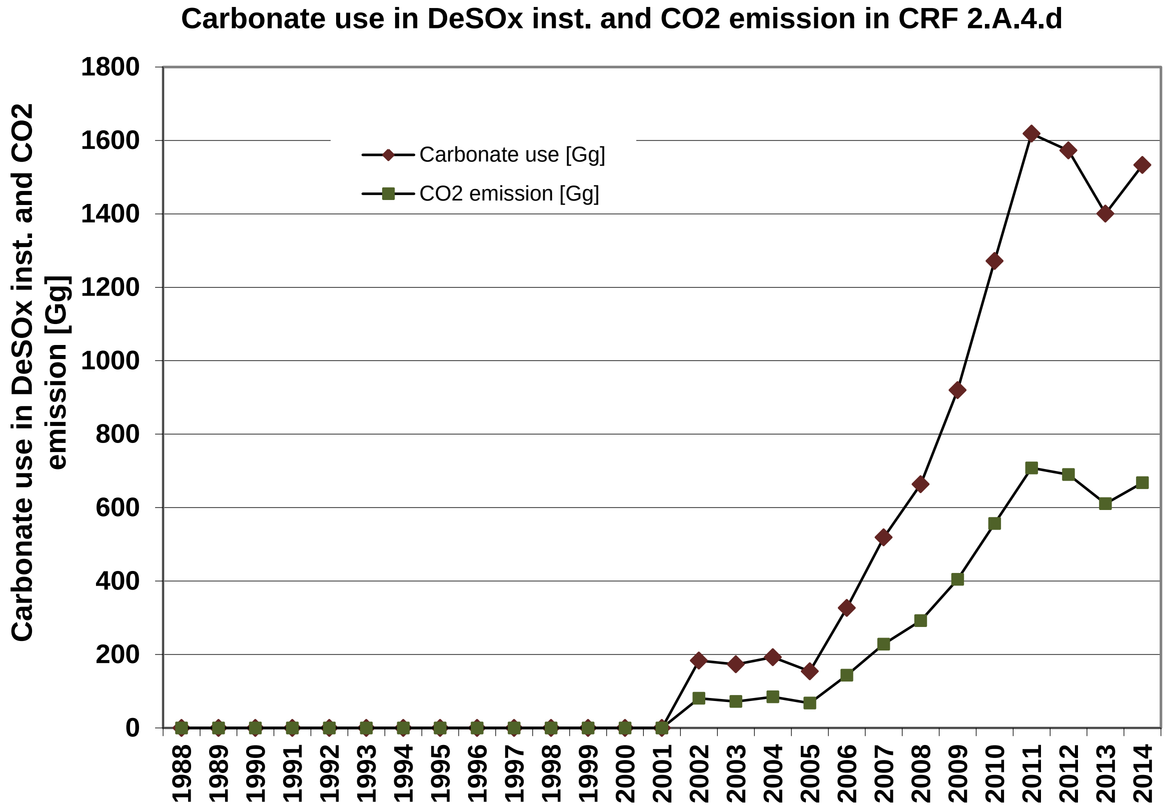

Figure 59 $CaCO_3$, $MgCO_3$ use and CO_2 emission in CRF 2.A.4.d "Other Process Uses of Carbonates"

4.2.6.3 Methodological issues

Tier 2 method for the CO_2 emissions estimation is used. The CO_2 emissions estimated using the above equation are taken from the LCP operators the EU ETS reports. The quantities of calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$) used for the estimations are also taken form the EU ETS reports thus allowing to take into account the pure carbonates used in the process.

4.2.6.3.1 Method

Tier 2 method for the CO_2 emissions estimation is used. Under Tier 2, the amount of CO_2 emitted from the use of limestone and dolomite is estimated from a consideration of consumption and the stoichiometry of the chemical processes.

The equation used to estimate the emissions is as follows:

$$\mathbf{CO_2\ Emissions = (M_{Ca} \bullet EF_{Ca}) + (M_{Mg} \bullet EF_{Mg})}$$

Where:

CO_2 Emissions = emissions of CO_2 from other process uses of carbonates - desulphurisation, tonnes

M_{Ca} or M_{Mg} = mass of Ca Carbonate and Mg Carbonate (consumption), tonnes.

EF_{Ca} or EF_{Mg} = emission factor for Ca Carbonate and Mg Carbonate calcination respectively, tonnes CO_2/tonne carbonate

The CO_2 emissions estimated using the above equation are taken from the operators EU ETS reports.

4.2.6.3.2 CO_2 Emission factor

The emission factor is based on the mass of CO_2 released per mass of carbonate consumed (2006 IPCC GL, p. 2.7).

The EFs used to estimate CO_2 emissions from desulphurization processes are the following:

EF_{CaCO3} = 0.440,

EF_{MgCO3} = 0.522.

4.2.6.3.3 Activity data

Plant specific activity data on the amount of carbonates use are obtained from the EU ETS reports.

Issue of double counting:

The quantity of carbonates used in desulphurization are not considered in CRF 2.A.3 Limestone and dolomite use.

Table 119 Carbonate use in DeSOx inst.($CaCO_3$ and $MgCO_3$) use and CO_2 emission in CRF 2.A.4.d

Year	Ca Carbonate and Mg Carbonate use [kt/y]	CO_2 EF [kt CO_2/kt Lime]	CO_2 Emissions [Gg CO_2]
1988	0,0	-	0,0
1989	0,0	-	0,0
1990	0,0	-	0,0
1991	0,0	-	0,0
1992	0,0	-	0,0
1993	0,0	-	0,0
1994	0,0	-	0,0
1995	0,0	-	0,0
1996	0,0	-	0,0
1997	0,0	-	0,0
1998	0,0	-	0,0
1999	0,0	-	0,0
2000	0,0	-	0,0
2001	0,0	-	0,0
2002	183.58	0.440	80.77
2003	173.28	0.416	72.10
2004	192.61	0.440	84.75
2005	154.26	0.440	67.87
2006	326.62	0.440	143.71
2007	518.91	0.440	228.32
2008	663.61	0.440	292.19
2009	919.70	0.440	404.66
2010	1271.65	0.438	556.68

Year	Ca Carbonate and Mg Carbonate use [kt/y]	CO_2 EF [kt CO_2/kt Lime]	CO_2 Emissions [Gg CO_2]
2011	1618.22	0.438	708.16
2012	1572.51	0.439	690.11
2013	1400.64	0.436	610.83
2014	1532.72	0.436	667.83

4.2.6.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	2.9 %
AD	±1.5 %
EF	±2.5 %

Uncertainty for AD:

Activity data uncertainties are greater than the uncertainties associated with emission factors. Assuming that carbonate consumption is allocated to the appropriate consuming sectors/industries, the uncertainty associated with weighing or proportioning the carbonates for any given industry is 1-3 percent. The uncertainty of the overall chemical analysis pertaining to carbonate content and identity also is 1-3 percent (2006 IPCC GL, p. 2.39).

Uncertainty for EF:

In theory the uncertainty associated with the emission factor for this source category should be relatively low, as the emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon calcination of the carbonate. In practice, there are uncertainties due, in part, to variations in the chemical composition of the limestone and other carbonates. For example, in addition to calcium carbonate, limestone may contain smaller amounts of magnesia, silica and sulphur. Assuming that the activity data are collected correctly, and thus the correct emission factor is applied, there is negligible uncertainty associated with the emission factor. There may be some uncertainty associated with assuming a fractional purity of limestone and dolomite in cases where only carbonate rock data are available (+/- 1-5 percent) (2006 IPCC GL, p. 2.39).

4.2.6.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.

AD compared with the annual reports under IPPC.
ISO 9001 and 14 001 standards.
EU ETS reports

4.2.6.6 Source specific recalculations

There are no source specific recalculations for this category.

4.2.6.7 Source specific planned improvements

No source specific improvements are planned.

4.3 CHEMICAL INDUSTRY (CRF 2.B)

4.3.1 AMMONIA PRODUCTION (CRF 2.B.1)

4.3.1.1 Source category description

Ammonia is synthesised from nitrogen and hydrogen by the following reaction:

$$N_2 + 3H_2 = 2NH_3.$$

The technological process for Ammonia production in both of the currently operating plants is similar. Ammonia (NH_3) is produced by catalytic steam reforming of natural gas. The feedstock is reformed with steam in a heated primary reformer and subsequently with air in a second reformer in order to produce the synthesis gas.

The reaction taking place during primary reforming is:

$$CH_4 + H_2O = CO + 3H_2$$

$$CO + H_2O \rightarrow CO_2 + H_2$$

The main objective of secondary reforming is to add the nitrogen required for the synthesis and to complete the conversion of the hydrocarbon feed.

The synthesis gas then undergoes processes of heat and CO_2 removal and reaction of methanation due to the fact that small amounts of CO and CO_2, remaining in the synthesis gas, are poisonous for the ammonia synthesis catalyst. The synthesis gas is then compressed in a compressor to the required pressure for Ammonia synthesis.

Currently ammonia is produced in two plants in Bulgaria. Both plants are falling under the IPPC Directive and EU ETS. Until the year of 2002 there were four plants operating.

Urea production

The basic process, developed in 1922, is also called the Bosch–Meiser urea process after its discoverers. The various commercial urea processes are characterized by the conditions under which urea formation takes place and the way in which unconverted reactants are further processed. The process consists of two main equilibrium reactions, with incomplete conversion of the reactants. The first is carbamate formation: the fast exothermic reaction of liquid ammonia with gaseous carbon dioxide (CO2) at high temperature and pressure to form ammonium carbamate (H2N-COONH4):

$$2NH_3 + CO_2 \rightleftharpoons H_2N\text{-}COONH_4$$

The second is urea conversion: the slower endothermic decomposition of ammonium carbamate into urea and water:

$$H_2N\text{-}COONH_4 \rightleftharpoons (NH_2)_2CO + H_2O$$

The overall conversion of NH_3 and CO_2 to urea is exothermic, the reaction heat from the first reaction driving the second. Like all chemical equilibria, these reactions behave according to Le Chatelier's principle, and the conditions that most favour carbamate formation have an unfavourable effect on the urea conversion equilibrium. The process conditions are, therefore, a compromise: the ill-effect on the first reaction of the high temperature (around 190̂°C) needed for the second is compensated for by conducting the process under high pressure (140–175 bar), which favours the first reaction. Although it is necessary to compress gaseous carbon dioxide to this pressure, the ammonia is available from the ammonia plant in liquid form, which can be pumped into the system much more economically. To allow the slow urea formation reaction time to reach equilibrium a large reaction space is needed, so the synthesis reactor in a large urea plant tends to be a massive pressure vessel

4.3.1.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation, which is the case in 1999/2000 and 2002 when two of the ammonia producing plants stopped working.

Urea production is discontinued after 2003 with termination / suspension of operations of two of the four factories for the production of fertilizers in Bulgaria.

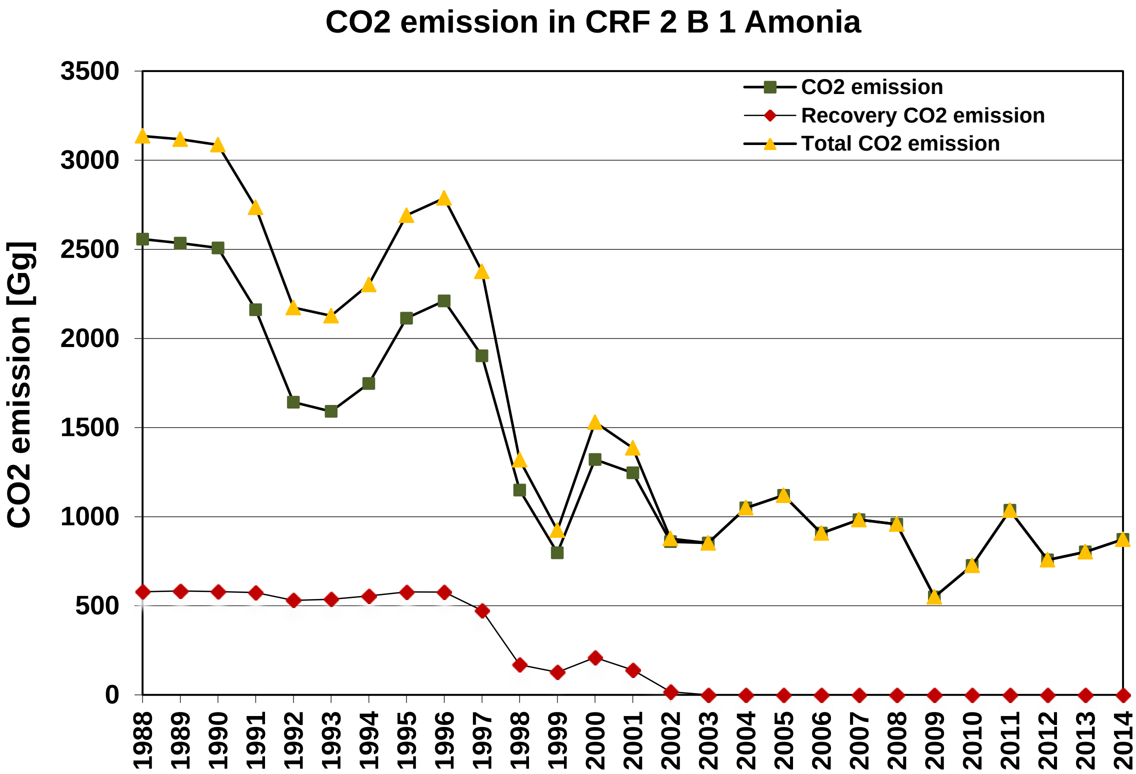

Figure 60 Ammonia Production and CO_2 emission in CRF 2 B 1 Ammonia production

4.3.1.3 Methodological issues

4.3.1.3.1 Method

Tier method – Tier 2, is applied using the following equations from the 2006 IPCC Guidelines (Chapter 3: Chemical Industry Emissions, equation 3.2).

TOTAL FUEL REQUIREMENT FOR AMMONIA PRODUCTION – TIER 2

$$TFR_i = \sum_j (AP_{ij} \times FR_{ij})$$

Where:

TFR_i = total fuel requirement for fuel type i, GJ

AP_{ij} = ammonia production using fuel type i in process type j, tonnes

FR_{ij} = fuel requirement per unit of output for fuel type i in process type j, GJ/tonne ammonia produced

CO_2 EMISSIONS FROM AMMONIA PRODUCTION – TIER 2

$$E_{CO_2} = \sum_i \left(TFR_i \times CCF_i \times COF_i \times \frac{44}{12} \right) - R_{CO_2}$$

Where:

E_{CO2} = emissions of CO_2, kg

TFR_i = total fuel requirement for fuel type i, GJ

CCF_i = carbon content factor of the fuel type i, kg C/GJ

COF_i = carbon oxidation factor of the fuel type i, fraction – "1"

R_{CO2} = CO_2 recovered for downstream use (urea production, CO_2)

Data on COF are default (1, fraction) and they are taken from Table 3.1 from the 2006 IPCC Guidelines (Chapter 3, p. 3.15). All other parameter and data are plant specific.

4.3.1.3.2 CO_2 Emission factor

Based on plant specific data of the currently operating plants emission factors for the whole time series are estimated.

An implied emission factor is used to recalculate CO_2 emissions for the rest of the ammonia producing plants.

4.3.1.3.3 Activity data

For the whole time series (where available) plant specific activity data were used. An adjustment with statistical data from NSI has been made for the periods where no activity data for all the ammonia producing plants were available.

The following questionnaire is regularly sent to the plant operator:

Table 120 Questionnaire to plant operator of Ammonia production

1	Ammonia production (100%)	t
2	Amount of natural gas per t Ammonia	$Nm^3/t\ NH_3$
3	Amount of natural gas used	Nm^3
4	Natural gas input (Net caloric value)	GJ
5	Amount of natural on the base of the density of natural gas	t
6	Carbon content	t
7	Carbon content	kg/GJ
8	Carbon stored	t

Issue of double counting:

In order to avoid double counting, the quantity of gas used is subtracted from the quantity reported under energy and non-energy use in the Energy Chapter.

Table 121 Ammonia production and CO_2 emission in CRF 2.B.1 Ammonia production

Year	Ammonia Production (NH_3) [kt/y]	Ammonia Production (NH_3) [kt/y]	CO_2 IEF [kt CO_2/kt NH_3]	Total CO_2 Emissions [Gg CO_2]	CO_2 Emissions [Gg CO_2]	Recovery CO_2 Emissions [Gg CO_2]
1988	PS data / NSI	C	C	3135.83	2557.48	578.35
1989	PS data / NSI	C	C	3117.50	2534.99	582.51
1990	PS data / NSI	C	C	3086.75	2507.86	578.89
1991	PS data / NSI	C	C	2735.14	2161.46	573.68
1992	PS data / NSI	C	C	2172.80	1642.49	530.31
1993	PS data / NSI	C	C	2126.94	1590.65	536.29
1994	PS data / NSI	C	C	2302.31	1747.51	554.81
1995	PS data / NSI	C	C	2690.85	2113.66	577.19
1996	PS data / NSI	C	C	2787.40	2210.79	576.60
1997	PS data / NSI	C	C	2375.83	1902.39	473.44
1998	PS data / NSI	C	C	1318.42	1149.26	169.15
1999	PS data / NSI	C	C	923.66	797.10	126.57
2000	PS data / NSI	C	C	1530.19	1320.60	209.59
2001	PS data / NSI	C	C	1385.59	1246.05	139.53
2002	PS data / NSI	C	C	876.68	859.89	16.79
2003	PS data	C	C	852.05	852.05	0.00
2004	PS data	C	C	1049.30	1049.30	0.00
2005	PS data	C	C	1119.75	1119.75	0.00
2006	PS data	C	C	907.38	907.38	0.00
2007	PS data	C	C	983.34	983.34	0.00
2008	PS data	C	C	957.37	957.37	0.00
2009	PS data	C	C	549.64	549.64	0.00
2010	PS data	C	C	726.12	726.12	0.00

Year	Ammonia Production (NH_3) [kt/y]	Ammonia Production (NH_3) [kt/y]	CO_2 IEF [kt CO_2/kt NH_3]	Total CO_2 Emissions [Gg CO_2]	CO_2 Emissions [Gg CO_2]	Recovery CO_2 Emissions [Gg CO_2]
2011	PS data	C	C	1035.76	1035.76	0.00
2012	PS data	C	C	757.52	757.52	0.00
2013	PS data	C	C	802.19	802.19	0.00
2014	PS data	C	C	872.51	872.51	0.00

C - Confidential data

Confidentiality issue

In accordance with the 'Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. As mentioned in § 27 emissions and removals should be reported at the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information (FCCC/SBSTA/2006/9).

In CRF 2.B.1 Ammonia production the production data and the EF as well as IEF is marked as confidential "C", because these information could lead to the disclosure of confidential information provided by the plant operator.

4.3.1.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	7.8 %
AD	±3.5 %
EF	7%

Uncertainty for AD:

The two following aspects are relevant (2006 IPCC GL, Chapter 3.2.3)

Where activity data are obtained from plants, uncertainty estimates can be obtained from producers. These activity data are likely to be highly accurate (i.e., with uncertainty as low as ±2 percent).
Where uncertainty values are not available from other sources, a default value of ±5 percent can be used.
For two plants, which stopped in 1999/2000 and 2002 respectively, statistical data had to be used. Therefore an uncertainty of 3.5 % for activity data is assumed.

Uncertainty for EF:

The uncertainty for the EF is about 7%. This values is derived from European average values for specific energy consumption (Mix of modern and older plants) Average value – natural gas (2006 IPCC GL, Chapter 3, Table 3.1)

Quantitative uncertainty estimates are provided in Annex 6.

4.3.1.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

Check if the estimated emission factors are within the range of default emission factors provided for the Tier 1 method
Check of CO_2 generation rate
ISO 9001 and 14 001 standards, EMAS.

4.3.1.6 Source specific recalculations

There are no source specific recalculations for this category.

4.3.1.7 Source specific planned improvements

No source specific improvements are planned.

4.3.2 NITRIC ACID PRODUCTION (CRF 2.B.2)

4.3.2.1 Source category description

Currently nitric acid is produced in two plants in Bulgaria. Both plants are falling under the IPPC Directive and ETS. Until 1999/2000 there were three plants operating.

The nitric acid is produced by following general technological steps:

Oxidation of NH_3

NH_3 is reacted with air on a catalyst in the oxidation section. Nitric oxide and water are formed in this process according to the main equation:

$$4\ NH_3 + 5\ O_2 = 4\ NO + 6\ H_2O$$

Nitrous oxide, nitrogen and water are formed simultaneously in accordance with the following equations:

$$4\ NH_3 + 3\ O_2 = 2\ N_2 + 6\ H_2O$$

$$4\ NH_3 + 4\ O_2 = 2\ N_2O + 6\ H_2O$$

The reaction is carried out in the presence of a catalyst.

Oxidation of NO and absorption in H_2O

Nitric oxide is oxidised to nitrogen dioxide as the combustion gases are cooled, according to the equation:

$$2\ NO + O_2 = 2\ NO_2$$

For this purpose, secondary air is added to the gas mixture obtained from the ammonia oxidation. Demineralised water, steam condensate or process condensate is added at the top of the absorption column. The weak acid solution (approximately 43 %) produced in the cooler condenser is also added to the absorption column. The NO_2 in the absorption column is contacted counter currently with flowing H_2O, reacting to give HNO_3 and NO:

$$3\ NO_2 + H_2O = 2\ HNO_3 + NO$$

The oxidation, absorption of the nitrogen dioxide and its reaction to nitric acid and nitric oxide take place simultaneously in the gaseous and liquid phases. Both reactions (oxidation and

HNO_3 formation) depend on pressure and temperature and are favoured by higher pressure and lower temperature.

The most common treatment techniques for tail gases from nitric acid plants are:

SCR (Selective Catalytic Reduction, for NOx abatement)
NSCR (Selective Non-Catalytic Reduction, for NOx and N_2O abatement)
One of the currently operating plants conducts both reactions of oxidation and absorption at normal pressure and the other plant – at high pressure. Both of the plants are using NSCR as emissions abatement technology.

4.3.2.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation, which is the case around 1999/2000 with one of the nitric acid producing plants.

There is 44% reduction of the total emission in the sector in 2012 compared to 2011, which is due to production decrease with 28% in November 2011 as well as utilisation of new treatment facilities in one of the plants to reduce the N_2O emissions the following treatment facilities are utilised after 2005.

- Catalytic converter for N_2O reduction since September 2005 – average efficiency 75%
- Since November 2011 catalyst DN_2O(BASF) – 85% efficiency for N_2O

This is connected with the decrease of the Ammonia production which is performed by the same plants.

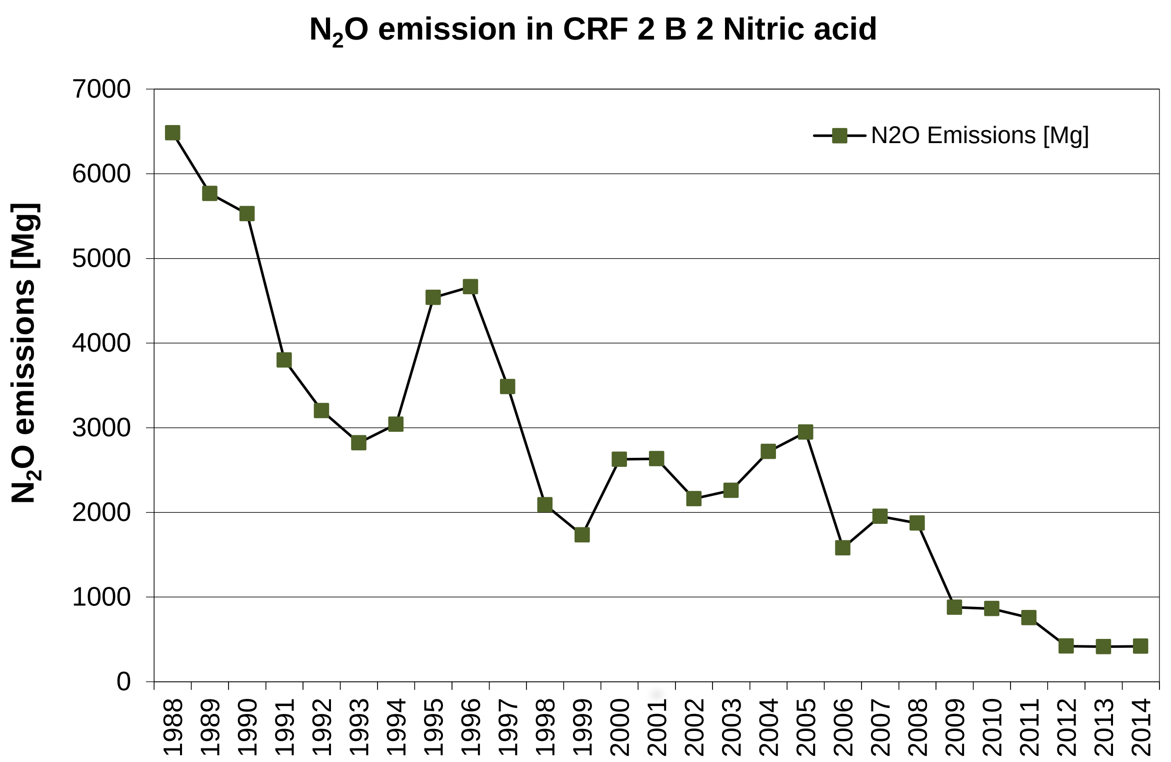

Figure 61 Nitric acid production and N_2O emission in CRF 2 B 2 Nitric acid production

4.3.2.3 Methodological issues

4.3.2.3.1 Method

Taking into account the recommendations of the ERT for N_2O emissions from the nitric production, plant specific data are used and a country specific emission factor was developed. Following the Decision tree for N_2O emissions from nitric acid production (IPCC GPG 2000, p. 3.32) plant specific data on N_2O emissions and destruction were obtained. A higher tier method (referred as Tier 3 in 2006 IPCC Guidelines, Chapter 3, p. 3.21) is applied, which means that the N_2O emissions are based on real measurement data.

For completing the time series additional data from NSI were also used. The emissions were recalculated using the following equation:

$$\text{Emission } N_2O = IEF * NAP$$

Where:

IEF – Implied emission factor,

NAP – Nitric acid production.

4.3.2.3.2 N_2O Implied Emission factor

For the years 2000 to 2012 a plant specific emission factor was calculated on the basis measured data from plants operators.

For the period 1988 – 2000 the IEF was applied, assuming that technology and abatement types are similar. A default emission factor was applied for the third plant where no information is available and which stopped working in period 1999/2000.

4.3.2.3.3 Activity data

For the 2000 to 2012 emission data from plant operators were available; for the entire time series the production data were available. Following the recommendations of 2006 IPCC GL as a good practice in order to reduce uncertainty all activity data obtained were for 100 % HNO_3.

For the third plant activity data from NSI were used.

The following questionnaire is regularly sent to the plant operator:

Table 122 Questionnaire to plant operator of Ammonia production

1	Nitric acid production (100%)	t
2	N_2O emissions	t/y

Table 123 Nitric acid production and N_2O emission

Year	Nitric acid Production (HNO_3) [kt/y]	Nitric acid Production (HNO_3) [kt/y]	Emission Factor [kt N_2O/kt HNO_3]	N_2O Emissions [kt N_2O]
1988	PS data / NSI	C	C	6.48
1989	PS data / NSI	C	C	5.77
1990	PS data / NSI	C	C	5.53
1991	PS data / NSI	C	C	3.80
1992	PS data / NSI	C	C	3.20
1993	PS data / NSI	C	C	2.82
1994	PS data / NSI	C	C	3.04
1995	PS data / NSI	C	C	4.54
1996	PS data / NSI	C	C	4.67
1997	PS data / NSI	C	C	3.49
1998	PS data / NSI	C	C	2.09
1999	PS data / NSI	C	C	1.73
2000	PS data	C	C	2.63
2001	PS data	C	C	2.63
2002	PS data	C	C	2.16
2003	PS data	C	C	2.26
2004	PS data	C	C	2.72
2005	PS data	C	C	2.95
2006	PS data	C	C	1.58
2007	PS data	C	C	1.95
2008	PS data	C	C	1.87
2009	PS data	C	C	0.88
2010	PS data	C	C	0.86
2011	PS data	C	C	0.76
2012	PS data	C	C	0.42
2013	PS data	C	C	0.41
2014	PS data	C	C	0.42

Confidential issue

In accordance with the 'Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. As mentioned in § 27 emissions and removals should be reported at the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information (FCCC/SBSTA/2006/9).

In CRF 2.B.2 Nitric acid production the production data and the EF as well as IEF is marked as confidential "C", because these information could lead to the disclosure of confidential information provided by the plant operator.

4.3.2.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	7.6 %
AD	±3 %
EF	7%

Uncertainty for AD:

The following aspects are relevant

Typical plant-level production data is accurate to ±2% due to the economic value of having accurate information (2000 IPCC GPG, Chapter 3.2).
A properly maintained and calibrated monitoring system can determine emissions within ±5% at the 95% confidence level (2000 IPCC GPG, Chapter 3.2).
Where uncertainty values are not available from other sources, a default value of ±2 percent can be used (2006 IPCC GL, Chapter 3.3.3.2).
Only for one plant, which stopped in 1999 - 2000, statistical data had to be used. Therefore an uncertainty of 3 % for activity data is assumed.

Uncertainty for EF:

The following aspects are relevant

Default EF uncertainty for Plants with NSCRa is ±10% (2000 IPCC GPG, Table 3.8, Chapter 3).
Default EF uncertainties for Plants with NSCRa (all processes) and Atmospheric pressure plants (low pressure) is ±10% (2006 IPCC GL, Chapter 3.3.2.2).
A properly maintained and calibrated monitoring system can determine emissions within ±5% at the 95% confidence level (2000 IPCC GPG, Chapter 3.2).
Only for one plant, which stopped in 1999 - 2000, data on the abatement technology were unavailable. Therefore an EF uncertainty of about 7 % is assumed.

Quantitative uncertainty estimates are provided in Annex 6.

4.3.2.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

Check with the activity data provided by NSI.

Check of AD with IPPC and E-PRTR reports.

ISO 9001 and 14 001 standards, EMAS.

4.3.2.6 Source specific recalculations

There are no source specific recalculations for this category.

4.3.2.7 Source specific planned improvements

No source specific improvements are planned.

4.3.3 CARBIDE PRODUCTION AND USE (CRF 2.B.5.B)

4.3.3.1 Source category description

Carbide production

There is one carbide producing plant in Bulgaria. It reports under the EU ETS and has the IPPC permit. The process which is used to produce carbide in it is as follows:

Calcium carbide (CaC_2) is made by reducing calcium oxide CaO with carbon e.g., anthracite coal, in electric arc furnaces. The reaction is:

$CaO + 3C \rightarrow CaC_2 + CO$ $(+ \frac{1}{2} O_2 \rightarrow CO_2)$

The CaO used for carbide production is produced by the same plant from limestone. This limestone usage is included in CRF 2.A.2 Lime production in order to avoid double counting with the quicklime production.

The most important application of calcium carbide is producing acetylene (C_2H_2) by reacting CaC_2 with water. A substantial use of acetylene is welding applications

Production and use of acetylene for welding applications is summarised by reaction:

$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$ $(+ 2.5O_2 \rightarrow 2CO_2 + H_2O)$

4.3.3.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

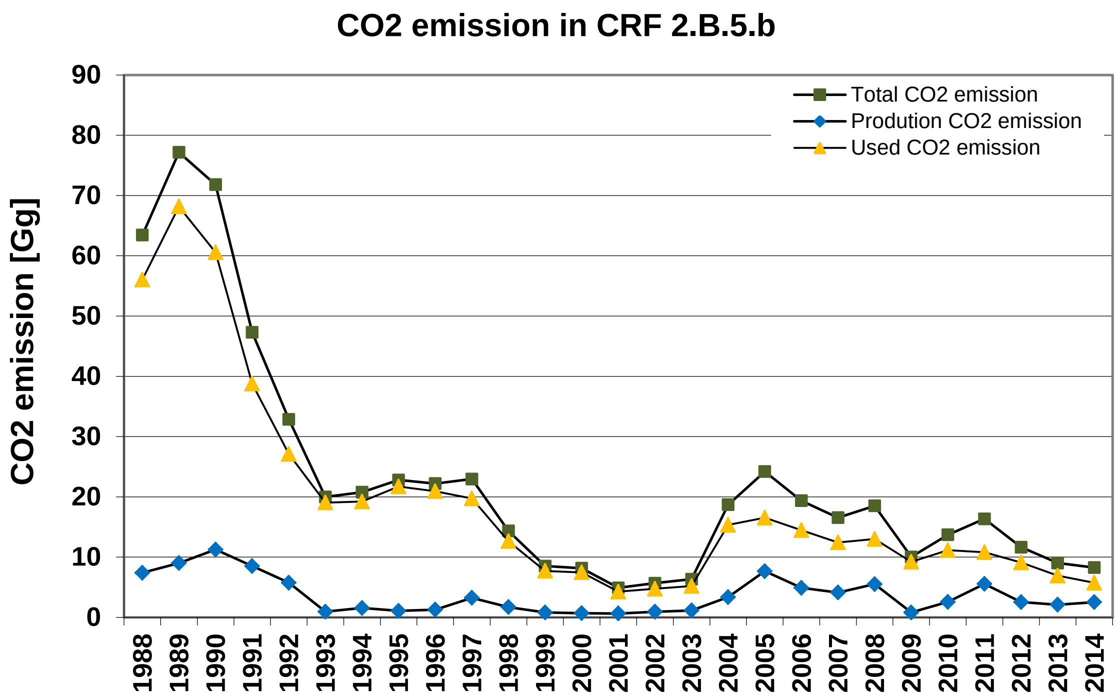

Figure 62 CO_2 emission of Carbide production and use in CRF 2.B.5.b

4.3.3.3 Methodological issues

Tier 3 has been applied from the 2006 IPCC Guidelines, Chapter 3, p. 3.42, additional data are required by the factory for the consumed quantities of coal and graphite electrodes. Data for the period 2003-2013 have been provided. The average ratio for that period has been determined and it is applied for the period 1988-2002.

For calcium carbide use is applied approach that the whole amount of calcium carbide is consumed for the acetylene production, which is used for welding / cutting of scrap metal.

To estimate CO_2 emission is used data from National Statistical Institute and producing factory.

4.3.3.3.1 Method

The emissions of calcium carbide production is calculated using the following equation:

$$E_{CO2} = (ADc \bullet EFc + ADe \bullet EFe – ADp \bullet EFp) \bullet 44/12$$

E_{CO2} - emissions of CO_2, tonnes

ADc - activity data on coal (antratcit) consumption, tonnes

ADe - activity data on graphite electrodes, tonnes

ADp - activity data on calcium carbide, tonnes

EFc - emission factor of carbon content in coals (based on data described in sector Energy - CCF , COF – 100%).

EFe - emission factor of carbon content in graphite electrodes (100%)

EFp- emission factor of carbon content in calcium carbide (based on stoichiometric ratio)

The emissions of calcium carbide use is calculated based on the following equation

$$E_{CO2} = ADp \cdot EFp \cdot 44/12$$

The recovered carbon from calcium carbide production is reported as 100% used.

4.3.3.3.2 CO_2 Emission factor

For the consumed amount of fuels using the same emission factors as described in Chapter energy.

For Graphite electrodes (100% "C" CO_2 / C - 44/12) and calcium carbide ($2CO_2$ / CaC_2 - 1.373 / 2C / Ca - 0,375) have been used the stoichiometric ratios.

4.3.3.3.3 Activity data

Activity data are obtained from producing factory and data from NSI.

Issue of double counting:

The following is considered:

Note that the CaO (lime) might not be produced at the carbide plant. In this case, the emissions from the CaO step should be reported as emissions from lime production and only the emissions from the reduction step and use of the product should reported as emissions from calcium carbide manufacture.

The amount of fuel used is also provided by the NSI in the form of EUROSTAT balance (see sector Energy).

Table 124 CO_2 emission of Carbide production and use in CRF 2.B.5.b

Year	Carbide production [kt/y]	CO_2 IEF [kt CO_2/kt CaC_2]	Total CO_2 Emissions [Gg CO_2]	Production CO_2 Emissions [Gg CO_2]	Used CO_2 Emissions [Gg CO_2]
1988	C	C	63.44	7.40	56.04
1989	C	C	77.18	9.00	68.18
1990	C	C	71.81	11.25	60.56
1991	C	C	47.29	8.52	38.78
1992	C	C	32.86	5.76	27.11
1993	C	C	19.99	0.95	19.04
1994	C	C	20.76	1.55	19.21
1995	C	C	22.80	1.08	21.72
1996	C	C	22.20	1.27	20.93
1997	C	C	22.96	3.24	19.72

Year	Carbide production [kt/y]	CO_2 IEF [kt CO_2/kt CaC_2]	Total CO_2 Emissions [Gg CO_2]	Production CO_2 Emissions [Gg CO_2]	Used CO_2 Emissions [Gg CO_2]
1998	C	C	14.35	1.70	12.64
1999	C	C	8.52	0.81	7.71
2000	C	C	8.16	0.69	7.47
2001	C	C	4.91	0.64	4.27
2002	C	C	5.67	0.93	4.74
2003	C	C	6.33	1.14	5.19
2004	C	C	18.70	3.37	15.34
2005	C	C	24.20	7.67	16.53
2006	C	C	19.37	4.90	14.46
2007	C	C	16.54	4.11	12.43
2008	C	C	18.52	5.52	13.00
2009	C	C	10.03	0.81	9.22
2010	C	C	13.70	2.56	11.14
2011	C	C	16.35	5.55	10.80
2012	C	C	11.64	2.54	9.10
2013	C	C	9.01	2.10	6.92
2014	C	C	8.26	2.53	5.73

Confidential issue

In accordance with the 'Updated UNFCCC reporting guidelines on annual inventories following incorporation of the provisions of decision 14/CP.11. As mentioned in § 27 emissions and removals should be reported at the most disaggregated level of each source/sink category, taking into account that a minimum level of aggregation may be required to protect confidential business and military information (FCCC/SBSTA/2006/9).

In CRF 2.B.5.b Carbide production the production data and the EF as well as IEF is marked as confidential "C", because these information could lead to the disclosure of confidential information provided by the plant operator.

4.3.3.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	11.2 %
AD	±5 %
EF	±10 %

Uncertainty for AD:

The two following aspects are relevant (2006 IPCC GL, p. 3.45)

Where activity data are obtained directly from plants, uncertainty estimates can be obtained from producers. This will include uncertainty estimates for petroleum coke and limestone used and for carbide production data. Data that are obtained from national statistical agencies or from industrial and trade organizations usually do not include uncertainty estimates. It is good practice to consult with national statistical agencies to obtain information on any sampling errors. Where national statistic agencies collect carbide production data from production facilities, uncertainties in national statistics are not expected to differ from uncertainties estimated from plant-level consultations. Where uncertainty values are not available from other sources, a default value of ±5 percent can be used.

Uncertainty for EF:

The following is taken into account:

In general, the default CO_2 emission factors are relatively uncertain because industrial-scale carbide production processes differ from the stoichiometry of theoretical chemical reactions. The uncertainty in the emission factors for CH_4 is due to the possible variations in the hydrogen-containing volatile compounds in the raw material (petroleum coke) that are used by different manufacturers and due to the possible variations in production process parameters. Where uncertainty values are not available from other sources, a default value of ±10 percent can be used.

It is good practice to obtain uncertainty estimates at the plant level which should be lower than uncertainties associated with default values. (2006 IPCC GL, p. 3.45)

4.3.3.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.
AD compared with the annual reports under IPPC.
ISO 9001 and 14 001 standards
EU ETS reports

4.3.3.6 Source specific recalculations

There are no source specific recalculations for this category.

4.3.3.7 Source specific planned improvements

No source specific improvements are planned.

4.3.4 SODA ASH PRODUCTION (CRF 2.B.7)

4.3.4.1 Source category description

There is one soda ash producing plant in Bulgaria. It applies Solvay process which is CO_2-neutral except for coke used for calcination of limestone.

Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production.

Highest drop in 2009 is due to global economic crisis, this trend is observed also in all sectors of the economy in the country.

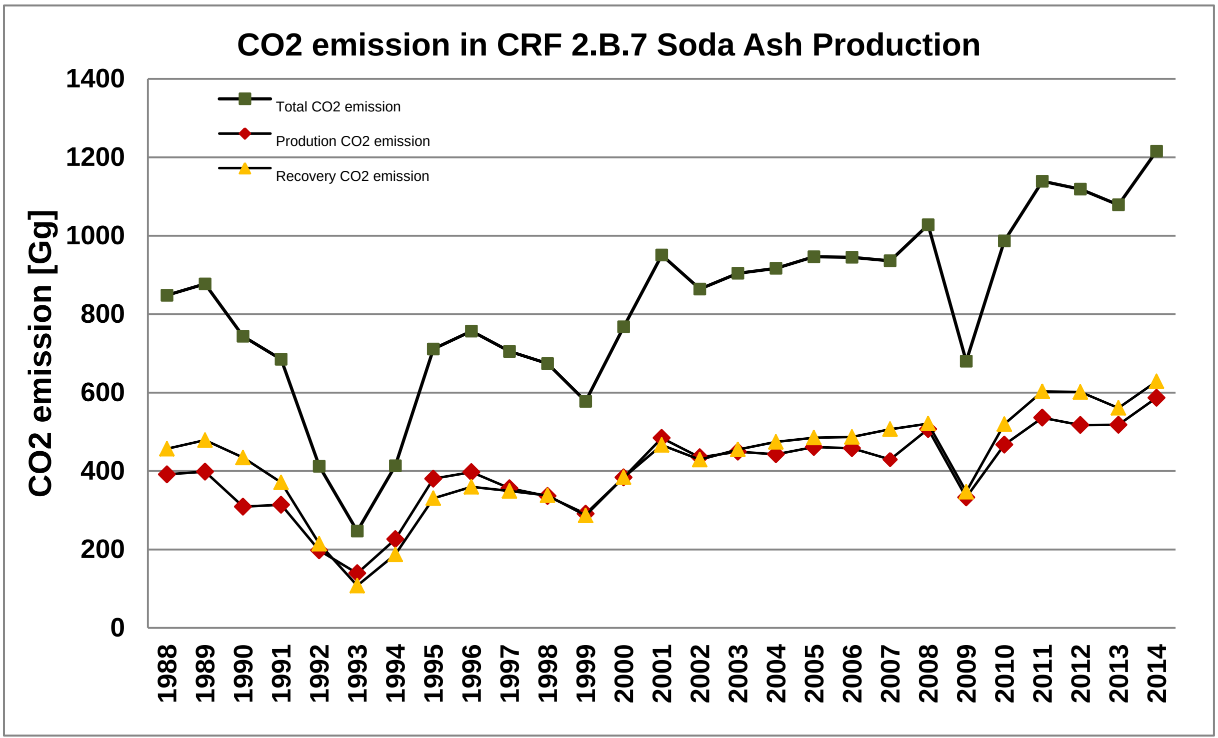

Figure 63 Soda ash production and CO_2 emission in CRF 2.B.7

4.3.4.2 Methodological issues

4.3.4.2.1 Method

Emissions of CO_2 from Soda ash production are estimated using the methodology described in the 2006 IPCC Guidelines. Plant specific and country specific data were used to estimate CO_2 emissions from Soda ash production.

Tier 2 method is applied and data for amount of fuel used and quicklime production was required by the operator. The following equation is used:

$$E_{CO2} = E_{CO2}\ \textbf{(used coal)} + E_{CO2}\ \textbf{(production quick lime)} – \textbf{Recovery}\ E_{CO2}$$

E_{CO2} (used coal) - Emissions from fuel used are calculated in the manner described in chapter Energy.

E_{CO2} (production quick lime) - Emissions from lime production are calculated using the formula described in Lime production – sector 2.A.2.

Recovery E_{CO2} - Recovery CO_2 emissions are calculated using the formula specified in Sector 2.A.4.b Soda ash use

4.3.4.2.2 CO_2 Emission factor

The same emission factors that is described in chapter Energy is used for the consumed amounts of fuels.

EF for the lime production is provided by the enterprise and stoichiometric ratios.

For recovery emissions see sector 2.A.4.b Soda ash use.

4.3.4.2.3 Activity data

Activity data is provided by producing factory and data from NSI.

Issue of double counting:

To avoid double counting of emissions amount of used fuel is removed from the data provided by the NSI in the form Eurostat balance (see the Energy Sector). Also from sector 2.A.2 Lime production, is subtracted the amount of lime produced by the enterprise due to data for sector 2.A.2 provided by the NSI, including data and factory producing soda ash.

Table 125 Soda ash production and CO_2 emission in CRF 2.B.7

Year	Soda ash production [kt/y]	CO_2 IEF [t CO_2/kt soda]	Total CO_2 Emissions [Gg CO_2]	Production CO_2 Emissions [Gg CO_2]	Recovery CO2 Emissions [Gg CO2]
1988	C	C	848.28	391.50	456.78
1989	C	C	877.23	398.48	478.75
1990	C	C	743.61	309.20	434.41
1991	C	C	684.95	314.04	370.91
1992	C	C	412.25	197.72	214.53
1993	C	C	247.05	139.32	107.73
1994	C	C	413.50	226.25	187.25
1995	C	C	711.15	380.61	330.54
1996	C	C	756.95	397.32	359.62
1997	C	C	705.11	356.01	349.10
1998	C	C	674.11	336.17	337.94
1999	C	C	577.81	291.06	286.75
2000	C	C	767.74	383.73	384.01
2001	C	C	950.72	484.37	466.34
2002	C	C	864.05	435.00	429.05
2003	C	C	904.37	449.52	454.85
2004	C	C	917.02	442.80	474.22
2005	C	C	946.40	461.24	485.17
2006	C	C	945.07	458.20	486.87
2007	C	C	936.16	429.46	506.69
2008	C	C	1027.92	506.99	520.94
2009	C	C	679.96	332.87	347.08
2010	C	C	986.62	467.06	519.55
2011	C	C	1139.05	536.00	603.05
2012	C	C	1118.82	517.31	601.50
2013	C	C	1078.85	517.90	560.95
2014	C	C	1215.55	586.88	628.67

4.3.4.3 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	2.4 %
AD	2 %
EF	+/-1 %

Uncertainty for AD:

The two following aspects are relevant (2006 IPCC GL, Chapter 2.5.2)

Assuming that carbonate consumption is allocated to the appropriate consuming sectors/industries, the uncertainty associated with weighing or proportioning the carbonates for any given industry is 1-3 percent.
The uncertainty of the overall chemical analysis pertaining to carbonate content and identity also is 1-3 percent.
Taking the above into account as well as that for the part of the time series statistical (and not plant specific) data were used an uncertainty of 2 % for activity data is assumed.

Uncertainty for EF:

The following is taken into account:

In theory the uncertainty associated with the emission factor for this source category should be relatively low, as the emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon calcination of the carbonate. In practice, there are uncertainties due, in part, to variations in the chemical composition of the limestone and other carbonates. For example, in addition to calcium carbonate, limestone may contain smaller amounts of magnesia, silica and sulphur. Assuming that the activity data are collected correctly, and thus the correct emission factor is applied, there is negligible uncertainty associated with the emission factor. There may be some uncertainty associated with assuming a fractional purity of limestone and dolomite in cases where only carbonate rock data are available (+/- 1-5 percent) (2006 IPCC GL, Chapter 2.5.2).

On the basis of the above as well as taking into account that for the part of the time series statistical (and not plant specific) data were used the emission factor uncertainty is assumed as ± 1 % - stoichiometric ratio.

Quantitative uncertainty estimates are provided in Annex 2.

4.3.4.4 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.

Revised the emission estimation method, by using soda ash mass balance
ISO 9001 and 14 001 standards
EU ETS reports - emission from soda ash used in glass production (calculated by plants in the reports) and using the mass balance approach are compared.

4.3.4.5 Source specific recalculations

A mistake in the calculation file is found, wrong EFs - $CO_2/CaCO_3$ and $CO_2/MgCO_3$ are used. For 2016 submission they are corrected - CO_2/CaO and CO_2/MgO.

CO_2/CaO	**0.78480**
CO_2/MgO	**1.09193**
$CO_2/CaCO_3$	**0.43971**
$CO_2/MgCO_3$	**0.52197**

The calculated emissions from quicklime production are multiplied by 1,02 LKD.

4.3.4.6 Source specific planned improvements

A plant-specific EF for used fuels (PSF) is intended to be done. Also data for calorific value from emissions trading reports are to be used.

4.4 METAL INDUSTRY (CRF 2.C)

4.4.1 IRON AND STEEL PRODUCTION (CRF 2.C.1.A)

4.4.1.1 Source category description

According to the information given in Best Available Techniques Reference Document on the Production of Iron and Steel, December 2001, p. 16, four routes are currently used for the production of steel: the classic blast furnace/basic-oxygen furnace route, direct melting of scrap (electric arc furnace), smelting reduction and direct reduction. At present (1998), EU (15) steel production is based on the blast furnace/ basic-oxygen route (approximately 65%) and the electric arc furnace (EAF) route (approximately 35%).[26]

The following steel making processes are present in Bulgaria:

*Open hearth furnace (*until *1993)*

A type of furnaces where excess carbon and other impurities are burnt out of pig iron to produce steel. Since steel is difficult to manufacture due its high melting point, normal fuels and furnaces are insufficient and the open hearth furnace overcomes this difficulty. Compared to Bessemer steel, which it displaced, its main advantages are that it doesn't expose the steel to excessive nitrogen (which would cause the steel to become brittle), is easier to control, and it permits the melting and refining of large amounts of scrap iron and steel.

[26] (ftp://ftp.jrc.es/pub/eippcb/doc/isp_bref_1201.pdf)

The process is far slower than that of Bessemer converter and thus easier to control and take samples for quality control. As the process is slow, it is not necessary to burn all the carbon away as in Bessemer process, but the process can be terminated at given point when desired carbon contents has been achieved.

*Basic oxygen steelmaking (*until November *2008)*

The objective in oxygen steelmaking is to burn (i.e., oxidise) the undesirable impurities contained in the metallic feedstock. The main elements thus converted into oxides are carbon, silicon, manganese, phosphorus, and sulphur. The purpose of this oxidation process, therefore, is:

to reduce the carbon content to a specified level (from approximately 4% to less than 1%, but often lower)
to adjust the contents of desirable foreign elements
to remove undesirable impurities to the greatest possible extent

The production of steel by the basic oxygen furnace (BOF) process is a discontinuous process which involves the following steps:

transfer and storage of hot metal
pre-treatment of hot metal (desulphurisation)
oxidation in the BOF (decarburisation and oxidation of impurities)
secondary metallurgical treatment
casting (continuous or/and ingot)

Electric steelmaking

The direct smelting of iron-containing materials, such as scrap is usually performed in electric arc furnaces (EAF). The major feed stock for the EAF is ferrous scrap, which may comprise of scrap from inside the steelworks (e.g. offcuts), cut-offs from steel product manufacturers (e.g. vehicle builders) and capital or post-consumer scrap (e.g. end of life products).

With respect to the end-products distinction has to be made between production of ordinary, so called carbon steel as well as low alloyed steel and high alloyed steels/stainless steels. In the EU about 85% of steel production is carbon or low alloyed steel [EC Study, 1996].For the production of carbon steel and low alloyed steels, following main operations are performed:

raw material handling and storage
furnace charging with/without scrap preheating
EAF scrap melting
steel and slag tapping
ladle furnace treatments for quality adjustment
slag handling
continuous casting

For high alloyed and special steels, the operation sequence is more complex and tailor-made for the end-products. In addition to the mentioned operations for carbon steels various ladle treatments (secondary metallurgy) are carried out like

desulphurisation

degassing for the elimination of dissolved gases like nitrogen and hydrogen
decarburisation (AOD=Argon-Oxygen-Decarburisation or VOD=Vacuum-Oxygen-Decarburi-sation)

The steel making plant which produced sinter, pig iron and steel (BOF) ceased operation in November 2008.

Currently in Bulgaria steel is produced only in EAF.

4.4.1.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

There is general reduction of the total emission in the sector in 2009 compared to 2008. This is mainly due to the world economic crisis in 2009 which lead to a reduction of the production processes rates. The total reduction in the sector production is about 45%.

Another factor leading to this reduction is that the biggest plant from this sector (which share in the steel production before 2008 was more than 50%) ceased operation of its pig iron and the following steel making in BOF in November 2008.

Fluctuations in emissions and production of steel is determined by the largest currently producer in the country and depends on the market for products made from it (the share of other producers is under 5%).

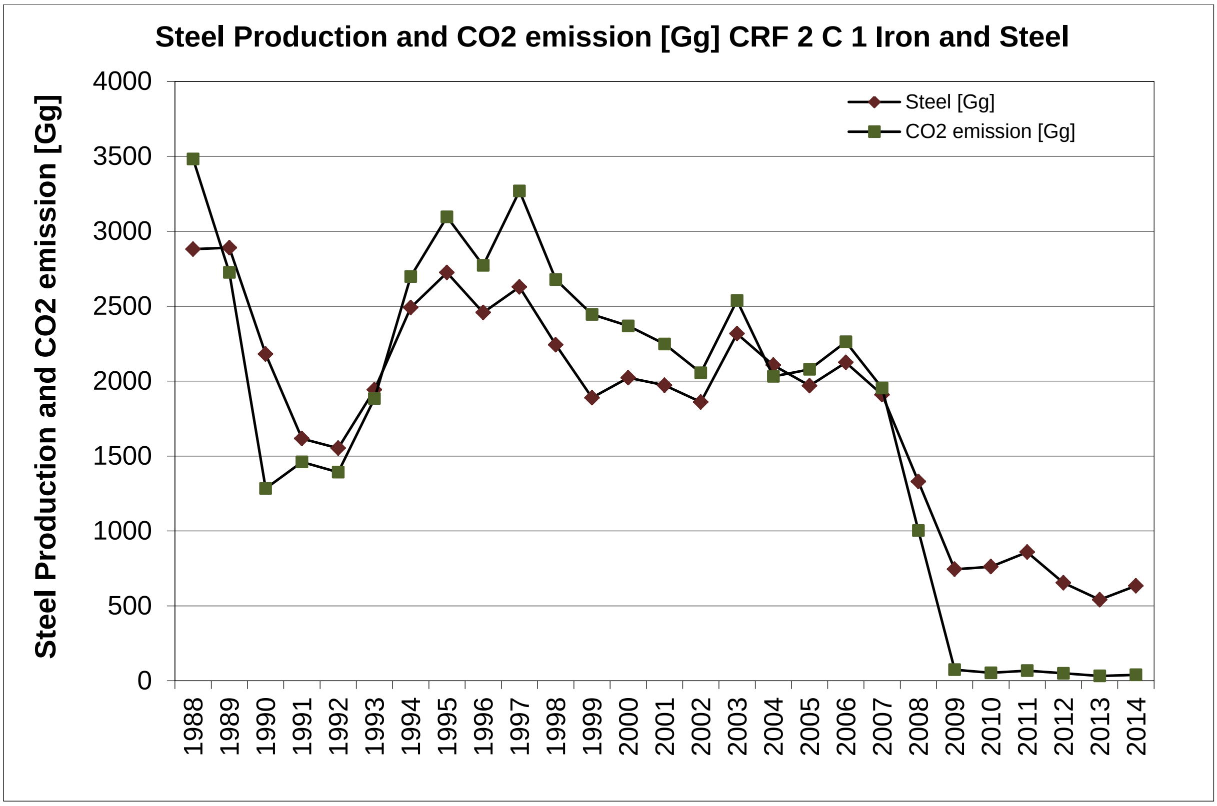

Figure 64 Iron and Steel Production and CO_2 emission in CRF 2.C.1.a Iron and Steel production

4.4.1.3 Methodological issues

4.4.1.3.1 Method

Open hearth furnace

To estimate the CO_2 emissions for this category Tier 1 method is used because the production of steel with this method terminated in 1993 and no information is available to apply a higher Tier method

Basic oxygen steelmaking

To estimate the CO_2 emissions for this category a Tier 2 balance approach is used – carbon contents in the raw materials and the final product. The emissions include the entire production process for this type of steel – including the intermediate pig iron production in the BOF. This method for emissions estimation is implemented during the 2012 ESD review in cooperation with the ESD review experts.

Electric steelmaking

The CO_2 emissions from the sector are calculated using country specific data from the EU ETS reports. Data for 2012 from Bulgarian association of metallurgical industry (BAMI, http://www.bcm-bg.com/) as well as data from World Steel Association (WSA, http://worldsteel.org) are used for crosscheck.

Total emissions are the sum of Equation:

$$\textbf{Iron \& Steel: ECO2, non-energy} = \textbf{BOF} \bullet \textbf{EF}_{\textbf{BOF}} + \textbf{EAF} \bullet \textbf{EF}_{\textbf{EAF}} + \textbf{OHF} \bullet \textbf{EF}_{\textbf{OHF}}$$

4.4.1.3.2 Emission factor

Open hearth furnace – default emission factor is used – 1.72 t CO_2/t Steel (TABLE 4.1

TIER 1 DEFAULT CO2 EMISSION FACTORS FOR COKE PRODUCTION AND IRON & STEEL PRODUCTION - 2006 IPCC GL, Chapter 4.2.2.3, p. 4.25)

Basic oxygen steelmaking

A production specific EF is calculated based on the amount of carbon in the raw materials and the final products. The EF varies for the period 1989 – 2009.

Electric steelmaking

Country specific emission factor was developed for the EAF steel based on data from EU ETS reports for the period 2007 - 2011. In the calculation of ETS emissions the operators performed a mass balance of the Carbon content in the raw materials used and the produced end product. Thus CO_2 emissions are estimated by an approach similar to the following equation (IPCC GPG 2000, p. 3.25):

EQUATION 3.6B

Emissions crude steel = (Mass of Carbon in the Crude Iron used for Crude Steel Production – Mass of Carbon in the Crude Steel) • 44/12 + Emission FactorEAF • Mass of Steel produced in EAF

4.4.1.3.3 Activity data

Country specific data from the EU ETS reports as well as from BAMI and WSA on total crude steel production were received.

Issue of double accounting:

In order to avoid double counting, the quantity the fuel used is subtracted from the quantity reported under energy and non-energy use in the Energy Chapter.

Table 126 Iron and Steel production and CO_2 emission

Year	Steel Production	Steel Production [kt/y]	Emission Factor [kt CO_2/kt Steel]	CO_2 Emissions [kt CO_2]
1988	BAMI / WSA	2880.00	1.209	3481.44
1989	BAMI / WSA	2890.00	0.943	2724.87
1990	BAMI / WSA	2180.00	0.589	1283.24
1991	BAMI / WSA	1616.00	0.904	1460.58
1992	BAMI / WSA	1552.00	0.897	1392.13
1993	BAMI / WSA	1942.00	0.970	1883.71
1994	BAMI / WSA	2490.00	1.083	2697.12
1995	BAMI / WSA	2724.00	1.136	3095.68
1996	BAMI / WSA	2457.00	1.128	2771.76
1997	BAMI / WSA	2628.00	1.244	3268.68
1998	BAMI / WSA	2242.00	1.194	2676.82
1999	BAMI / WSA	1889.00	1.294	2444.83
2000	BAMI / WSA	2022.00	1.171	2368.01
2001	BAMI / WSA	1972.00	1.140	2247.66
2002	BAMI / WSA	1860.00	1.105	2055.21
2003	BAMI / WSA	2316.00	1.096	2537.47
2004	BAMI / WSA	2106.00	0.965	2031.37
2005	BAMI / WSA	1969.00	1.055	2078.16
2006	BAMI / WSA	2124.00	1.065	2261.72
2007	BAMI / WSA / ETS	1909.00	1.023	1953.25
2008	BAMI / WSA / ETS	1330.00	0.754	1003.16
2009	BAMI / WSA / ETS	744.53	0.100	74.17
2010	BAMI / WSA / ETS	761.41	0.070	53.47
2011	BAMI / WSA / ETS	858.92	0.079	67.96
2012	BAMI / WSA / ETS	653.88	0.077	50.33
2013	BAMI / WSA / ETS	541.44	0.060	32.67
2014	BAMI / WSA / ETS	634.03	0.063	40.22

As can be seen in Table 126 the emission factor for 2008 is lower than the ones for the previous years. This is mainly due to the fact that in 2008 the biggest steel making plant (which is also the only one producing steel in BOF) significantly decreased and subsequently stopped BOF steel production. This leads to a decrease in the production as well as in the CO_2 emissions.

For the period 2009-2012, there is no BOF steel production in Bulgaria since the abovementioned steelmaking company stopped its BOF furnaces from operation in November 2008.

Currently the steel in Bulgaria is produced only in EAF hence the IEF takes into account only this type of steel making. In 2008 the IEF includes also BOF steel. Due to the described facts the IEF in 2009-2012 decreases significantly.

4.4.1.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	11.2 %
AD	5 %
EF	10 %

Uncertainty for AD:

The two following aspects are relevant

According to IPCC GPG 2000 (Chapter 3, p 3.28):
For both Tier 1 and 2 the most important type of activity data is the amount of reducing agent used for iron production. According to Chapter 2, Energy, energy data have a typical uncertainty of about 5% (about 10% for countries with less developed energy statistics). For calculating the carbon storage term Tier 2 requires additional activity data on amounts of pig iron and net crude steel production that have a typical uncertainty of a few percent. In addition, Tier 2 requires information on the carbon content of pig iron, crude steel, and of iron ore that may have an uncertainty of 5% when plant-specific data are available. Otherwise the uncertainty in the carbon content could be of the order of 25 to 50%. Finally, the uncertainty in the emission factors for the reducing agent (e.g. coke) are generally within 5% (see Section 2.1.1.6, CO_2 Emissions from Stationary Combustion, Uncertainty Assessment).

Taking into account that plant specific data from EU ETS reports were used to estimate emissions an uncertainty of 5% is considered.

Uncertainty for EF:

According to Table 4.4 (2006 IPCC GL, Chapter 4.2.3) applying Tier 2 material-specific carbon contents would be expected to have an uncertainty of 10 percent. This uncertainty is considered due to using EU ETS data.

Quantitative uncertainty estimates are provided in Annex 2.

4.4.1.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Section 1.6.

CO_2 emissions were taken from ETS reports.
Aggregated national steel production data provided by BAMI and reported by World Steel Association are used for crosscheck.

4.4.1.6 Source specific recalculations

There are no source specific recalculations for this category.

4.4.1.7 Source specific planned improvements

No source specific improvements are planned.

4.4.2 PIG IRON PRODUCTION (CRF 2.C.1.B)

4.4.2.1 Source category description

There is one pig iron production plant in Bulgaria. Currently it has ceased operation (since November 2008).

4.4.2.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

In particular in pig iron production case the only plant ceased operation in November 2008 (see also "Iron and steel production" chapter).

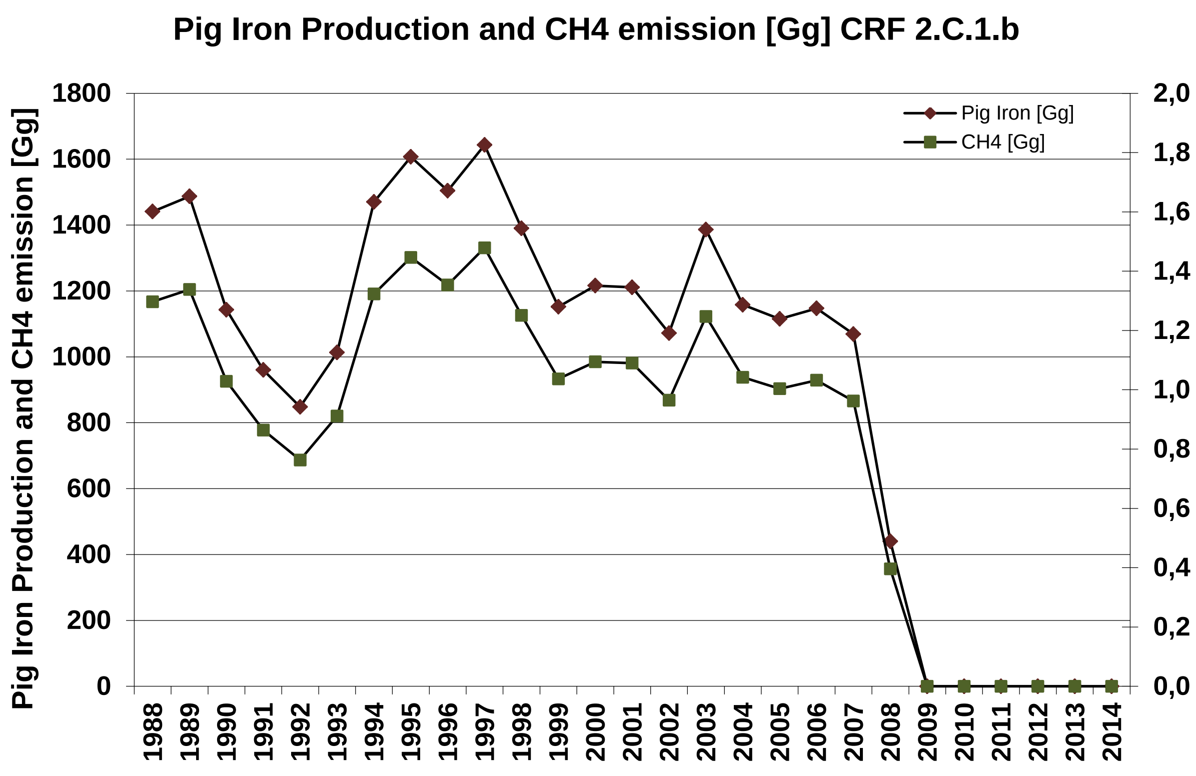

Figure 65 Pig iron Production and CH_4 emission in CRF 2.C.1.b Pig iron production

4.4.2.3 Methodological issues

4.4.2.3.1 Method

Tier 1 methodology for CH_4 based on emission factors and national production statistics is applied (2006 IPCC GL, p. 4.24).The emissions from the sector are calculated using country specific data on the total amount of pig iron produced taken from WSA Yearbooks. Default emission factor is applied.

The emissions are estimated using the following equation (2006 IPCC GL, p. 4.24, equation 4.13).

EQUATION 4.13

CH_4 EMISSIONS FROM BLAST FURNACE PRODUCTION OF PIG IRON (TIER 1)

$$E_{CH4,non-energy} = PI \bullet EF_{PI}$$

Where

$E_{CH4,non-energy}$ – non-energy CH_4 emissions from pig iron production

PI – pig iron production (kt)

EF_{PI} – emission factor for pig iron

4.4.2.3.2 Emission factor

The following is taken into account: "The conversion factors provided in Table 4.1 of the IPPC I&S BAT Document are 940 kg pig iron per tonne liquid steel" (2006 IPCC GL, p. 4.25, BAT Reference Document on the Production of Iron and Steel, December 2001).

Thus an emission factor of 0.9 [kg CH_4/ton production] is obtained.

4.4.2.3.3 Activity data

Country specific data on the total pig iron production are taken from WSA.

The following is also taken into account (2006 IPCC Guidelines, p. 4.28):

"The Tier 1 method requires only the amount of steel produced in the country by process type, the total amount of pig iron produced that is not processed into steel, and the total amount of coke, direct reduced iron, pellets, and sinter produced; in this case the total amount of coke produced is assume to be produced in integrated coke production facilities. These data may be available from governmental agencies responsible for manufacturing statistics, business or industry trade associations, or individual iron and steel companies."

Issue of double counting:

In order to avoid double counting, the CO_2 emissions from pig iron production are reported under BOF steel production (see *Basic oxygen steelmaking*).

Table 127 Pig iron production and CH_4 emission

Year	Pig Iron Production [kt/y]	Emission Factor [t CH_4/ kt production]	CH_4 Emissions [kt CH_4]
1988	1441,00	0,900	1,30
1989	1487,00	0,900	1,34
1990	1143,00	0,900	1,03
1991	960,00	0,900	0,86
1992	848,00	0,900	0,76
1993	1013,00	0,900	0,91
1994	1470,00	0,900	1,32
1995	1607,00	0,900	1,45
1996	1504,00	0,900	1,35
1997	1643,00	0,900	1,48
1998	1390,00	0,900	1,25
1999	1152,00	0,900	1,04
2000	1216,00	0,900	1,09
2001	1211,00	0,900	1,09
2002	1072,00	0,900	0,96
2003	1386,00	0,900	1,25
2004	1158,00	0,900	1,04
2005	1115,00	0,900	1,00
2006	1147,00	0,900	1,03

Year	Pig Iron Production [kt/y]	Emission Factor [t CH_4/ kt production]	CH_4 Emissions [kt CH_4]
2007	1069,00	0,900	0,96
2008	440,00	0,900	0,40
2009	0,00	0,900	0,00
2010	0,00	0,900	0,00
2011	0,00	0,900	0,00
2012	0,00	0,900	0,00
2013	0,00	0,900	0,00
2014	0,00	0,900	0,00

4.4.2.4 Uncertainties and time series consistency

Taking into account the economic crises of 1989/1990 and 1997/1998 all data and time series shall be regarded as consistent.

Combined uncertainty	26.9 %
AD	± 10 %
EF	± 25%

Uncertainty for AD:

For Tier 1 the most important type of activity data is the amount of steel produced using each method. National statistics should be available and likely have an uncertainty of ± 10 percent. (2006 IPCC GL, p. 4.30, see also Table 4.4).

Uncertainty for EF:

The default emission factors for coke production and iron and steel production used in Tier 1 may have an uncertainty of ± 25 percent. (2006 IPCC GL, p. 4.30, see also Table 4.4).

Quantitative uncertainty estimates are provided in Annex 6.

4.4.2.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

Aggregated national pig iron production data and default emission factor are used.

Comparison with NSI and BAMI data on pig iron production.

4.4.2.6 Source specific recalculations

There are no source specific recalculations for this category.

4.4.2.7 Source specific planned improvements

The only pig iron production plant has ceased operation.

No source specific improvements are planned.

4.4.3 FERROALLOYS PRODUCTION (CRF 2.C.2)

4.4.3.1 Source category description

Ferroalloys production is a non-key category.

Ferroalloys production involves a metallurgical reduction process that results in CO_2 emissions.

This is only a minor source of CO_2 and CH_4 emissions in Bulgaria: in 2013, emissions account for the 0.002% of total emissions from Industrial Processes sector.

There is one ferroalloys producer in Bulgaria. Recovered CO_2 emissions in ferroalloys production are not included.

4.4.3.2 Trend description

The periods around 1989/1991 and 1997/1999 represent the economic crisis time after which stabilization and increase in the production rates begins. After 1996 a process of privatization begins which leads to decrease in the plants' production. This process is followed by restructuring and modernization of the production while at the same time some of the enterprises cease operation.

There is a significant decrease of the total emission in the sector aftern 2008. This is due to the fact that a steel making plant which produced sinter, pig iron and steel ceased operation in November 2008.

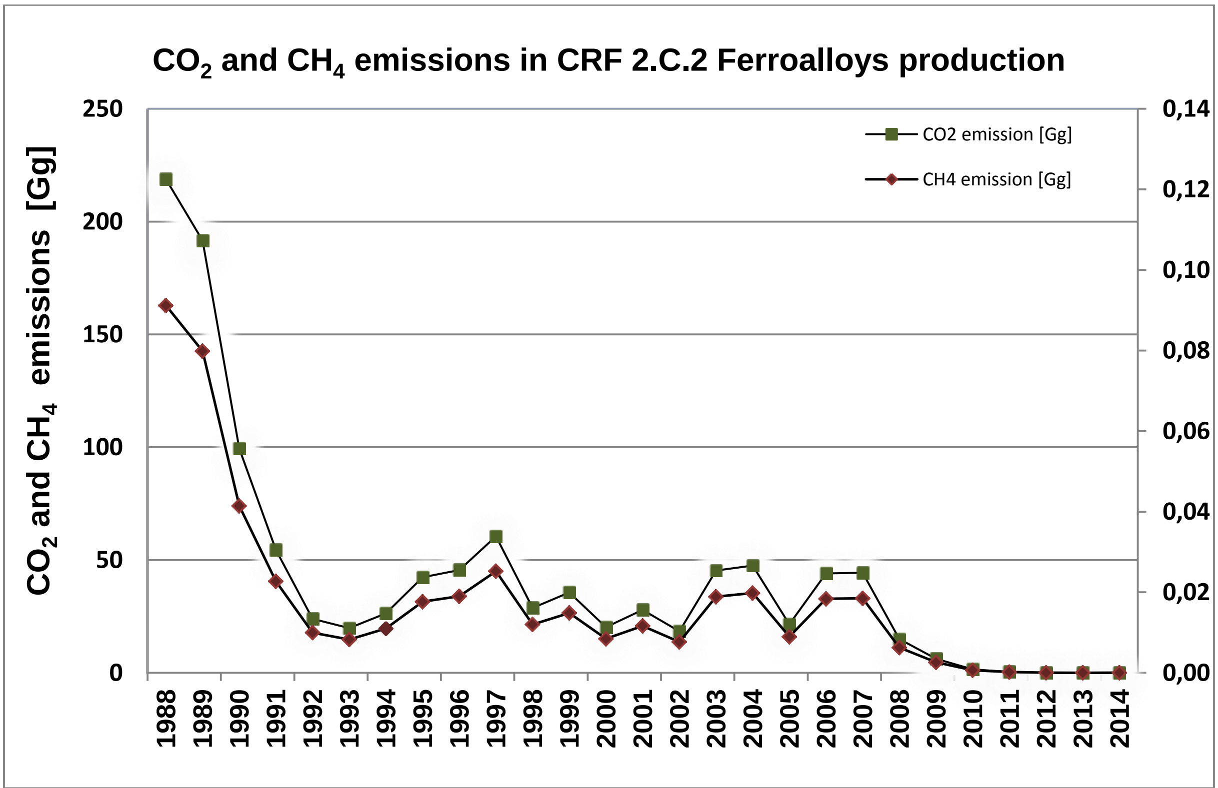

Figure 66 CO_2 and CH_4 emission in CRF 2.C.2 Ferroalloys production

4.4.3.3 Methodological issues

The Tier 1 method based on default values and national statistics is used.

The ferroalloys production is taken from NSI. This quantity is used as AD for the calculations of the emissions from category 2.C.2.

4.4.3.3.1 Method

Emissions of CO_2 and CH_4 from ferroalloys production is estimated using the methodology described in 2006 IPCC Guidelines and an average default emission factor from the same guidelines (table 4.5, p. 4.37 and table 4.7, p. 4.39).

In emissions estimations the general approach described in 2006 IPCC Guidelines is applied using the following equation:

$$\mathbf{TOTAL\ CO_2/CH_4 = \sum(AD_i \bullet EF_i)}$$

where:

TOTAL CO_2 / CH_4= the process emission (tonnes) of CO_2/ CH_4

AD_i = production of ferroalloy type „I“ (tonnes/yr)

EF_i = the emission factor for CO_2 and CH_4 for ferroalloys produced.

4.4.3.3.2 CO_2 and CH4 Emission factor

The EF for these calculations is taken as default (table 4.5, p. 4.37 and table 4.7, p. 4.39).

Average EFs are used for CO_2 emissions and they are presented in the table below by the types of available products and an average EF for CH4 - 1kg /t.

Table 128 CO_2 emission factors used for different types of products

Ferroalloy types	IEF [kg CO_2/t. product]
Ferroalloys	2.82
Ferromanganese - natura	1.40
Ferrosilicone - natura	3.73
Ferrosilicone - 45% Si (natura)	2.50
Ferromanganese, with <2% carbon by weight	1.50
Other Ferroalloys - natura	2.57

4.4.3.3.3 Activity data

Country-specific activity data on the amount of ferroalloys produced and use are obtained from NSI for the whole time period.

Table 129 Ferroalloys production, CO_2 and CH_4 emission in CRF 2.C.2

Year	Ferroalloys production [kt/y]	CH_4 Emissions [kt CH_4]	CO_2 Emissions [kt CO_2]
1988	C	0.0912	254.94
1989	C	0.0798	228.49
1990	C	0.0414	129.37
1991	C	0.0227	73.07
1992	C	0.0100	31.57
1993	C	0.0083	26.90
1994	C	0.0110	35.63
1995	C	0.0177	55.82
1996	C	0.0190	60.41
1997	C	0.0252	79.89
1998	C	0.0120	44.72
1999	C	0.0149	42.28
2000	C	0.0085	21.88
2001	C	0.0117	23.98
2002	C	0.0077	18.05
2003	C	0.0189	44.08
2004	C	0.0198	40.21
2005	C	0.0090	20.10
2006	C	0.0184	40.40
2007	C	0.0185	36.80
2008	C	0.0063	20.99
2009	C	0.0026	7.82
2010	C	0.0006	2.35
2011	C	0.0002	0.62
2012	C	0.0000	0.08
2013	C	0.0000	0.05
2014	C	0.0000	0.08

In CRF 2.C.2 Ferroalloys production the production data, because these information could lead to the disclosure of confidential information provided by the plant operator.

4.4.3.4 Uncertainties and time series consistency

Combined uncertainty	25.5 %
AD	± 5 %
EF	± 25 %

4.4.3.5 Source specific QA/QC and verification

The quality objectives and the QA/QC plan are presented in Chapter 1.6.

4.4.3.6 Source specific recalculations

There are no source specific recalculations for this category.

4.4.3.7 Source specific planned improvements

There are no source-specific planned improvements.

4.5 NON-ENERGY PRODUCTS FROM FUELS AND SOLVENT USE (CRF 2.D)

SOURCE CATEGORY DESCRIPTION

Source category 2D Non-energy products from fuels and solvent use comprises process emissions from lubricant and paraffin wax use, NMVOC emissions from coating applications, degreasing, dry cleaning as well as production and processing of chemical products, precursor emissions from road paving with asphalt and asphalt roofing as well as emissions from urea use in SCR catalysts of diesel engines (heavy motor vehicles).

4.5.1 LUBRICANT USE (CRF 2.D.1)

4.5.1.1 Source category description

Lubricants are mostly used in industrial and transportation applications. They can be subdivided into motor oils, industrial oils and greases, which differ in terms of physical characteristics, commercial applications and environmental fate.

4.5.1.2 Trend description

The trend of CO_2 emissions is presented in the following figure.

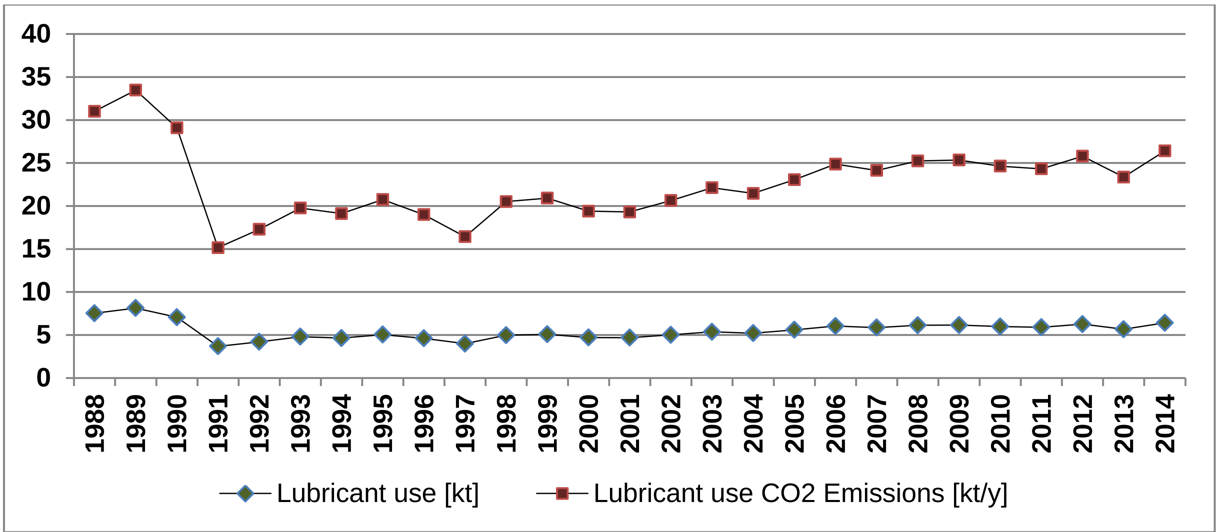

Figure 67 Lubricant use and CO_2 emissions in CRF 2.D.1

4.5.1.3 Methodological issues.

4.5.1.3.1 Methods

The use of lubricants in engines is primarily for their lubricating properties and associated CO_2 emissions are therefore considered as non-combustion emissions reported in 2D1 Lubricant use.

For the calculation of CO_2 emissions from oxidation of lubricants a Tier 1 approach according to the 2006 IPCC Guidelines, vol. 3, chap. 5.2 (IPCC 2006) is applied based on the following formulas:

CO_2,Emissions = AD • EFlubricant, CO_2

$EFlubricant, CO_2 = NCVlubricant \cdot CClubricant \cdot ODUlubricant \cdot 44/12$

Where AD is the activity data, NCV the net calorific value, CC the carbon content and ODU the fraction of lubricants oxidized during use.

4.5.1.3.2 Emission Factors

The emission factor is composed of a specific carbon content factor (tonne C/TJ) multiplied by the ODU factor.
A further multiplication by 44/12 (the mass ratio of CO_2/C) yields the emission factor (expressed as tonne CO_2/TJ). For lubricants the default carbon contents factor is 20.0 kg C/GJ on a Lower Heating Value basis. Tier 1: Having only total consumption data for all lubricants (i.e., no separate data for oil and grease), the weighted average ODU factor for lubricants as a whole is used as default value in the Tier 1 method. Assuming that 90 percent of the mass of lubricants is oil and 10 percent is grease, applying these weights to the ODU factors for oils and greases yields an overall (rounded) ODU factor of 0.2. This ODU factor can then be applied to an overall carbon content factor, which may be country-specific or the default value for lubricants to determine national emission levels from this source when activity data on the consumption of lubricants is known.

4.5.1.4 Activity Data

The activity data in subcategory 2.D.1 are based on the input data in COPERT model used in the road transportation. Please see subcategory Road transport – CRF 1.A.3.b.

Table 130 Lubricant use and CO_2 emissions in CRF 2.D.1.

CRF 2.D.1 - Lubricant use		
Year	Lubricant use [kt/y]	CO_2 Emissions [kt]
1988	7,53	23,48
1989	8,13	25,35
1990	7,06	22,04
1991	3,68	11,48
1992	4,20	13,09
1993	4,80	14,96
1994	4,64	14,48
1995	5,04	15,71
1996	4,61	14,39
1997	3,99	12,44
1998	4,98	15,54
1999	5,08	15,84
2000	4,71	14,69
2001	4,69	14,62
2002	5,01	15,63
2003	5,37	16,76
2004	5,21	16,26
2005	5,60	17,46
2006	6,04	18,83
2007	5,86	18,28
2008	6,13	19,11
2009	6,15	19,20
2010	5,98	18,66

CRF 2.D.1 - Lubricant use		
Year	Lubricant use [kt/y]	CO_2 Emissions [kt]
2011	5,90	18,42
2012	6,26	19,53
2013	5,67	17,69
2014	6,41	20,00

4.5.1.5 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in the following table.

Table 131 Uncertainty of subcategory 2D1 - Lubricant use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	CO_2	10	30	31.62

4.5.1.6 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Plausibility checks of the results (due to the national statistic and national VOC register);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.5.1.7 Source specific recalculation

No source specific recalculation.

4.5.1.8 Source specific planned improvements

No source specific improvements are planned.

4.5.2 PARAFFIN WAX USE (CRF 2.D.2)

4.5.2.1 Source category description

The category, as defined here, includes such products as petroleum jelly, paraffin waxes and other waxes, including ozokerite (mixtures of saturated hydrocarbons, solid at ambient temperature). Paraffin waxes are separated from crude oil during the production of light (distillate) lubricating oils. Paraffin waxes are categorized by oil content and the amount of refinement.

4.5.2.2 Trend description

The trend of CO_2 emissions is presented in the following figure.

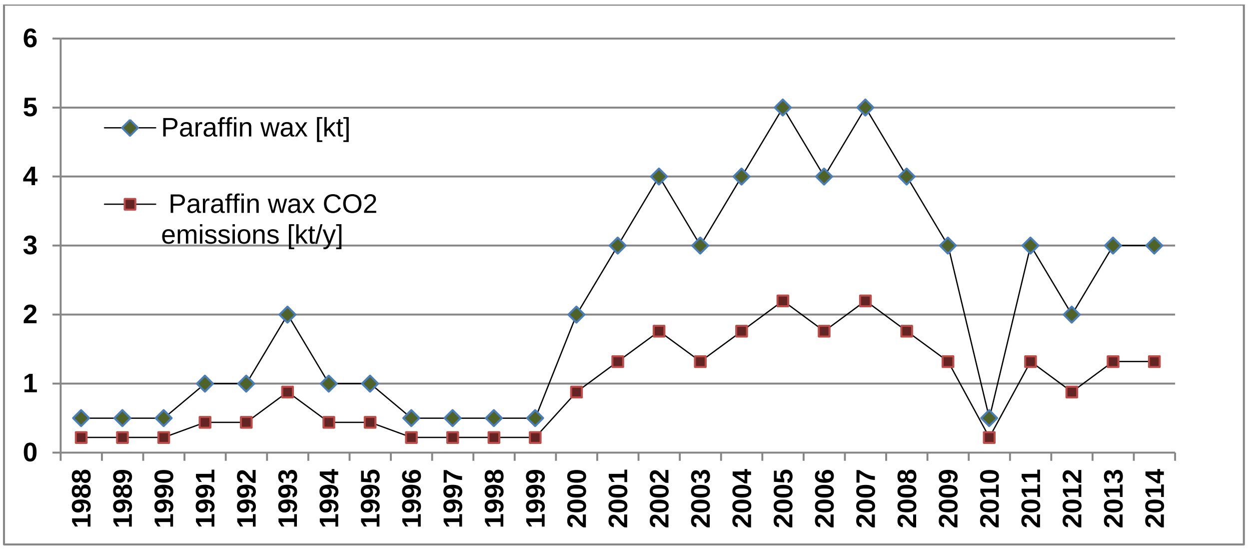

Figure 68 Paraffin wax use and CO_2 emissions in CRF 2.D.2.

4.5.2.3 Methodological issues.

4.5.2.3.1 Methods

Waxes are used in a number of different applications. Paraffin waxes are used in applications such as: candles, corrugated boxes, paper coating, board sizing, food production, wax polishes, surfactants (as used in detergents) and many others. Emissions from the use of waxes derive primarily when the waxes or derivatives of paraffinsare combusted during use (e.g., candles), and when they are incinerated with or without heat recovery or inwastewater treatment (for surfactants). In the cases of incineration and wastewater treatment the emissionsshould be reported in the Energy or Waste Sectors.

There are two methodological tiers for determining emissions and storage from paraffin waxes. Both Tier 1 and Tier 2 rely on essentially the same analytical approach, which is to apply emission factors to activity data on the amount of paraffin waxes consumed in a country (in energy units, e.g., TJ). The Tier 2 method relies on determining the actual use of paraffin waxes and applying a country-specific ODU factor to activity data, while the Tier 1

method relies on applying default emission factors to activity data (see decision tree, Figure 5.3).
Tier 1: CO_2 emissions are calculated according to Equation 5.4 with aggregated default data for the limited parameters available:

CO_2 Emissions = PW •CCWax •ODUWax • 44 /12
Where:
CO_2 Emissions = CO2 emissions from waxes, tonne CO_2
PW = total wax consumption, TJ
CCWax = carbon content of paraffin wax (default), tonne C/TJ (= kg C/GJ)
ODUWax = ODU factor for paraffin wax, fraction
44/12 = mass ratio of CO_2/C

4.5.2.4 Emission factors

For Tier 1 it can be assumed that 20 percent of paraffin waxes are used in a manner leading to emissions, mainly through the burning of candles, leading to a default ODU factor of 0.2

4.5.2.4.1 Activity data

Data on the use of paraffin waxes are required to estimate emissions, with activity data expressed in energy units(TJ). To convert consumption data in physical units, e.g., in tonnes, into common energy units, e.g., in TJ (on a Lower Heating Value basis), calorific values are required (for specific guidance see Section 1.4.1.2 of Chapter 1 of Volume 2 on Energy). Basic data on non-energy products used in a country may be available from production, import and export data and on the energy/non-energy use split in national energy statistics

The activity data for estimation of emissions in subcategory 2.D.2 Paraffin wax use are provided by the NSI in format, obtained by Eurostat Balance.

Table 136: Paraffin wax use and CO2 emissions – CRF 2.D.2 [kt/1000]

CRF 2.D.2 - PARAFFIN WAX USE		
Year	Paraffin wax [kt/year]	CO_2 Emissions [kt/year]
1988	0,50	0,22
1989	0,50	0,22
1990	0,50	0,22
1991	1,00	0,44
1992	1,00	0,44
1993	2,00	0,88
1994	1,00	0,44
1995	1,00	0,44
1996	0,50	0,22
1997	0,50	0,22
1998	0,50	0,22
1999	0,50	0,22
2000	2,00	0,88
2001	3,00	1,32
2002	4,00	1,76

CRF 2.D.2 - PARAFFIN WAX USE		
Year	Paraffin wax [kt/year]	CO_2 Emissions [kt/year]
2003	3,00	1,32
2004	4,00	1,76
2005	5,00	2,20
2006	4,00	1,76
2007	5,00	2,20
2008	4,00	1,76
2009	3,00	1,32
2010	0,50	0,22
2011	3,00	1,32
2012	2,00	0,88
2013	3,00	1,32
2014	3,00	1,32

4.5.2.5 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in the following table.

Table 132 Uncertainty of subcategory 2.D.2 – Paraffin wax use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	CO_2	10	30	31.62

4.5.2.6 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Plausibility checks of the results (due to the national statistic and national VOC register);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.5.2.7 Source specific recalculation

No source specific recalculation.

4.5.2.8 Source specific planned improvements

No source specific improvements are planned.

4.5.3 OTHER - UREA USE IN SCR CATALYSTS OF DIESEL ENGINES (CRF 2D3D)

4.5.3.1 Source category description

This source category encompasses CO_2 emissions from the use of urea containing AdBlue in diesel engines with SCR-catalysts in road transportation (Euro V/VI).

4.5.3.2 Trend description

The trend of CO2 emissions is presented in the following figure.

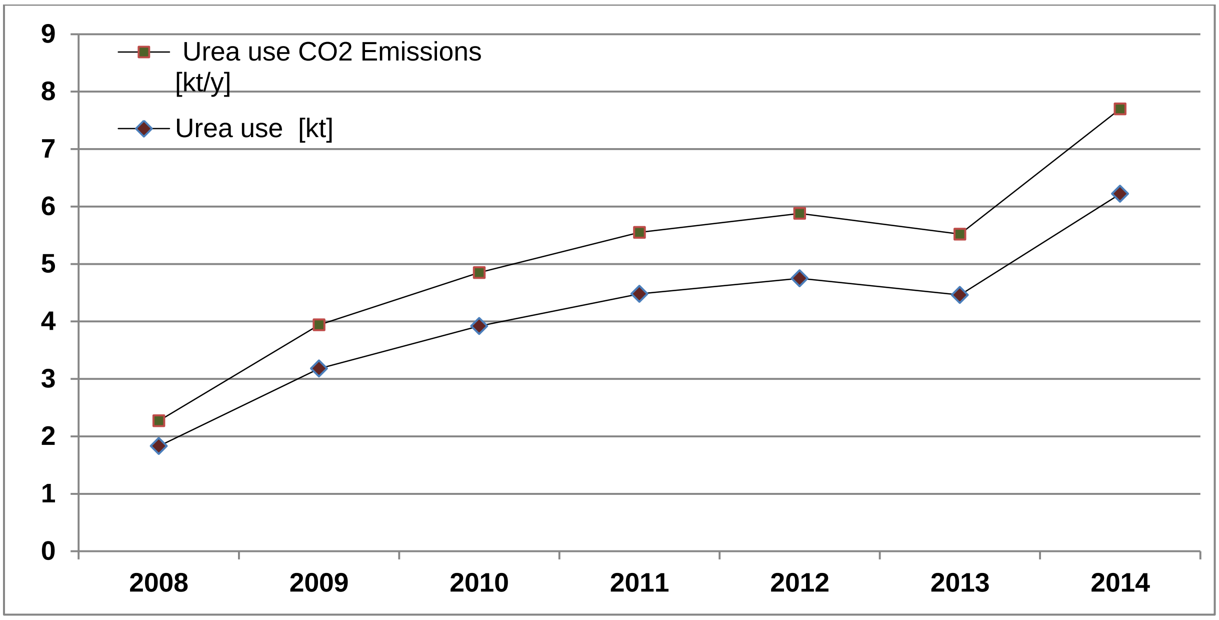

Figure 69 Urea use and CO_2 emissions in CRF 2.D.3.d.

4.5.3.3 Methodological issues.

4.5.3.3.1 Methods

For the first time and in accordance with the new 2006 IPCC guidelines the consumption of Ad Blue is reported in this submission following a methodology suggested in the EMEP/EEA guidebook 2013 (EMEP/EEA 2013; part B, chap. 1.A.3.b.i-iv, page 48). A specific percentage of the fuel consumption of SCR-vehicles in road transportation according to their Euro class is applied for Ad Blue consumption estimates. Emissions are calculated according to following formula:

CO_2 Emissions = EF • FC • Share of SCR vehicles mileage • Specific urea share

"FC" - relates to the fuel consumption in [t] of the entire vehicle category

"Share of SCR vehicles mileage" - implies the mileage share of SCR-vehicles in the entire vehicle category

"Specific urea share" - comprises the percentage of fuel consumption which relates to AdBlue (urea solution) consumption.

4.5.3.3.2 Emission factors

The emission factor for CO_2 emissions from urea use in SCR-catalysts in vehicles is a default value (EMEP/EEA 2013) considering the molecular mass conversion of urea into CO_2 during the reaction with water and the content of 32.5% of the aqueous AdBlue urea solution. The EF amounts to 0.238 t per ton of AdBlue.

4.5.3.3.3 Activity Data

The activity data in subcategory 2.D.3.d. are based on the input data in COPERT model used in the road transportation. Please see subcategory Road transport – CRF 1.A.3.b.

Table 133 Urea use and CO2 emissions in CRF 2.D.3.d.

2D3D - UREA USE IN SCR CATALYSTS OF DIESEL ENGINES		
Year	Urea use [kt]	CO_2 Emissions [kt/year]
2008	1,83	0,44
2009	3,18	0,76
2010	3,92	0,93
2011	4,48	1,07
2012	4,75	1,13
2013	4,46	1,06
2014	6,22	1,48

1.1.1.1 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in the following table.

Table 134 Uncertainty of subcategory 2D3d – Urea use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	CO_2	10	30	31.62

4.5.3.4 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Plausibility checks of the results (due to the national statistic and national VOC register);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.5.3.5 Source specific recalculation

No source specific recalculation.

4.5.3.6 Source specific planned improvements

No source specific improvements are planned.

4.5.4 OTHER - SOLVENT USE (CRF 2.D.3.B)

4.5.4.1 Source category description

This chapter describes the methodology used for calculating greenhouse gas emissions from solvent use in Bulgaria. Solvents are chemical compounds, which are used to dissolve substances as paint or for used also for cleaning purposes (degreasing of metals and dry cleaning). Most of the solvents are released into air after application of these substances or other processing. Solvents consist mainly of NMVOC, it is the cause their use is a major source for anthropogenic NMVOC emissions. Once released into the atmosphere NMVOCs react with air molecules (mainly HO-radicals) or high energetic light and generated emission of CO_2.

NMVOC emissions from 2D3b *Solvent use* are calculated, based on the emission factors, set in the EMEP/EEA Guidebooks (2006 and 2013) and activity data, provided by the NSI.

Sub-category Solvent use 2D3b include paint application, Degreasing and Dry cleaning and Chemical products.

4.5.4.2 Trend description

The trend of the Solvent use and CO2 emissions is presented in following three figures.

The drop from 1993 to 1995 is mainly due to economic crisis. The production of many plants in Bulgaria is decreased in the same period. Thus the metal degreasing activities decreased.

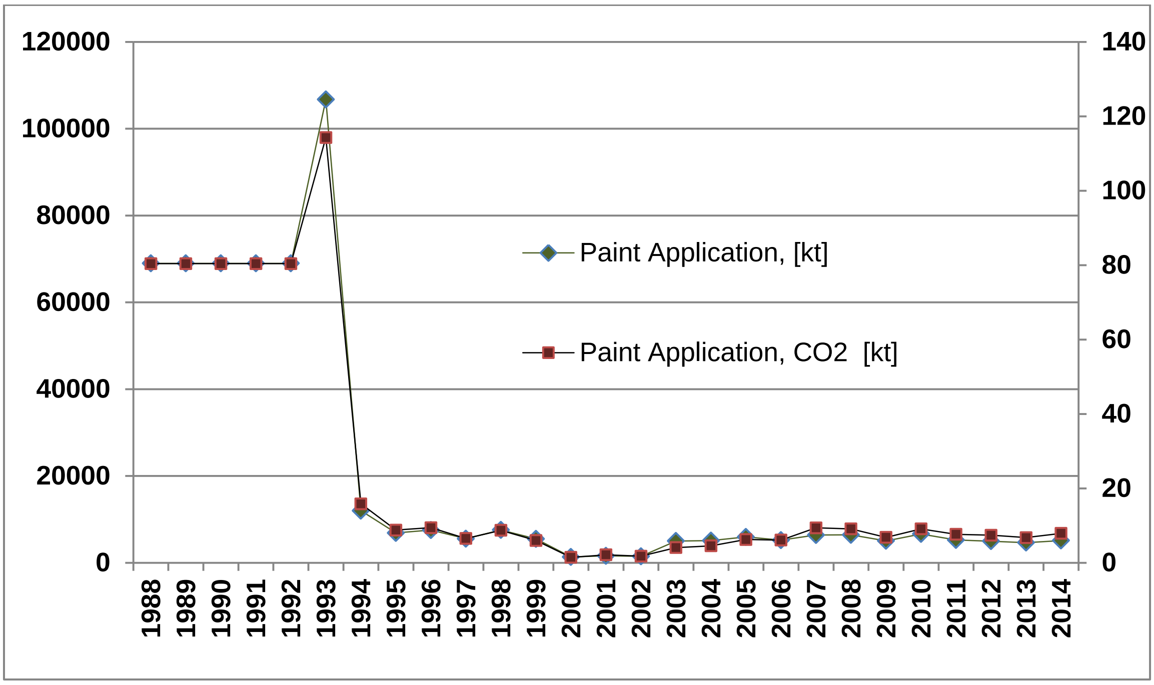

Figure 70 Paint application and CO_2 emissions.

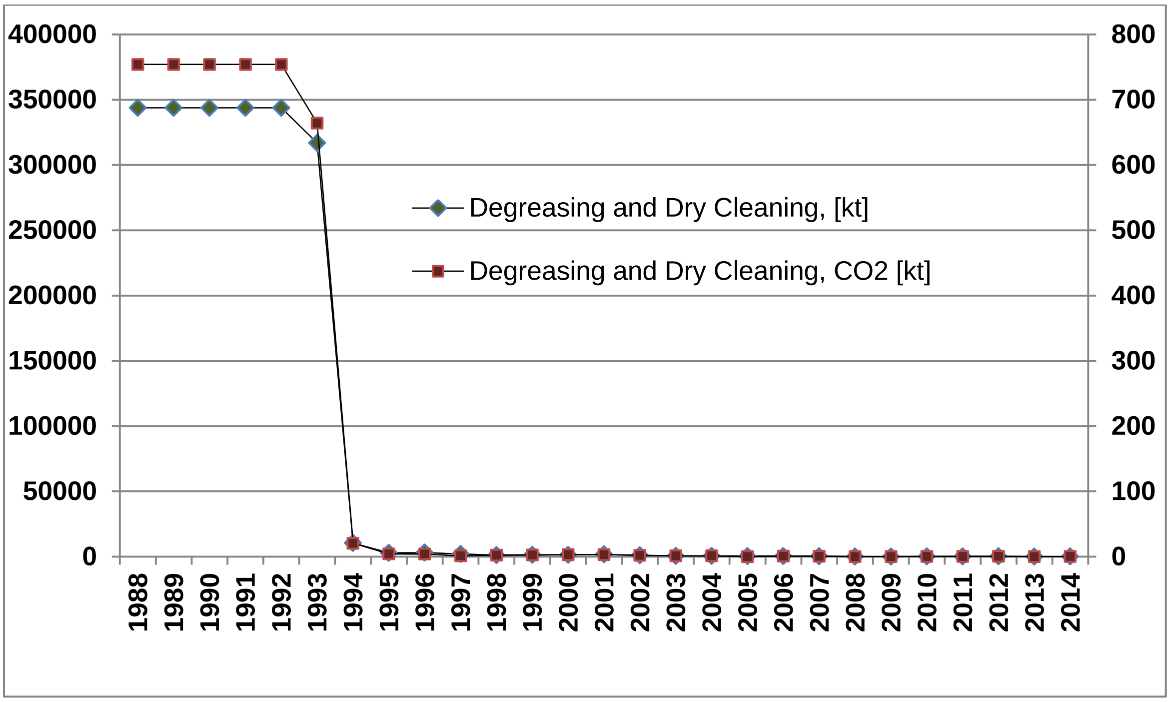

Figure 71 Degreasing and Dry cleaning and CO_2 emissions.

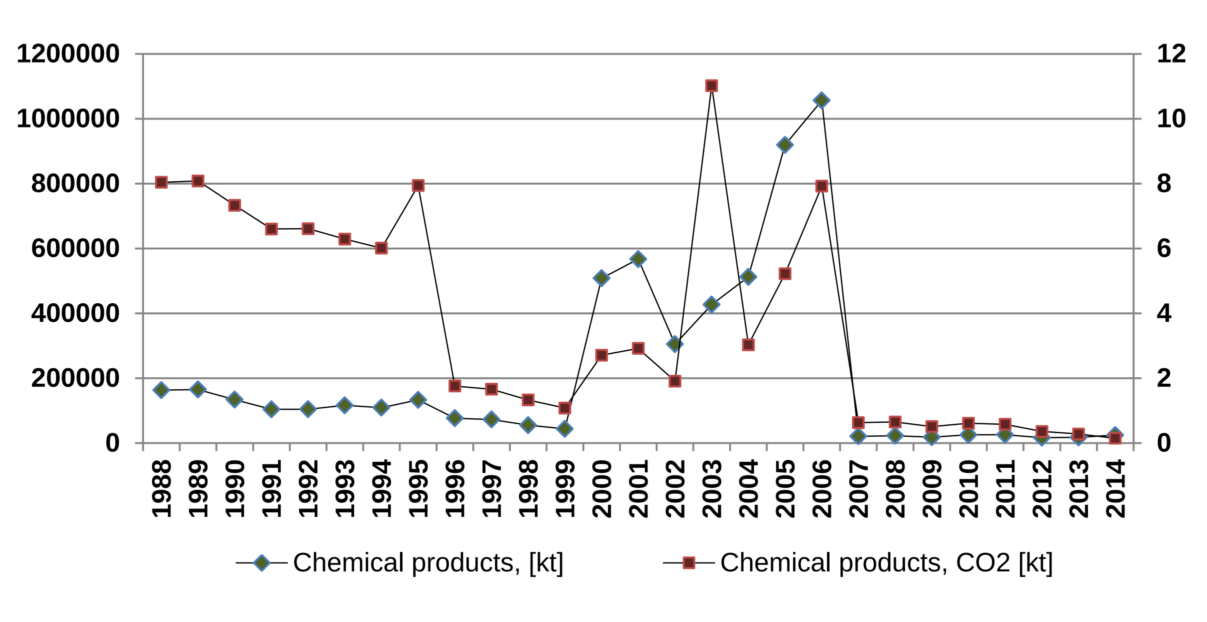

Figure 72 Chemical products and CO_2 emissions.

Paint application

This activity deals with the use of paints within the industrial and domestic sectors.

Decorative coating application, which includes:

- Paint application: construction and buildings (SNAP 060103)
- Paint application: domestic use (SNAP 060104)

Industrial coating application, which includes:

- Paint application: manufacture of automobiles (SNAP 060101)
- Paint application: car repairing (SNAP 060102)
- Paint application: coil coating (SNAP 060105)
- Paint application: boat building (SNAP 060106)
- Paint application: wood (SNAP 060107)
- Other industrial paint application (SNAP 060108)

Other coating application, which includes:

- Other non-industrial paint application (SNAP 060109)

Degreasing and Dry cleaning

This category deals with the following activities:

- Degreasing - process for cleaning products from water-insoluble substances such as grease, fats, oils, waxes, carbon deposits, fluxes and tars. In most cases the process is applied to metal products, but also plastic, fibreglass, printed circuit boards and other products are treated by the same process.

- Dry cleaning - refers to any process to remove contamination from furs, leather, down leathers, textiles or other objects made of fibres using organic solvents.

Chemical products, manufacture and processing

- Chemical products
  This sector covers the emissions from the use of chemical products, use of lacquers and solvents, manufacture and processing (polyester processing, polyvinylchloride processing, polyurethane foam processing, rubber processing, pharmaceutical products manufacturing, paints manufacturing, inks manufacturing, glues manufacturing, asphalt blowing).

The decrease of solvent emissions is due to the positive impact of the enforced regulations in Bulgaria:

- Regulation №7/2003 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations, which replaced a Council Directive 1999/13/EC into national legislation;
- Regulation on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain paints and varnishes and vehicle refinishing products from 23/02/2007, which replace the Council Directive 2004/42/CE of the European Parliament and of the Council of 21 April 2004.

NMVOC emissions in 2D3 Solvent use have been calculated for the period 1988 - 2014. The emission factors are in accordance with the EMEP/EEA air pollutant emission inventory guidebook –2006 and 2013[27]. The activity data are provided mainly by the National Statistics Institute – NSI.

4.5.4.3 Methodological issues.

4.5.4.3.1 Methods

The Tier 2 default approach has been implemented for the inventory of most of the SNAP activities in 2D3b Solvent use and Tier 3 has been implemented for SNAP activity 060201 Metal Degreasing.

<u>NMVOC emissions:</u>

The emissions of NMVOC are estimated based on the EMEP/EEA Guidebook 2013. The general equation is:

$$Emission_{NMVOC} = AR_{Production} \times EF_{Pollutant}$$

Where:

$Emission_{NMVOC}$ = the emission of NMVOC

[27] In the following referred as EMEP/EEA Guidebook (2013)

$AR_{production}$ = the activity rate (consumption of paint)

EF_{NMVOC} = the emission factor for NMVOC.

This equation is applied at national level, using annual national total figures for the activity data.

CO_2 emissions:

Converting of NMVOC into CO_2 with conversion factor is provided in the 2006 IPCC Guidelines, Volume 1, Chapter 7.2.1.5 Carbon Emitted in Gases Other than CO_2.

From NMVOC:

$$Inputs_{CO_2} = Emissions_{NMVOC} \times C \times \frac{44}{12}$$

Where C is the fraction carbon in NMVOC by mass (default = 0.6)

Reference for default: conversion- factor NMVOC – CO_2, the 2006 IPCC Guidelines, Volume 3, Chapter 5: Industrial Processes and Product Use, page 5.17, 2006 IPCC Guidelines s, Volume 1, Chapter 7: Precursors and Indirect Emissions, page 7.6

4.5.4.3.2 Emission Factor

The default emission factors for NMVOC are taken from the EMEP/EEA Guidebook – 2006 and EMEP/EEA Guidebook 2013.

The default emission factors used for assessment of emissions of NMVOC from 2D3b Solvent use are presented in Table 135.

Table 135 Emission factors used for estimation of NMVOC emissions from Solvent use-2D3b.

2D3a Solvent use				
SNAP activity	Name of activity	Emission factor	Unit	Reference
Paint application				
060101	Manufacture of automobiles	500	g/kg of paint	EMEP/EEA guidebook – 2006
060102	Car repairing	720	g/kg of paint	EMEP/EEA guidebook – 2013
060103	Construction and buildings (except 060107)	230	g/kg of paint	EMEP/EEA guidebook – 2013
060104	Domestic use (except 060107)	230	g/kg of paint	EMEP/EEA guidebook – 2013
060105	Coil coating	480	g/kg of paint	EMEP/EEA guidebook – 2013
060106	Boat building	750	g/kg of paint	EMEP/EEA guidebook – 2006
060107	Wood	800	g/kg of paint	EMEP/EEA guidebook – 2013

060108	Other industrial paint application	750	g/kg of paint	EMEP/EEA guidebook – 2006
060109	Other non-industrial paint application	740	g/kg of paint	EMEP/EEA guidebook – 2013
Degreasing and Dry cleaning				
060201	Metal degreasing	1000	kg/Mg solvent use	EMEP/EEA guidebook – 2013
060203	Electronic components manufacturing	740	kg/Mg wafer	
060202	Dry cleaning	1000	kg/Mg solvent use	
060202	Dry cleaning - Open-circuit machine	177	g/kg textiles cleaned	
060202	Dry cleaning - closed - circuit machine (abatement n=89%)	19.47	g/kg textiles cleaned	
Chemical products, manufacturing and processing				
060301	Polyester processing	50	g/kg monomer used	EMEP/EEA guidebook – 2013
060302	Polyvinylchloride processing	10	g/kg product	
060303	Polyurethane foam processing	120	g/kg foam processed	
060304	Polystyrene foam processing	60	g/kg foam processed	
060305	Rubber processing	8	g/kg rubber produced	
060306	Pharmaceutical products manufacturing	300	g/kg solvents used	
060307	Paints manufacturing	11	g/kg product	
060308	Inks manufacturing	11	g/kg product	
060309	Glues manufacturing	11	g/kg product	
060310	Asphalt blowing	1710	g/Mg asphalt	

4.5.4.3.3 Activity Data

The activity data for estimation of emissions in subcategory 2D3a Solvent use are provided by the NSI. For the most SNAP activities under 2D3b the NSI has provided activity data just for the period 1992 – 2014. For some categories as Paints manufacturing (SNAP 060307), the activity data for the last seven years are taken from the National Register under the European Solvents Directive 1999/13/EC.

Due to lack of data, the activity data for the period 1988 – 1991 are taken the same as first available year.

Table 136 Solvent use and CO_2 emissions in CRF 2.D.3.b

CRF 2.D.3.B - SOLVENT USE						
Year	Paint Application		Degreasing and Dry Cleaning		Chemical products	
	[kt]	CO_2 [kt]	[kt]	CO_2 [kt]	[kt]	CO_2 [kt]
1988	68980,00	80,40	343821,05	754,06	163309,00	8,04
1989	68980,00	80,40	343821,05	754,06	165162,00	8,08
1990	68980,00	80,40	343821,05	754,06	134017,00	7,33
1991	68980,00	80,40	343821,05	754,06	103984,00	6,60
1992	68980,00	80,40	343821,05	754,06	104366,00	6,61
1993	106725,00	114,30	316958,05	664,31	116476,00	6,29
1994	11994,00	15,85	10503,05	20,63	109136,00	6,01
1995	6867,00	8,79	2916,05	4,22	133085,00	7,94
1996	7532,00	9,43	3097,05	4,05	76780,00	1,76
1997	5540,00	6,53	2082,05	1,28	72662,00	1,66
1998	7549,00	8,72	1221,05	2,27	55100,00	1,33
1999	5496,00	6,00	1449,05	2,51	43917,00	1,08
2000	1331,00	1,46	1456,05	3,03	508161,00	2,71
2001	1595,00	2,14	1744,05	3,13	567293,00	2,92
2002	1486,00	1,78	1022,05	2,19	304864,00	1,91
2003	4999,26	4,08	605,42	1,29	426959,90	11,02
2004	5096,06	4,54	628,05	1,35	512452,43	3,03
2005	5950,15	6,25	469,06	0,10	919251,82	5,22
2006	5210,49	6,10	455,94	0,99	1056244,19	7,92
2007	6393,40	9,40	363,75	0,75	20928,43	0,63
2008	6428,13	9,10	105,19	0,22	22774,22	0,65
2009	5038,10	6,83	125,30	0,27	18064,10	0,51
2010	6619,95	9,11	210,12	0,37	25470,61	0,61
2011	5249,99	7,64	229,74	0,41	25897,48	0,58
2012	4960,70	7,41	286,56	0,53	16584,98	0,36
2013	4641,80	6,77	112,98	0,22	17562,13	0,28
2014	5110,78	7,90	143,25	0,29	24677,68	0,15

4.5.4.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in the following table.

Table 137 Uncertainty of subcategory 2D3b -Solvents use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	CO_2	10	30	31.62

4.5.4.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Plausibility checks of the results (due to the national statistic and national VOC register);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.5.4.6 Source specific recalculation

No source specific recalculation.

4.5.4.7 Source specific planned improvements

No source specific recalculation.

4.6 ELECTRONICS INDUSTRY (CRF 2.E)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

4.7 PRODUCT USES AS SUBSTITUTES FOR ODS– SECTOR OVERVIEW (CRF 2.F)

The following table and figure summarize the results for CRF Sector 2.F for 2014:

Table 138 Summary of the results for 2014

Sector	Actual emission 2014	Actual share
	Gg CO_2-eq.	%
Solvents	0,00	0,00%
Aerosols	10.54	1.35%
Foams	7.41	0.95%
Domestic refrigeration	17.46	2.23%
Commercial and industrial refrigeration	78.06	9.96%
Transport refrigeration	8.18	1.04%
Domestic AC	325.89	41.60%

Sector	Actual emission 2014	Actual share
	Gg CO_2-eq.	%
Stationary AC	25.05	3.20%
Mobile AC	305.35	38.98%
Fire protection	5.42	0.69%
Total	783.36	100.00%

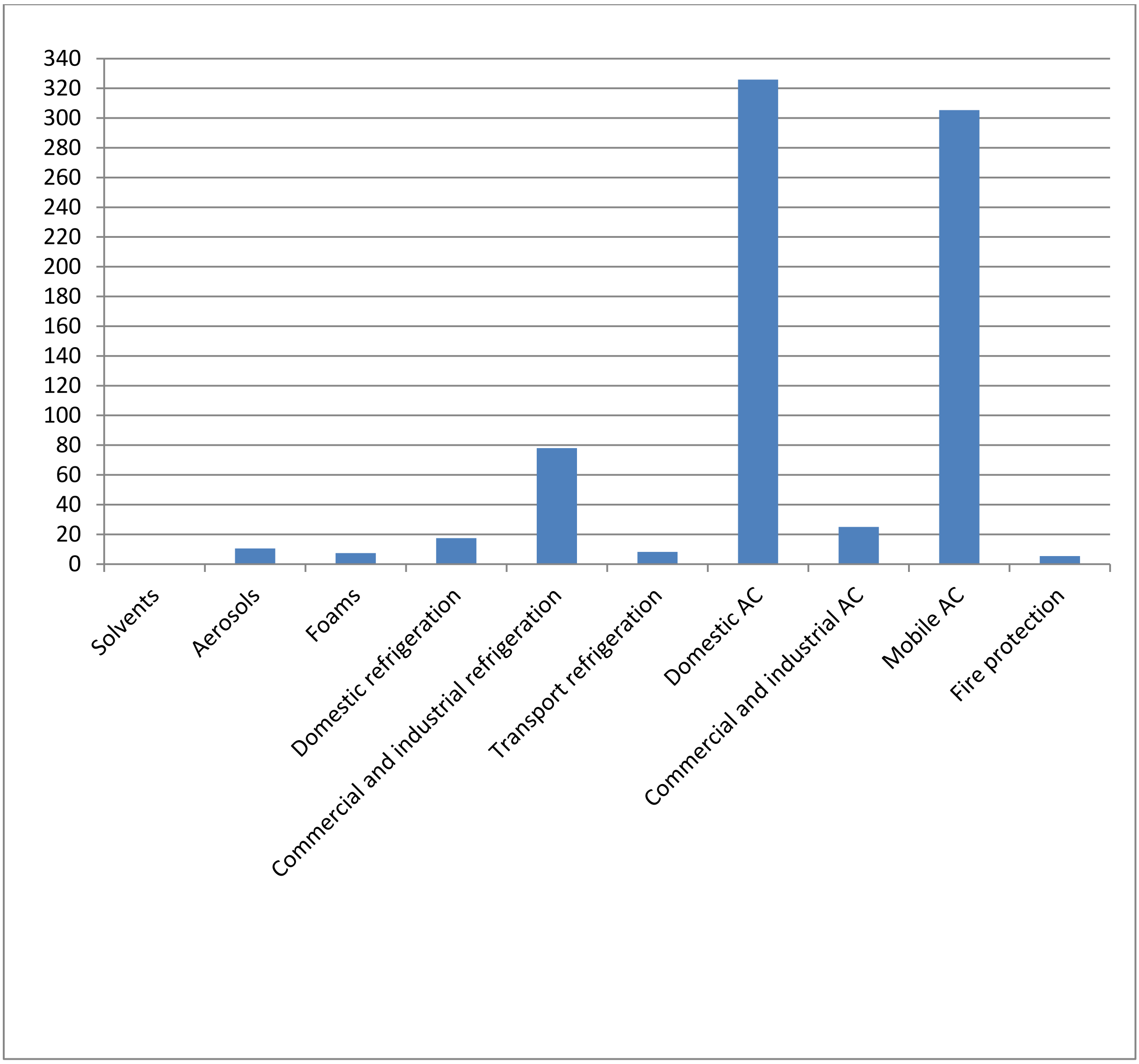

Figure 73 Actual emissions for 2014 [Gg CO_2-eq.]

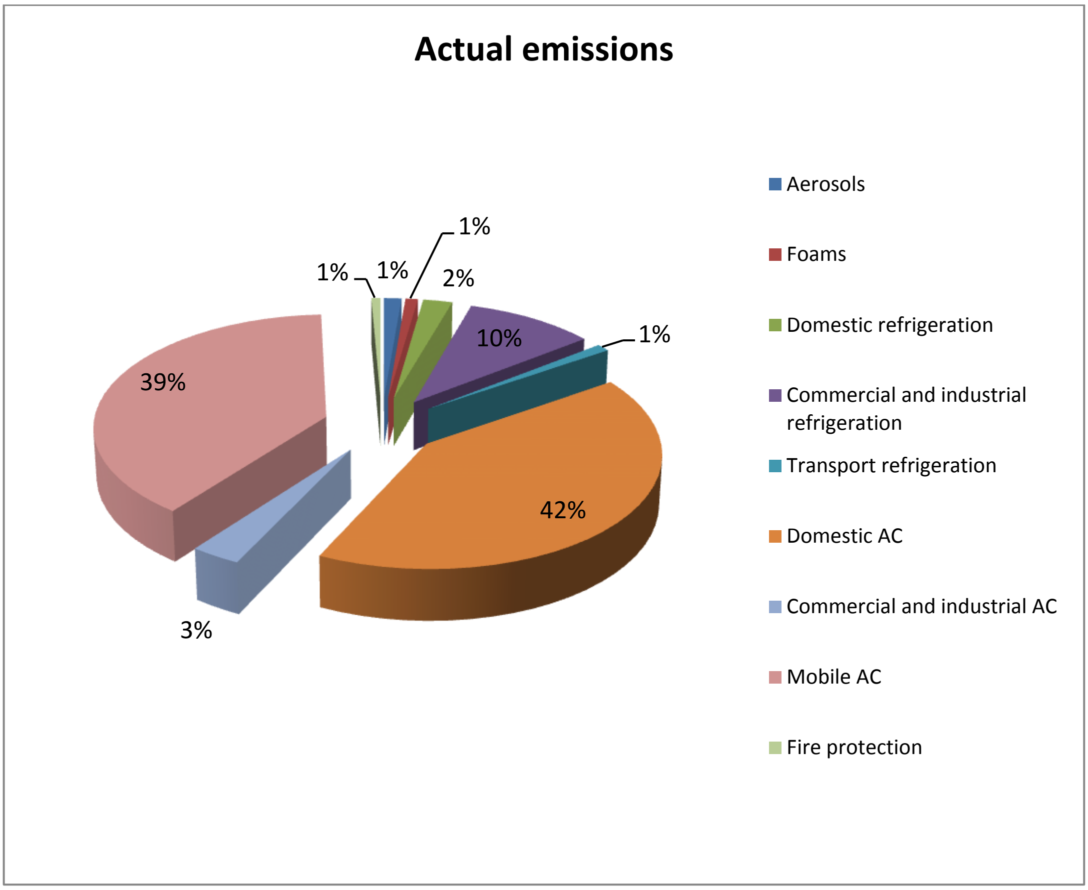

Figure 74 Actual emissions for 2014 [Gg CO_2-eq.]

The following table and figure represent the actual emissions for the whole time series:

Table 139 Actual emissions [Gg CO_2-eq.]

Year	Solvents	Aerosols	Foams	Domestic Ref	Industrial and Commercial Ref	Transport Ref	Domestic AC	Commercial and industrial AC	Mobil AC	Fire protecion
1988	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	0.00	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	0.01	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	0.02	NO	NO	NO	NO	1.06	NO
1995	NO	NO	NO	0.04	NO	NO	NO	NO	2.95	NO
1996	NO	NO	NO	0.06	NO	0.01	NO	NO	5.09	NO

Year	Solvents	Aerosols	Foams	Domestic Ref	Industrial and Commercial Ref	Transport Ref	Domestic AC	Commercial and industrial AC	Mobil AC	Fire protecion
1997	NO	NO	NO	0.08	NO	0.05	NO	NO	8.00	NO
1998	NO	1.11	NO	0.12	NO	0.10	NO	NO	12.02	NO
1999	NO	1.78	NO	0.17	NO	0.17	NO	NO	17.84	NO
2000	NO	0.76	NO	0.23	0.81	0.25	NO	0.14	23.43	NO
2001	NO	0.33	NO	0.27	5.35	0.43	0.08	1.51	28.81	0.52
2002	NO	0.81	NO	0.30	9.89	0.67	0.63	2.88	36.15	0.65
2003	NO	1.30	NO	0.33	14.42	0.99	2.34	4.25	44.94	0.81
2004	NO	1.88	NO	0.36	18.96	1.50	7.22	5.62	64.56	1.01
2005	NO	2.60	2.93	0.38	23.50	2.21	14.34	6.99	90.97	1.26
2006	NO	7.17	8.53	1.41	28.04	3.43	23.74	8.36	109.60	1.56
2007	NO	9.89	11.55	2.86	32.58	4.39	40.57	9.73	147.92	1.95
2008	NO	10.31	96.67	4.45	37.12	5.26	81.50	11.10	196.42	2.43
2009	NO	11.91	22.35	5.08	41.66	6.39	147.89	12.46	230.82	3.42
2010	NO	10.89	11.98	7.73	46.20	6.74	172.21	13.83	249.79	3.42
2011	NO	10.35	10.33	8.56	53.29	7.08	202.62	15.48	262.22	4.78
2012	NO	9.98	8.71	10.45	70.36	7.79	248.43	19.72	278.90	4.80
2013	NO	10.54	7.41	17.46	78.06	8.18	325.89	25.05	305.35	5.42
2014	NO	9.52	7.55	20.66	89.05	11.02	389.78	30.99	318.71	5.63

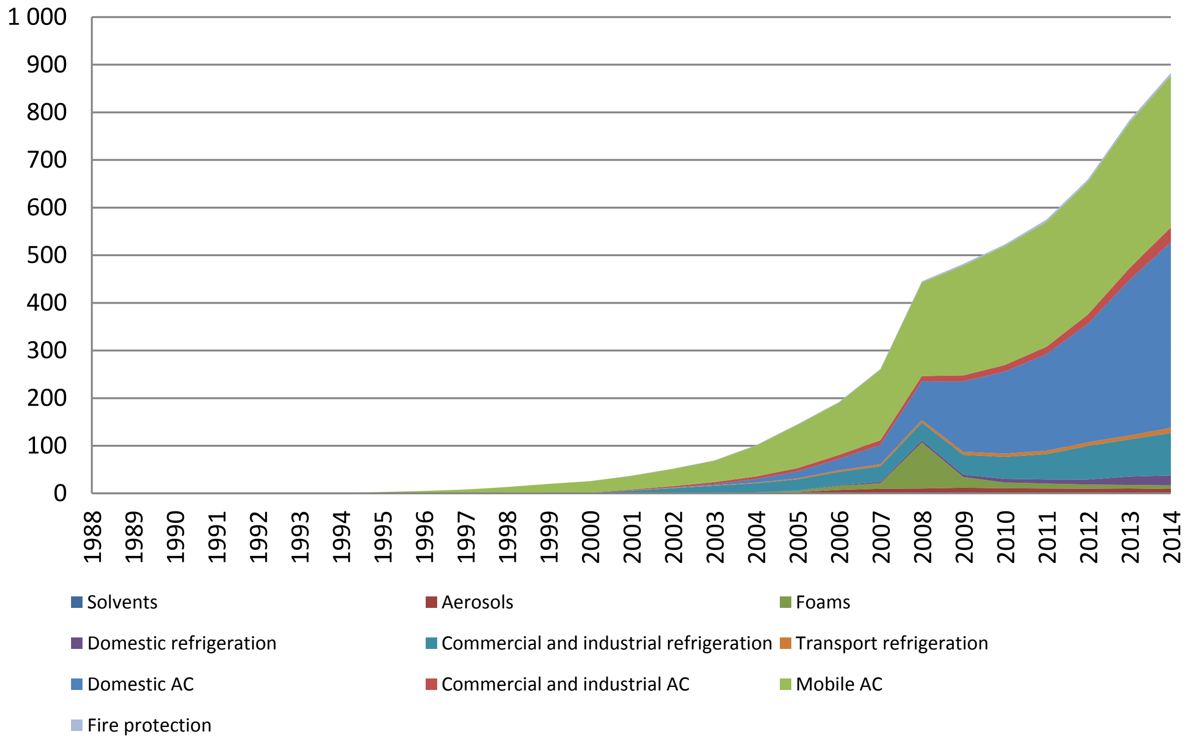

Figure 75 Actual emissions [Gg CO_2-eq.]

4.7.1 REFRIGERATION AND AIR CONDITIONING

4.7.1.1 Source Category Description

Depending on the purpose and specifics of the country, the refrigeration and air conditioning equipment can be divided into six major subcategories listed below. It should be noted that according to a recent study, subsector Refrigeration and Air Conditioning employs over 1000 certified technicians and over 70 licensed service companies in the country.

4.7.1.1.1 Commercial and industrial refrigeration (2.F.1.a and 2.F.1.c)

In this subsector emissions from the production of refrigerators, emissions from refrigeration of goods in a supermarket for example, as in other retail outlets are included. The task to determine emissions from this sector is complex because it is more heterogeneous in terms of equipment characteristics: design, size, type of refrigerant, the amount of losses and more. In addition to supermarkets, there is also a wide range of equipment for other types of applications - slaughterhouses, gastronomy, agriculture and others. In contrast to household refrigeration equipment or automotive air conditioning systems, systems that are manufactured in batch production are in smaller quantities than those produced on demand.

Today the most commonly used blend of HFC is R-404A, which becomes even more important than HFC-134a. R-407C also plays an important role. Currently, there are still banked amounts of HCFC-22.

Since the available data does not permit a separate calculation of the banked quantities used in commercial and industrial refrigeration equipment and since the emission factors as recommended by the IPCC Guidelines, are in similar margins, it was decided the two subcategories - commercial and industrial refrigeration - to be grouped and evaluated together.

Even before the entry into force of the Montreal Protocol bans for the use of CFCs and HCFCs (which were subsequently implemented in the European and national legislation), industrial refrigeration equipment was the only sector using alternative cooling agents in significant quantities (mainly ammonia). However, after the ban on the CFC-12 use, imposed by the Montreal Protocol, the main substitute on the market became different types of HFCs. It is also difficult to determine the annual inflow of new refrigerant for this sector due to the its heterogeneity.

The following tables represent the activity date for the subsector:

Table 140 Activity data for Commercial refrigeration – HFC-134a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	2,181	2,143	NO	0,038	NO	NO
2001	2,181	4,286	NO	0,038	0,214	NO
2002	2,181	6,428	NO	0,038	0,429	NO
2003	2,181	8,571	NO	0,038	0,643	NO
2004	2,181	10,714	NO	0,038	0,857	NO
2005	2,181	12,857	NO	0,038	1,071	NO
2006	2,181	14,999	NO	0,038	1,286	NO
2007	2,181	17,142	NO	0,038	1,500	NO
2008	2,181	19,285	NO	0,038	1,714	NO
2009	2,181	21,428	NO	0,038	1,929	NO
2010	2,181	23,571	NO	0,038	2,143	NO
2011	7,057	30,504	NO	0,124	2,357	NO
2012	8,225	38,586	NO	0,144	3,050	NO
2013	10,862	49,258	NO	0,190	3,859	NO
2014	3,161	52,364	NO	0,055	4,926	NO

Table 141 Activity data for Commercial refrigeration – HFC-32 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	0,446	0,438	NO	0,008	NO	NO
2001	0,446	0,876	NO	0,008	0,044	NO
2002	0,446	1,315	NO	0,008	0,088	NO
2003	0,446	1,753	NO	0,008	0,131	NO
2004	0,446	2,191	NO	0,008	0,175	NO
2005	0,446	2,629	NO	0,008	0,219	NO
2006	0,446	3,067	NO	0,008	0,263	NO
2007	0,446	3,505	NO	0,008	0,307	NO
2008	0,446	3,944	NO	0,008	0,351	NO
2009	0,446	4,382	NO	0,008	0,394	NO
2010	0,446	4,820	NO	0,008	0,438	NO
2011	0,956	5,759	NO	0,017	0,482	NO
2012	0,222	5,978	NO	0,004	0,576	NO
2013	2,991	8,916	NO	0,052	0,598	NO
2014	0,058	8,972	NO	0,001	0,892	NO

Table 142 Activity data for Commercial refrigeration – HFC-125 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	5,395	5,301	NO	0,094	NO	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2001	5,395	10,601	NO	0,094	0,530	NO
2002	5,395	15,902	NO	0,094	1,060	NO
2003	5,395	21,203	NO	0,094	1,590	NO
2004	5,395	26,503	NO	0,094	2,120	NO
2005	5,395	31,804	NO	0,094	2,650	NO
2006	5,395	37,104	NO	0,094	3,180	NO
2007	5,395	42,405	NO	0,094	3,710	NO
2008	5,395	47,706	NO	0,094	4,241	NO
2009	5,395	53,006	NO	0,094	4,771	NO
2010	5,395	58,307	NO	0,094	5,301	NO
2011	23,249	81,149	NO	0,407	5,831	NO
2012	8,458	89,460	NO	0,148	8,115	NO
2013	12,945	102,179	NO	0,227	8,946	NO
2014	11,634	113,609	NO	0,204	10,218	NO

Table 143 Activity data for Commercial refrigeration – HFC-143a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	5,346	5,252	NO	0,094	NO	NO
2001	5,346	10,504	NO	0,094	0,525	NO
2002	5,346	15,756	NO	0,094	1,050	NO
2003	5,346	21,008	NO	0,094	1,576	NO
2004	5,346	26,260	NO	0,094	2,101	NO
2005	5,346	31,512	NO	0,094	2,626	NO
2006	5,346	36,764	NO	0,094	3,151	NO
2007	5,346	42,016	NO	0,094	3,676	NO
2008	5,346	47,268	NO	0,094	4,202	NO
2009	5,346	52,520	NO	0,094	4,727	NO
2010	5,346	57,772	NO	0,094	5,252	NO
2011	22,262	79,644	NO	0,390	5,777	NO
2012	7,447	86,961	NO	0,130	7,964	NO
2013	10,788	97,561	NO	0,189	8,696	NO
2014	15,758	113,043	NO	0,276	9,756	NO

Table 144 Activity data for Commercial refrigeration – HFC-152a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	NO	NO	NO	NO	NO	NO
2002	NO	NO	NO	NO	NO	NO
2003	NO	NO	NO	NO	NO	NO
2004	NO	NO	NO	NO	NO	NO
2005	NO	NO	NO	NO	NO	NO
2006	NO	NO	NO	NO	NO	NO
2007	NO	NO	NO	NO	NO	NO
2008	NO	NO	NO	NO	NO	NO
2009	NO	NO	NO	NO	NO	NO
2010	NO	NO	NO	NO	NO	NO
2011	0,002	0,002	NO	0,000	NO	NO
2012	0,031	0,033	NO	0,001	0,000	NO
2013	NO	NO	0,030	NO	0,003	0,030
2014	0,001	0,000	NO	0,000	NO	NO

Table 145 Activity data for Commercial refrigeration – HFC-23 [kg]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2001	NO	NO	NO	NO	NO	NO
2002	NO	NO	NO	NO	NO	NO
2003	NO	NO	NO	NO	NO	NO
2004	NO	NO	NO	NO	NO	NO
2005	NO	NO	NO	NO	NO	NO
2006	NO	NO	NO	NO	NO	NO
2007	NO	NO	NO	NO	NO	NO
2008	NO	NO	NO	NO	NO	NO
2009	NO	NO	NO	NO	NO	NO
2010	NO	NO	NO	NO	NO	NO
2011	0,028	0,028	NO	0,005	NO	NO
2012	NO	0,008	0,017	NO	0,003	0,017
2013	NO	0,008	NO	NO	0,001	NO
2014	0,001	0,009	NO	0,000	0,001	NO

4.7.1.1.2 Domestic refrigeration (2.F.1.b)

There is no production of domestic refrigeration using HFCs in Bulgaria. The producers have switched from CFCs, HFCs, HCFCs and ammonia to other alternatives as i-butane, for example. Therefore, the calculations on this subsector are based on data for imports. The following table represents the activity date for the subsector:

Table 146 Activity data for Domestic refrigeration – HFC-134a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	0,731	0,731	NO	NO	NO	NO
1992	1,761	2,491	NO	NO	0,002	NO
1993	2,888	5,375	NO	NO	0,007	NO
1994	3,345	8,712	NO	NO	0,016	NO
1995	5,243	13,942	NO	NO	0,026	NO
1996	5,851	19,772	NO	NO	0,042	NO
1997	7,213	26,956	NO	NO	0,059	NO
1998	12,245	39,161	NO	NO	0,081	NO
1999	14,566	53,668	NO	NO	0,117	NO
2000	9,201	62,788	NO	NO	0,161	NO
2001	7,819	70,512	NO	NO	0,188	NO
2002	6,543	76,950	NO	NO	0,212	NO
2003	6,569	83,404	NO	NO	0,231	NO
2004	5,198	88,477	NO	NO	0,250	NO
2005	2,952	91,296	NO	NO	0,265	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2006	3,178	93,623	NO	NO	0,274	0,715
2007	3,374	95,134	NO	NO	0,281	1,722
2008	2,695	94,863	NO	NO	0,285	2,823
2009	1,395	92,846	NO	NO	0,285	3,270
2010	1,278	88,858	NO	NO	0,279	5,126
2011	1,273	84,277	NO	NO	0,267	5,721
2012	1,313	78,411	NO	NO	0,253	7,053
2013	1,339	67,660	NO	NO	0,235	11,973
2014	1,450	54,767	14,241	NO	0,203	14,241

4.7.1.1.3 Transport refrigeration (2.F.1.d)

Since the reporting of refrigeration vehicles is not obligated by the legislation, as it is for stationary equipment above 3 kg, there are not many companies, which have submited any data in their annual reports to the RIEW. It is observed that the reports are missing data for years before 2007, and the available for 2007-2013 is scarce, probably inaccurate and it is registered only on the territories of the inspectorates in Sofia, Plovdiv, Varna and Burgas.

Therefore, it was attempted to contact and obtain information directly from some large transport companies, including ones operating outside Bulgaria. Attempt was unsuccessful. As it was not possible to compel the operators to report the data, but apparently, there is data lack in the annual reports of RIEW, estimates are made using one of the largest websites for vehicle resales in Bulgaria. According to statistic extract from the website database, the average number of refrigerated vehicles is taken and after they are classified based on expert judgement and foreign studies' verification and experience (F-gases, Germany, 2005).

The following tables represent the activity date for the subsector:

Table 147 Activity data for Transport refrigeration – HFC-134a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	0,027	0,027	NO	NO	NO	NO
1996	0,073	0,101	NO	NO	0,005	NO
1997	0,095	0,196	NO	NO	0,020	NO
1998	0,121	0,317	NO	NO	0,039	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1999	0,162	0,479	NO	NO	0,063	NO
2000	0,330	0,810	NO	NO	0,096	NO
2001	0,467	1,276	NO	NO	0,162	NO
2002	0,621	1,897	NO	NO	0,255	NO
2003	0,918	2,815	NO	NO	0,379	NO
2004	1,056	3,844	NO	NO	0,563	0,027
2005	2,739	6,509	NO	NO	0,769	0,073
2006	1,542	7,940	NO	NO	1,302	0,095
2007	1,419	9,225	NO	NO	1,588	0,121
2008	1,484	10,537	NO	NO	1,845	0,162
2009	0,398	10,574	NO	NO	2,107	0,330
2010	0,372	10,454	NO	NO	2,115	0,467
2011	0,550	10,363	NO	NO	2,091	0,621
2012	0,606	10,035	NO	NO	2,073	0,918
2013	0,697	9,663	NO	NO	2,007	1,056
2014	0,661	7,654	2,658	NO	1,932	2,658

Table 148 Activity data for Transport refrigeration – HFC-152a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	NO	NO	NO	NO	NO	NO
2002	0,014	0,014	NO	NO	NO	NO
2003	0,009	0,020	NO	NO	0,003	NO
2004	0,014	0,030	NO	NO	0,004	NO
2005	0,005	0,029	NO	NO	0,006	NO
2006	NO	0,024	NO	NO	0,006	NO
2007	NO	0,019	NO	NO	0,005	NO
2008	NO	0,015	NO	NO	0,004	NO
2009	NO	0,012	NO	NO	0,003	NO
2010	NO	0,010	NO	NO	0,002	NO
2011	NO	0,008	NO	NO	0,002	NO
2012	NO	0,006	NO	NO	0,002	NO
2013	NO	NO	NO	NO	0,001	0,005

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2014	NO	NO	NO	NO	0,001	NO

Table 149 Activity data for Transport refrigeration – PFC-218 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	NO	NO	NO	NO	NO	NO
2002	NO	NO	NO	NO	NO	NO
2003	NO	NO	NO	NO	NO	NO
2004	NO	NO	NO	NO	NO	NO
2005	NO	NO	NO	NO	NO	NO
2006	NO	NO	NO	NO	NO	NO
2007	NO	NO	NO	NO	NO	NO
2008	0,012	0,012	NO	NO	NO	NO
2009	NO	0,009	NO	NO	0,002	NO
2010	NO	0,007	NO	NO	0,002	NO
2011	NO	0,006	NO	NO	0,001	NO
2012	NO	0,005	NO	NO	0,001	NO
2013	NO	0,004	NO	NO	0,001	NO
2014	NO	0,004	NO	NO	0,001	NO

Table 150 Activity data for Transport refrigeration – HFC-125 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1994	NO	NO	NO	NO	NO	NO
1995	0,001	0,001	NO	NO	NO	NO
1996	0,010	0,012	NO	NO	0,000	NO
1997	0,015	0,026	NO	NO	0,002	NO
1998	0,018	0,045	NO	NO	0,005	NO
1999	0,024	0,069	NO	NO	0,009	NO
2000	0,047	0,116	NO	NO	0,014	NO
2001	0,066	0,181	NO	NO	0,023	NO
2002	0,087	0,269	NO	NO	0,036	NO
2003	0,124	0,393	NO	NO	0,054	NO
2004	0,163	0,555	NO	NO	0,079	0,001
2005	0,250	0,795	NO	NO	0,111	0,010
2006	0,318	1,098	NO	NO	0,159	0,015
2007	0,255	1,335	NO	NO	0,220	0,018
2008	0,212	1,523	NO	NO	0,267	0,024
2009	0,051	1,527	NO	NO	0,305	0,047
2010	0,051	1,512	NO	NO	0,305	0,066
2011	0,089	1,514	NO	NO	0,302	0,087
2012	0,107	1,496	NO	NO	0,303	0,124
2013	0,135	1,468	NO	NO	0,299	0,163
2014	0,114	1,332	0,250	NO	0,294	0,250

Table 151 Activity data for Transport refrigeration – HFC-32 [kg]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	0,003	0,003	NO	NO	NO	NO
1999	0,003	0,005	NO	NO	0,001	NO
2000	0,005	0,010	NO	NO	0,001	NO
2001	0,010	0,020	NO	NO	0,002	NO
2002	0,012	0,032	NO	NO	0,004	NO
2003	0,015	0,046	NO	NO	0,006	NO
2004	0,022	0,068	NO	NO	0,009	NO
2005	0,036	0,103	NO	NO	0,014	NO
2006	0,043	0,146	NO	NO	0,021	NO
2007	0,032	0,175	NO	NO	0,029	0,003
2008	0,027	0,199	NO	NO	0,035	0,003

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2009	0,005	0,199	NO	NO	0,040	0,005
2010	0,005	0,194	NO	NO	0,040	0,010
2011	0,010	0,192	NO	NO	0,039	0,012
2012	0,013	0,190	NO	NO	0,038	0,015
2013	0,015	0,184	NO	NO	0,038	0,022
2014	0,013	0,161	0,036	NO	0,037	0,036

Table 152 Activity data for Transport refrigeration – HFC-143a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	0,002	0,002	NO	NO	NO	NO
1996	0,012	0,014	NO	NO	0,000	NO
1997	0,017	0,031	NO	NO	0,003	NO
1998	0,019	0,050	NO	NO	0,006	NO
1999	0,026	0,075	NO	NO	0,010	NO
2000	0,050	0,125	NO	NO	0,015	NO
2001	0,066	0,191	NO	NO	0,025	NO
2002	0,089	0,280	NO	NO	0,038	NO
2003	0,130	0,410	NO	NO	0,056	NO
2004	0,168	0,576	NO	NO	0,082	0,002
2005	0,254	0,818	NO	NO	0,115	0,012
2006	0,325	1,126	NO	NO	0,164	0,017
2007	0,265	1,372	NO	NO	0,225	0,019
2008	0,219	1,565	NO	NO	0,274	0,026
2009	0,054	1,570	NO	NO	0,313	0,050
2010	0,054	1,557	NO	NO	0,314	0,066
2011	0,093	1,562	NO	NO	0,311	0,089
2012	0,112	1,544	NO	NO	0,312	0,130
2013	0,142	1,518	NO	NO	0,309	0,168
2014	0,120	1,385	0,254	NO	0,304	0,254

4.7.1.1.4 Mobile air conditioning (2.F.1.e)

Emissions from mobile air conditioners are summarized in the IPCC manual under the chapter "3.7.5. Mobile air-conditioning sub-source category". There are no special comments, guidelines and methodologies for the separation of air conditioners into different subcategories. However, in this report, mobile air conditioners are divided into three subcategories - for cars, trucks, buses and railway carriages - as each of them has its own specifics that need to be addressed. Production of air conditioners for railway carriages started in 2011.

The following table represents the activity date for the subsector:

Table 153 Activity data for Mobile air conditioning – HFC-134a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	4,939	4,198	NO	NO	0,741	NO
1995	15,191	13,129	NO	NO	2,062	NO
1996	25,398	23,390	NO	NO	3,563	NO
1997	38,643	37,808	NO	NO	5,597	NO
1998	55,551	57,736	NO	NO	8,409	NO
1999	75,292	82,666	NO	NO	12,474	NO
2000	97,482	110,847	NO	NO	16,384	NO
2001	121,649	141,601	NO	NO	20,149	NO
2002	146,480	175,369	NO	NO	25,281	NO
2003	183,901	219,465	NO	NO	31,426	NO
2004	267,740	305,977	NO	NO	45,149	NO
2005	394,645	433,762	NO	NO	63,616	NO
2006	463,285	518,235	NO	NO	76,643	NO
2007	667,295	712,157	NO	NO	103,441	NO
2008	886,772	929,889	NO	NO	137,355	NO
2009	998,108	1045,925	NO	NO	161,413	NO
2010	1125,840	1157,940	NO	NO	174,228	0,449
2011	1224,935	1242,775	NO	0,065	182,313	0,960
2012	1331,773	1330,835	NO	0,054	193,153	1,788
2013	1478,162	1452,169	NO	0,064	210,522	2,903
2014	1543,677	1505,953	3,290	0,064	219,488	3,290

Table 154 Activity data for Mobile air conditioning – HFC-125 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2009	NO	NO	NO	NO	NO	NO
2010	NO	NO	NO	NO	NO	NO
2011	C	NO	NO	0,003	NO	NO
2012	C	NO	NO	0,004	NO	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2013	C	NO	NO	0,006	NO	NO
2014	C	NO	NO	0,005	NO	NO

Table 155 Activity data for Mobile air conditioning – HFC-32 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2009	NO	NO	NO	NO	NO	NO
2010	NO	NO	NO	NO	NO	NO
2011	C	NO	NO	0,003	NO	NO
2012	C	NO	NO	0,003	NO	NO
2013	C	NO	NO	0,006	NO	NO
2014	C	NO	NO	0,004	NO	NO

Table 156 Activity data for Mobile air conditioning – PFC-218 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2007	NO	NO	NO	NO	NO	NO
2008	NO	NO	NO	NO	NO	NO
2009	0,030	0,030	NO	NO	NO	NO
2010	0,013	0,038	NO	NO	0,004	NO
2011	0,001	0,034	NO	NO	0,006	NO
2012	NO	0,029	NO	NO	0,005	NO
2013	NO	0,024	NO	NO	0,004	NO
2014	NO	0,021	NO	NO	0,004	NO

4.7.1.1.5 Stationary air conditioning (2.F.1.f)

Stationary air conditioning is divided on domestic and commercial air conditioning systems, respectively divided into more than 20 kW and 20 kW of power. Commercial systems have capacity that is able to provide a comfortable temperature in the whole buildings (central air conditioning systems) or large rooms. In both types of systems, a wide range of HFC is used. Emissions may occur during installation, charging and disposal. Emissions from domestic and commercial air conditioning systems are calculated separately. The following four tables represent the activity date for the subsector, divided by HFC types:

Table 157 Activity data for Stationary air conditioning – HFC-32 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	1,608	1,596	NO	0,012	NO	NO
2001	4,316	5,886	NO	0,012	0,139	NO
2002	10,886	16,637	NO	0,012	0,412	NO
2003	28,978	45,145	NO	0,012	1,009	NO
2004	42,547	86,265	NO	0,012	2,493	NO
2005	56,781	140,222	NO	0,012	4,608	NO
2006	100,616	236,166	NO	0,012	7,365	NO
2007	240,222	468,399	NO	0,012	12,222	NO
2008	392,778	845,102	NO	0,012	23,892	NO
2009	162,175	978,058	NO	0,012	42,786	NO
2010	169,418	1113,354	0,291	0,012	49,493	0,291
2011	216,603	1289,169	2,188	0,088	56,317	2,188
2012	241,410	1479,362	6,788	0,067	65,542	6,788
2013	249,107	1658,151	19,458	0,074	75,384	19,458
2014	240,635	1812,973	28,959	0,066	84,691	28,959

Table 158 Activity data for Stationary air conditioning – HFC-125 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	2,578	2,556	NO	0,021	NO	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
2001	5,344	7,863	NO	0,021	0,234	NO
2002	12,035	19,751	NO	0,021	0,605	NO
2003	30,484	49,745	NO	0,021	1,306	NO
2004	44,285	92,565	NO	0,021	2,912	NO
2005	58,739	148,415	NO	0,021	5,159	NO
2006	103,026	246,671	NO	0,021	8,058	NO
2007	244,168	482,704	NO	0,021	13,077	NO
2008	397,834	864,216	NO	0,021	24,984	NO
2009	164,618	999,234	NO	0,021	44,166	NO
2010	171,695	1136,374	0,303	0,021	51,023	0,303
2011	216,184	1311,293	2,240	0,070	57,986	2,240
2012	242,516	1501,980	6,926	0,065	67,077	6,926
2013	251,372	1682,135	19,846	0,085	76,931	19,846
2014	245,890	1841,108	29,510	0,109	86,358	29,510

Table 159 Activity data for Stationary air conditioning – HFC-134a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	2,693	2,671	NO	0,022	NO	NO
2001	4,200	6,833	NO	0,022	0,245	NO
2002	7,387	14,114	NO	0,022	0,564	NO
2003	16,652	30,483	NO	0,022	1,039	NO
2004	22,696	52,400	NO	0,022	1,968	NO
2005	28,403	79,335	NO	0,022	3,175	NO
2006	40,165	117,168	NO	0,022	4,633	NO
2007	80,090	193,679	NO	0,022	6,636	NO
2008	108,932	296,432	NO	0,022	10,572	NO
2009	41,024	327,758	NO	0,022	15,821	NO
2010	36,715	353,441	0,315	0,022	17,498	0,315
2011	42,600	383,092	1,370	0,063	18,894	1,370
2012	53,389	420,364	3,602	0,181	20,690	3,602
2013	47,964	445,063	10,090	0,164	23,449	10,090
2014	30,099	447,498	14,322	0,034	25,495	14,322

Table 160 Activity data for Stationary air conditioning – HFC-143a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	0,518	0,513	NO	0,005	NO	NO
2001	0,518	1,026	NO	0,005	0,051	NO
2002	0,518	1,539	NO	0,005	0,103	NO
2003	0,518	2,052	NO	0,005	0,154	NO
2004	0,518	2,565	NO	0,005	0,205	NO
2005	0,518	3,078	NO	0,005	0,256	NO
2006	0,518	3,590	NO	0,005	0,308	NO
2007	0,518	4,103	NO	0,005	0,359	NO
2008	0,518	4,616	NO	0,005	0,410	NO
2009	0,518	5,129	NO	0,005	0,462	NO
2010	0,518	5,642	NO	0,005	0,513	NO
2011	0,518	6,155	NO	0,005	0,564	NO
2012	0,021	6,176	NO	0,000	0,616	NO
2013	0,430	6,601	NO	0,004	0,618	NO
2014	2,873	9,445	NO	0,029	0,660	NO

4.7.1.2 Methodological Issues

4.7.1.2.1 Commercial and industrial refrigeration (2.F.1.a and 2..F.1.c)

Emission factor of 1.75% was used for the first year and 10% emission factor for emissions from operation (IPCC, 2006). Emissions from disposal of equipment are accounted only if this is explicitly written in the reports of any of the 16 RIEWs, from which the data is taken. The calculations are based on Tier 2a method.

4.7.1.2.2 Domestic refrigeration (2.F.1.b)

A default emission factor of 0.3% per year and average amount of refrigerant in a number of equipment - 0,1 kg was used (IPCC, 2006). In this subsector, emissions from disposal are estimated with lifetime of the equipment set to 15 years (which falls within the boundaries set by IPCC Guidelines, 1996 and 2006).

4.7.1.2.3 Transport refrigeration (2.F.1.d)

The only data that was obtained is used for the amount of refrigerant in the railways from 1998 to 2012. Therefore, their emissions are calculated, even the small amounts of HFC used. Railway carriages were filled with R-12 which is being gradually replaced by HFC-134a, R-401A and R-413A. Tier 2a method, default emission factor for emissions from operation of 20% were used, which fully coincide with the given limits of the Guidelines (IPCC, 2006). This equipment has not been used since 2008 and is kept on storage, but not decommissioned i.e. the equipment is not removed and the cooling agent is not drawn and therefore is being reported.

Concerning the use of refrigeration equipment and cooling agents respectively within the motoring transport, the data concerning the import of heavy and light trucks for the period observed is extracted from statistical databases (NSI, 2012), as well as online database of the one of the biggest websites for vehicle resells in Bulgaria. The statistical processing of the data lets to the calculation of the share of heavy and light trucks imported related to the number of those, equipped with refrigeration system. This share after related to the number of the vehicles imported in the country based on data from NSI, gives us the number of vehicles with refrigeration equipment, divided by categories.

A default EF of 20% (average for Europe) for operation emissions is used, which falls within the boundaries set by the Guidelines (IPCC, 2006). There is no production of mobile refrigeration equipment in the country. It is assumed that 5% in 1995 of the refrigerated trucks used HFCs, reaching 75% in 2010 (IPCC, Working group III). Here, as well as in other categories because of lack of enough stable data for the country, the data concerning the average quantity and type of agent within the different categories of equipment is taken from different European studies (F-gases Germany, 2005). The emissions from disposal are calculated based on lifetime of 9 years.

4.7.1.2.4 Mobile air conditioning (2.F.1.e)

The Guidelines does not take into account the quantities of refrigerant over 1.5 kg and therefore offers no default emission factors for such systems. Only quantities over 1.5 kg for bus air-conditioners are used for the calculations.

Due to the specifics of the Bulgarian car market, a detailed model for the emissions calculation from Car AC subsector had to be created. As regards the fact that in Bulgaria there is no production of trucks or buses, data about import from NSI was used (data from the Association of Automobile manufacturers and their authorized representatives in Bulgaria, which have data from 1991 to today is used for verification). For the proper assessment of the Bulgarian fleet, a detailed statistics of the Road Control Department and the largest website in the country for trade of new and used cars, including the year of manufacture of the vehicle, the presence of air-conditioning system and year of import in Bulgaria was obtained. From 2011, there is production of cars in Bulgaria and data for F-gases (HFC-134A) has been provided by the producer. The results obtained are based on Tier 2a method.

For the selection of appropriate EF, a number of foreign researches have been reviewed. The most detailed information was found in a British study (AEAT, 2003), in which values are set for an average amount of agent 1,2 kg in 1993, declining to 0,8 kg in 2000. Expectations of this study is the amount to decrease up to 0,6 kg in 2010 on the annual level of losses (which include losses from normal use and losses in accidents), the data show that losses in 1995 is amounted to 15%, reducing to 10% in 2000 and projections are for about 6% in 2010. Disposal emissions are not calculated as average lifetime for the country is very high (over 20 years). Overall emissions are overestimated due to the fact that it is assumed that after the refrigerant has been leaked, it has been recharged in 100% of the cases.

According to various international studies (F-gases Germany, 2005; AEAT, 2003), the average quantity of refrigerant in air conditioning systems in the cabins of trucks varies around 1,00-1,20 kg. Similar studies are an appropriate source of information for this report, since Bulgaria does not produce trucks, as well as studies in this field.

According to the classification of NSI (NSI, 2011) whose data were used, mainly trucks are divided by weight - less than 5 t, 5-20 t and over 20 t. In the lowest grade trend over the years is the amount of refrigerant to decrease from 1 to 0,85 kg, while in the other two classes, it remains constant - 1,20 kg. However, for the purposes of this project, a constant quantity of 1 kg for the lower class was chosen, because of lack of accurate data on truck fleet in Bulgaria and the assumption that the car park is older than the average age for Western Europe. The amount of coolant in the three classes vary in small range, since it considers that the magnitude of the cabin and the corresponding volume to be cooled remain almost identical regardless of the increasing weight of the vehicle.

The refrigerant used is mainly HFC-134a. It enters mass market after 1993-1995, as a substitute of CFC-12. At the end of 1993 in Germany, half of all new trucks used cooling agent based on HFCs. Admittedly, in Bulgaria this share was lower. Studies show that from 1994 to 2002, the percentage of trucks with air conditioners has increased from 5 to 32% and this share continues to grow today, especially for heavy trucks (Schwarz, 2007a).

Operating losses of coolant here are much higher than in vehicle AC for number of reasons such as long time driving, larger loads, the greater length of piping and more. No evidence of studies on the loss of agent in trucks over 1,5 t was observed. Additional 5% on 10% emissions during operation are considered acceptable because of the possibility of higher losses in trucks compared to cars and light trucks. The results obtained are based on Tier 2a.

It is assumed that all coaches manufactured after 1999 are equipped with air-conditioning system, and since 1995 their percentage is growing slowly from 20% (AEAT, 2003). As with other mobile air conditioning systems, here the most used cooling agent is HFC-134a. Its average quantity contained in one air conditioner is assumed to be 12 kg. The length of piping may exceed 30 m in order to reach the cooled air to all passengers. Due to this great length, emissions from leakage are increased. Emissions of refrigerant in use are accepted as 15% annually. Here, as in trucks, to 10% emission factor adopted for passenger cars a further 5% were added due to longer pipelines and more frequent bus exploitation. Equipment lifetime is assumed to be 15 years. Emissions from disposal are also included. Calculations were conducted according to Tier 2a methodology.

Since this year the data from the railways is divided to refirgaration and air conditioning(before that all were reported as refrigeration). The quantities of imported carriages for passenger transport are included in this category. To calculate the emissions from this sub-category an EF of 15% is used. Production of air conditioners for railway carriages started in 2011 and all of it is exported. The data is acquired from the manufacturer's report, where it is said also that the used cooling agents are HFC-134a and R-407C. An EF of 0.35% is used for emission estimation.

4.7.1.2.5 Stationary air conditioning (2.F.1.f)

Data about domestic AC was received from NSI. The most commonly used refrigerants are R-407C and R-410A (in ratio of approximately 2:3). The calculation of emissions from domestic systems was made after the following assumptions: EF of 5 % (Preparatory study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases, Germany, 2011) was used and the average quantity of agent is 1,5 kg per unit equipment. Emission lifetime is set to 10 years. The results are calculated based on Tier 2a.

Data on F-gas quantities used in the commercial air conditioning equipment were obtained from RIEW reports that importers, operators and service companies are required to report each year. Emission factor of 1.0% was used for the first year and 10% emission factor for emissions from operation (IPCC, 2006). Emissions from disposal of equipment are accounted only if this is explicitly written in the reports of any of the 16 RIEWs, from which the data is taken. The results are based on Tier 2a.

4.7.1.3 Uncertainties and time-series consistency

4.7.1.3.1 Commercial and industrial refrigeration (2.F.1.a and 2.F.1.c)

Since the beginning of 2009 in Bulgaria a new legal instrument (Ordinance establishing measures for the implementation of Regulation (EC) № 842/2006 on certain fluorinated greenhouse gases, called The Ordinance for short) is in effect, that fulfils the Regulation (EC) № 842/2006 requirements. According to the Ordinance, operators of equipment containing more than 3 kg refrigerant must report annually their relevant quantities to RIEWs, which then send a summary report of all reported to MOEW. Prior to 2008, the reports have been prepared under the legislation for the control and management of ODS. In order to assess emissions from this sector, reports from all 16 RIEW in Bulgaria for the period 1996-2012 were analysed. After summarizing the information it was concluded that in the years before 2009 a significant number of companies were not aware of the new reporting obligations. Therefore, to make an accurate assessment of this sector data from 2010 was used and then linearly extrapolated back in time

4.7.1.3.2 Domestic refrigeration (2.F.1.b)

The share of domestic refrigeration equipment using HFCs in Bulgaria has been allocated approximately from 0% in 1990 to a maximum of 90% in 1998. A drop follows to 40% in 2002 and 5% in 2005. These numbers show the change of Bulgarian producers and importers to use a hydrocarbon refrigerant, replacing HFCs. It is believed that the level of equipment containing HFCs after 2005 remains within 5%. According to a relevant British study (AEAT, 2003) the only agent to be used in this sector is HFC-134a, which has GWP of 1300. Data about the calculation of emission was extracted from the import of refrigeration and air conditioning of the NSI from 2000 to 2010. Data for the years 1988-1999 was extrapolated as a function of data about the total amount of imports of goods and services in Bulgaria (NSI, 2011). An uncertainty in the rage of 20-100% is applied.

. Uncertainty is assumed to be around 50%.

4.7.1.3.3 Transport refrigeration (2.F.1.d)

It is a high uncertainty (80%) that emissions from this subsector are calculated based on many assumptions extracted from foreign studies and do not reflect in the best way the Bulgarian case.

4.7.1.3.4 Mobile air conditioning (2.F.1.e)

Data on annual imports of new and second hand cars from NSI was received for the period 2000-2012. The data for the years between 1990 and 1999 were extrapolated from the data as a function of the total imports of goods and services in Bulgaria.

NSI data for imports of trucks provides information only on the years 2000-2012 and therefore it was necessary here on the basis of imports of goods and services (World Bank, 2011) to extrapolate the input data back to 1988.

Data on the number of buses imported into the country were taken from NSI, but only for the years 2000 to 2012. For the years before 2000, data were based on extrapolation of the imports of goods and services for the period 1988-1999 (World Bank, 2011).The subsector is assumed to have approx. 80% uncertainty

4.7.1.3.5 Stationary air conditioning (2.F.1.f)

Data for actual numbers of AC units is available for the period 2000-2005. For the period after 2006 the NSI provides data only for the total money spent on AC equipment. To estimate the number of units after 2006, first the average price of an AC unit calculated for 2005 and the the total numbers for the next period were divided into in. The average price for 2005 was taken insted of average price for 2000-2005 because throught the period the price of a single AC unit drops with a stready trend. Admission was made that before 1999 the majority of equipment was using CFCs and therefore, the calculations do not include the years before 2000. After 2007, legislative modifications have forced the import of equipment with HFCs. Despite that 35% of the refrigerant used in this sector is assumed still to be a CFC (AEAT, 2003).

It is believed that the data concerning commercial AC and reported for the years before 2009 from RIEW reports are not reliable enough. Therefore, to calculate the emissions, data for 2012 were used by 1% emission factor for the first year and 10% in operating emission factor (IPCC, 2006) and then linearly extrapolated back to 1999. Uncertainty is assumed to be around 15%.

4.7.1.4 Source-Specific QA/QA and Verification

In general, the whole Refrigeration and air conditioning subsector (CRF 2.F.1) is verified by an external expert from the MOEW. The expert was introduced with all activity data collection and assumptions, methodological issues and calculation approaches. After a discussion, some measures and improvements, concerning assumptions of the overall subsector were decided to be implemented.

4.7.1.5 Source-Specific recalculations

4.7.1.5.1 Commercial and industrial refrigeration (2.F.1.a and 2.F.1.c)

A technical error has occurred in the F-gases quantities in refrigeration and air-conditioning, These quantities are replaced in three of the reports by RIEW.

4.7.1.5.2 Domestic refrigeration (2.F.1.b)

There are no source specific recalculations for this category.

4.7.1.5.3 Transport refrigeration (2.F.1.d)

There are no source specific recalculations for this category.

4.7.1.5.4 Mobile air conditioning (2.F.1.e)

Recalculation due to the inclusion of the production of cars in Bulgaria and change the data source of the cars' statistics.

4.7.1.5.5 Stationary air conditioning (2.F.1.f)

Reclauclation due to the update of the data with the new study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases, Germany 2011.

Please see the explanation in the point "Commercial and industrial refrigeration".

4.7.1.6 Source-Specific planned improvements

If new information is available for changes and trends in the category, improvements will be made in the relevant field including AD, EF etc.

4.7.2 FOAM BLOWING(CRF 2.F.2)

4.7.2.1 Source category description

Only two types of HFCs are used in the manufacture of extruded polystyrene insulation foams (XPS), solid polyurethane foams and one component foams (OCF). In Bulgaria, there are several larger companies in the production of foams. The largest of them, using as a blowing agent HFCs, imports raw materials from abroad. Others are using CO_2 and/or water as a substitute for HCFCs.

A large manufacturers of XPS, using HFCs is on the Bulgarian market since 2005. Quantity of imported and used HFCs is reported annually. These quantities (reported to RIEW/MoEW) are used to calculate emissions in this category, by assuming the entire quantity of produced foams stays in the country (although more than 50% is exported). There is no data available for the quantities of foams containing HFCs that were imported in the country.

The following two tables represent the activity date for the subsector:

Table 161 Activity data for Foam blowing – HFC-134a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	NO	NO	NO	NO	NO	NO
2002	NO	NO	NO	NO	NO	NO
2003	NO	NO	NO	NO	NO	NO
2004	NO	NO	NO	NO	NO	NO
2005	NO	NO	NO	NO	NO	NO
2006	NO	NO	NO	NO	NO	NO
2007	NO	NO	NO	NO	NO	NO
2008	C	C	NO	60,175	NO	NO
2009	C	C	NO	4,550	1,354	NO
2010	NO	C	NO	NO	1,446	NO
2011	NO	C	NO	NO	1,435	NO
2012	NO	C	NO	NO	1,425	NO
2013	NO	C	NO	NO	1,414	NO
2014	NO	C	NO	NO	1,403	NO

Table 162 Activity data for Foam blowing – HFC-152a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	NO	NO	NO	NO	NO	NO
2002	NO	NO	NO	NO	NO	NO
2003	NO	NO	NO	NO	NO	NO
2004	NO	NO	NO	NO	NO	NO
2005	C	C	NO	77,008	NO	NO
2006	C	C	NO	205,282	19,252	NO
2007	C	C	NO	238,300	65,760	NO
2008	C	C	NO	170,610	108,895	NO
2009	C	C	NO	241,645	124,323	NO
2010	C	C	NO	107,200	153,654	NO
2011	C	C	NO	75,766	142,040	NO
2012	C	C	NO	50,043	125,472	NO
2013	C	C	NO	35,152	106,615	NO
2014	C	C	NO	57,128	88,749	NO

4.7.2.2 Methodological issues

The data about quantities of HFCs were obtained from questionnaires and annual reports of RIEWs. Market research in Bulgaria showed that only HFC-134a and HFC-152a are used, where foam blowing is carried out with HFCs. For the purposes of the calculations, default emission factors were used as follows - for HFC-134a 25% loss in the first year and 0.75% annual loss, for HFC-152a - 50% EF for the first year and 25% per annum thereafter (IPCC, 2006). Global warming potential of the two gases are respectively 1300 and 140 for HFC-134a and HFC-152a. The results, calculated based on Tier 2a, represent 26,42 Gg CO_2-eq. actual emissions in 2012 and 304,77 Gg CO_2-eq. potential emissions.

Activity data for Foam blowing – HFC-152a, HFC-134a could not be reported, because there is only one producer and data is confidential.

4.7.2.3 Uncertainties and time-series consistency

It is assumed that import and export balance each other, but could also be 40/60 or 60/40 (20% uncertainty).

4.7.2.4 Source-Specific QA/QA and Verification

No source-specific QA/QC and verification is obtained.

4.7.2.5 Source-Specific recalculations

There are no source specific recalculations for this category.

4.7.2.6 Source-Specific planned improvements

There are no planned improvements in this category.

4.7.3 FIRE PROTECTION (CRF 2.F.3)

4.7.3.1 Source category description

According to experts from the industry, who have been asked, fire protections activities with the use of HFC in Bulgaria are implemented in very rare cases - mainly in fire protection systems installed in the server and computer rooms. At the same time in Bulgaria filling of fire fighting equipment is not practiced. It is all imported, as there are no Bulgarian manufacturers of fire protection equipment, using HFC.

The following two tables represent the activity date for the subsector:

Table 163 Activity data for Fire Protection – HFC-125 [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	0,148	0,148	NO	NO	0,007	NO
2002	0,037	0,185	NO	NO	0,009	NO
2003	0,046	0,231	NO	NO	0,012	NO
2004	0,057	0,288	NO	NO	0,014	NO
2005	0,071	0,359	NO	NO	0,018	NO
2006	0,088	0,447	NO	NO	0,022	NO
2007	0,110	0,557	NO	NO	0,028	NO
2008	0,138	0,695	NO	NO	0,035	NO
2009	2,712	3,407	NO	NO	0,170	NO
2010	NO	3,407	NO	NO	0,170	NO
2011	NO	3,407	NO	NO	0,170	NO
2012	NO	3,407	NO	NO	0,170	NO
2013	3,409	6,816	NO	NO	0,341	NO
2014	0,346	7,161	NO	NO	0,358	NO

Table 164 Activity data for Fire Protection – HFC-227a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	NO	NO	NO	NO	NO	NO
1999	NO	NO	NO	NO	NO	NO
2000	NO	NO	NO	NO	NO	NO
2001	3,065	3,065	NO	NO	0,153	NO
2002	0,756	3,821	NO	NO	0,191	NO
2003	0,943	4,764	NO	NO	0,238	NO
2004	1,176	5,940	NO	NO	0,297	NO
2005	1,466	7,406	NO	NO	0,370	NO
2006	1,827	9,233	NO	NO	0,462	NO
2007	2,278	11,511	NO	NO	0,576	NO
2008	2,841	14,352	NO	NO	0,718	NO
2009	3,162	17,514	NO	NO	0,876	NO
2010	NO	17,514	NO	NO	0,876	NO
2011	8,463	25,977	NO	NO	1,299	NO
2012	0,114	26,091	NO	NO	1,305	NO
2013	0,138	26,229	NO	NO	1,311	NO
2014	0,977	27,206	NO	NO	1,360	NO

4.7.3.2 Methodological Issues

Data about banked HFC quantities in firefighting equipment were used(mainly FM-200 and NAFS-125 type), according to which the mainly used HFC is HFC-227ea (80%) and to a lesser extent - HFC-125. This data is provided by "National Fire Safety and Protection of Population Service" in Ministry of Interior. Using default EF of 5% of the IPCC Guidelines, 1996, the results obtained based on Tier 2a show actual emissions of 4,26 Gg CO_2-eq. and 85,16 Gg CO_2-eq. potential emission for both gases in 2012.

4.7.3.3 Uncertainties and time-series consistency

Analysis of data obtained by the questionnaires from operators and importers determined that there is no use of F-gases in fire protection equipment before 2005, while reports of RIEW have reported small amounts of HFC-227ea imports since 2001. Therefore, it is assumed that the starting year of HFC usage in fire protection equipment is 2001. To calculate emissions for the years before 2008, an assumption for linear growth of about 25%

in fire fighting equipment was made. Uncertainty is considered to be in range of 60-100% of the original value.

4.7.3.4 Source-Specific QA/QA and Verification

No source-specific QA/QC and verification is obtained.

4.7.3.5 Source-Specific recalculations

Revision of data as companies, included in a list from National Fire Safety and Protection of Population Service" which have fire extinguishing installations were reviewed.

4.7.3.6 Source-Specific planned improvements

No source-specific planned improvements are to be performed.

4.7.4 AEROSOLS (CRF 2.F.4)

4.7.4.1 Source category description

The used HFCs as propellants currently are HFC-134a, HFC-227ea and HFC-152a. Data on their use as medical and technical aerosols were obtained directly from industry by telephone calls and questionnaires. After direct contact with experts from the industry, the researched showed that in Bulgaria there is only one producer, which uses HFC-134a in the production of aerosols. There are several companies working in this field, but they do not use any F-gases.

Concerning the import and usage of meter dose inhalers (MDIs) in the medicine, according to an official letter of the Executive Drug Agency in Bulgaria HFC-134a is the only F-gas used in MDIs. The Agency provided a full list of operators and importers of MDIs, containing HFC-134a. A profound research on those companies and contacting them helped in collecting data for the use of such equipment since 2005. Therefore, the results are based on real numbers, reported by the companies.

The following table represents the activity date for the subsector:

Table 165 Activity data for Aerosols/Meter dose inhalers – HFC-134a [t]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	NO	NO	NO	NO	NO	NO
1989	NO	NO	NO	NO	NO	NO
1990	NO	NO	NO	NO	NO	NO
1991	NO	NO	NO	NO	NO	NO
1992	NO	NO	NO	NO	NO	NO
1993	NO	NO	NO	NO	NO	NO
1994	NO	NO	NO	NO	NO	NO
1995	NO	NO	NO	NO	NO	NO
1996	NO	NO	NO	NO	NO	NO
1997	NO	NO	NO	NO	NO	NO
1998	1,559	0,779	NO	779,3	0,779	NO

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1999	0,925	0,462	NO	462,46	0,462	0,779
2000	0,134	0,067	NO	67,10	0,067	0,462
2001	0,323	0,162	NO	161,53	0,162	0,067
2002	0,816	0,408	NO	408,00	0,408	0,162
2003	0,996	0,498	NO	497,96	0,498	0,408
2004	1,640	0,820	NO	819,96	0,820	0,498
2005	1,990	0,995	NO	995,00	0,995	0,820
2006	8,039	4,020	NO	4019,73	4,020	0,995
2007	5,791	2,896	NO	2742,63	2,896	4,020
2008	8,628	4,314	NO	3992,13	4,314	2,896
2009	8,034	4,017	NO	3927,67	4,017	4,314
2010	7,194	3,597	NO	3476,65	3,597	4,017
2011	7,283	3,641	NO	3699,86	3,641	3,597
2012	6,682	3,341	NO	3337,14	3,341	3,641
2013	8,064	4,032	NO	4020,11	4,032	3,341
2014	5,245	2,623	NO	2622,54	2,623	4,032

4.7.4.2 Methodological Issues

According to the 2006 IPCC Guidelines, aerosol emissions are considered to be immediate, occurring during the first year of production. Using data on quantities of HFC-134a consumed by the company for the period 1988-2011, the default EF of 50% for the first year and 100% for the next year (IPCC, 2006), emissions were calculated as 4,81 Gg CO_2-eq. potential emissions in 2011 and 9.33 Gg CO_2-eq. real emissions in 2011. The EFs selected are default because of the absence of specific empirical data on the territory of Bulgaria. Results are obtained according to Tier 2a method.

4.7.4.3 Uncertainties and time-series consistency

Uncertainty is assumed to be around 30% for the whole subsector.

4.7.4.4 Source-Specific QA/QA and Verification

Data is verified by MOEW expert.

4.7.4.5 Source-Specific recalculations

A technical error has been found in the calculations.

4.7.4.6 Source-Specific planned improvements

No source-specific planned improvements are to be performed.

4.7.5 SOLVENTS (2.F.5)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

4.7.6 OTHER APPLICATION USING ODS SUBSTITUTES (2.F.6 CRF SOURCE CATEGORY NUMBER)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

4.7.7 SEMICONDUCTOR MANUFACTURING (CRF SOURCE CATEGORY NUMBER)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

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4.8 OTHER PRODUCT MANUFACTURE AND USE (CRF 2.G)

4.8.1 ELECTRICAL EQUIPMENT (CRF 2.G.1)

4.8.1.1 Source category description

In 2009, the ExEA has conducted a study concerning the determination of banked quantities of SF_6 in the country. This study was extended in the years after - detailed questionnaires to 30 companies were sent, including importers and operators of equipment. The purpose of the survey was to gather additional historical data, with the desire to apply a higher tier to calculate the emissions and in view of the fact that reported data for imports of SF_6 and equipment containing SF_6 is incomplete. The following table represents the activity date for the subsector:

Table 166 Activity data for Eclectrical Equipment – SF6 [kg]

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal

Activity Data	Filled in new manufactured products	In operating systems	Remained in products at decommissioning	Actual emissions from manufacturing	Actual emissions from stocks	Actual emissions from disposal
1988	471.31	5957.16	NO	32.75	111.99	NO
1989	498.65	6302.68	NO	34.65	118.48	NO
1990	527.57	6668.24	NO	36.66	125.35	NO
1991	558.17	7054.99	NO	38.79	132.63	NO
1992	590.54	7464.18	NO	41.03	140.32	NO
1993	624.79	7897.10	NO	43.41	148.46	NO
1994	661.03	8355.14	NO	45.93	157.07	NO
1995	699.37	8839.73	NO	48.60	166.18	NO
1996	739.93	9352.44	NO	51.42	175.81	NO
1997	782.85	9894.88	NO	54.40	186.01	NO
1998	828.26	10468.78	NO	57.55	196.80	NO
1999	876.30	11075.97	NO	60.89	208.22	NO
2000	927.12	11718.38	NO	64.42	220.29	NO
2001	980.89	12398.05	NO	68.16	233.07	NO
2002	1037.79	13117.13	NO	72.11	246.59	NO
2003	1097.98	13877.93	NO	76.29	260.89	NO
2004	1161.66	14682.85	NO	80.72	276.02	NO
2005	930.74	15255.48	NO	66.08	292.03	NO
2006	967.04	15850.44	NO	68.66	303.42	NO
2007	1004.76	16468.61	NO	71.34	315.25	NO
2008	1043.94	17110.88	NO	74.12	327.55	NO
2009	1084.66	17778.21	NO	77.01	340.32	NO
2010	3058.64	20290.02	NO	193.24	353.59	NO
2011	3694.76	23362.46	NO	222.04	400.27	NO
2012	4932.80	27449.03	NO	391.80	454.43	NO
2013	4585.92	31169.98	NO	311.76	553.23	NO
2014	1028.17	31513.23	NO	56.66	628.25	NO

4.8.1.2 Methodological Issues

The data obtained were used to assess emission using Tier 2a and default EF, according to the IPCC Guidelines, 2006.

Due to the long life of equipment and lack of sufficient data from the questionnaires, it is not possible to calculate country-specific EF. Default EF given by the IPCC Guidelines for the equipment containing SF_6, are 0.002 (0.2%) (for Sealed-for-life Equipment) and 0.026 (2.6%) (for Closed Pressure Systems) (IPCC, 2006).

In the temporal scope of this study in Bulgaria there was no manufacturing of equipment containing SF_6, but just imported. Extremely small amounts were reported as installation emissions. No amounts of SF_6 were reported as used in servicing of equipment or quantities contained in retiring equipment.

Most of the companies who were sent questionnaires are power plants that use equipment containing from 1 to 30 kg of SF_6. Three electricity distribution companies operate on the Bulgarian market, holding a total of less than 4,000 kg SF_6 in their facilities. The most important company for the purposes of this study was "Electricity System Operator" PLC, having equipment with a total of around 12,000 kg SF_6. The total amount of banked quantities is about 17,000 kg. Companies have reported SF_6 in very small quantities used in new equipment during the entire period 1988-2009 (less than 500 kg), the reason for which is probably the longer life of equipment and lack of data on the early years of the study. Significant amount (about 2,500 kg, 20% of the total amount of banks) was reported as a quantity that is contained not in equipment, but in containers (bottles).

According to the IPCC Guidelines 2006, equipment is divided into two main types - with and without the possibility of topping up. Systems without the possibility of additional charging (Sealed-for-life Equipment) usually have a capacity of less than 5 kg per functional unit and they are used at a voltage below 52 kV. They do not require any maintenance during the period of operation; their respective emission factor is much lower. Systems capable of charge (Closed Pressure Systems) are used in more than 52 kV tension and may contain amounts of 5 to several hundred kg.

Since it is not possible to do a proper allocation between the equipment with or without possibility of charge, it was assumed that the equipment of the high-voltage grid owned by "Electricity System Operator" PLC is closed pressured (about 97% of equipment is with a capacity of over 5 kg and is part of 110, 220 or 400 kV grid). It was assumed that 25% of the quantities of equipment could be initially charged, according to data from the questionnaires about the newly installed equipment, and the quantities used for initial charging,

The data collected made it possible to calculate the SF_6 emissions for period observed. Actual emissions amount of 11,96 Gg CO_2-eq. and potential emissions of 559,76 Gg CO_2-eq. were calculated.

4.8.1.3 Uncertainties and time-series consistency

Although the study was designed to cover the years from 1988 to 2010, almost no company that can report on data from the years before 2003, but most of them reported only data from the last 2-3 years. Therefore, the calculations for previous years were made by extrapolation of the reported amounts for 2009 under the assumption for annual growth rate of newly installed equipment by 5.8% for the period 1995-2003 and 3.9% for the period 2004-2010 (Ecofys, 2005).

Activity data in last years is assumed to be uncertain by +/-10%, in 1988 much less information is available (+/-50%). Furthermore, based on the default EF used, also default uncertainty of the EF (+/-30%) is applied.

4.8.1.4 Source-Specific QA/QA and Verification

No source-specific QA/QC and verification is performed.

4.8.1.5 Source-Specific recalculations

Methodology is not changed for this sector, however due to revised activity data, results increase compared to the previous year.

4.8.1.6 Source-Specific planned improvements

No source-specific planned improvements are to be performed.

4.8.2 SF_6 AND PFCS FROM OTHER PRODUCT USE (CRF 2.G.2)

Research showed that this activity is not applicable for Bulgaria and emissions are not ocurring.

4.8.3 N_2O FROM PRODUCT USES - MEDICAL APPLICATION (CRF 2.G.3A)

4.8.3.1 Source category description

N_2O emissions are caused by medical uses of N_2O (for anaesthesia).

Calculation of N_2O emission from subcategory *2G3a Other product manufacture and use, medical application* are based on emission factor in accordance with the 2006 IPCC Guidelines.

4.8.3.2 Trend description

Trend for N_2O emissions from subcategory 2G3 N_2O from product use (2G3a - Medical application).

The N_2O emissions from 2G3a - Medical application are calculated for the entire time series 1988 – 2014.

The trend of N_2O emissions is presented in the following figure.

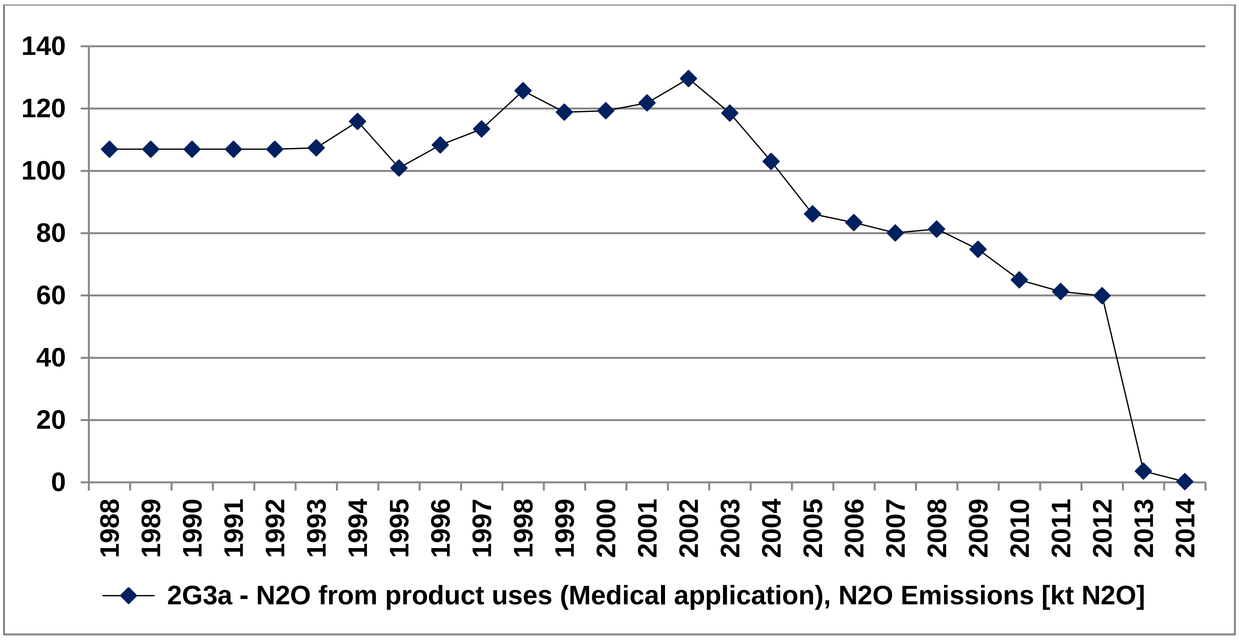


Figure 76 Medical application (Anaesthesia) – N_2O emissions.

4.8.3.3 Methodological issues.

4.8.3.3.1 Method

The N_2O emissions from 2G3a Medical application are estimated based on methodological issues set in the 2006 IPCC Guideline (Volume 3: Industrial Processes and Product Use, Chapter 8). Equation 8.24 for estimation of N_2O emissions from other product use is implemented. It is assumed that none of the administered N_2O is chemically changed by the body, and all is returned to the atmosphere. It is reasonable to assume an emission factor of 1.0.

4.8.3.3.2 Emission Factor

The default emission factors used for assessment of emissions of N_2O from 2G3a Medical application are presented inTable 167.

Table 167 Emission factor N_2O for 2G3a is 1.0.

2G3 N_2O from product uses (Medical application)				
SNAP activity	Name of activity	Emission factor	Unit	Reference
2G3a	Medical application	1.0	Mg/Mg	CORINAIR

4.8.3.3.3 Activity Data

The activity data from1988 – 2012 are provided by the Bulgarian Plant operator – NEOHIM AD. For 2014 this operator haven't production of N_2O and activity data for this year are from Agency „Costums“ in Bulgaria.

Due to lack of data, the activity data for the period 1988 – 1991 are taken the same as first available year.

Table 168 AD for N_2O emissions from 2G3 N2O from product use (2G3a - Medical application), Mg

2G3a - N_2O from product uses (Medical application)	
Year	N2O Emissions [t N2O]
1988	106,95
1989	106,95
1990	106,95
1991	106,95
1992	106,95
1993	107,38
1994	115,87
1995	100,95
1996	108,32
1997	113,44
1998	125,73
1999	118,84

***2G3a* - N_2O from product uses (Medical application)**	
Year	**N2O Emissions [t N2O]**
2000	119,30
2001	121,82
2002	129,62
2003	118,53
2004	103,01
2005	86,17
2006	83,39
2007	80,08
2008	81,31
2009	74,83
2010	65,00
2011	61,26
2012	59,93
2013	3,63
2014	0,24

4.8.3.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 169 .

Table 169 Uncertainty of subcategory 2G3 N_2O emissions from product uses (2G3a Medical application), %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2	No	N_2O	10	100	100,5

4.8.3.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.8.3.6 Source specific recalculation

No source specific recalculation.

4.8.3.7 Source specific planned improvements

No source specific improvements are planned.

4.8.4 N_2O FROM PRODUCT USES - PROPELLANT FOR PRESSURE AND AEROSOL PRODUCT (CRF 2.G.3.B)

4.8.4.1 Source category description

N_2O emissions are caused by uses of Propellant for pressure and aerosol product (aerosol cans).

Calculation of N_2O emission from subcategory *2G3b* N_2O from product uses (2G3b - Propellant for pressure and aerosol product), are based on emission factor in accordance with the 2006 IPCC Guidelines.

4.8.4.2 Trend description

Trend for N_2O emissions from subcategory 2G3b N_2O from product use (2G3b Propellant for pressure and aerosol product).The N_2O emissions from 2G3b - Propellant for pressure and aerosol product are calculated for the entire time series 1988 – 2014.

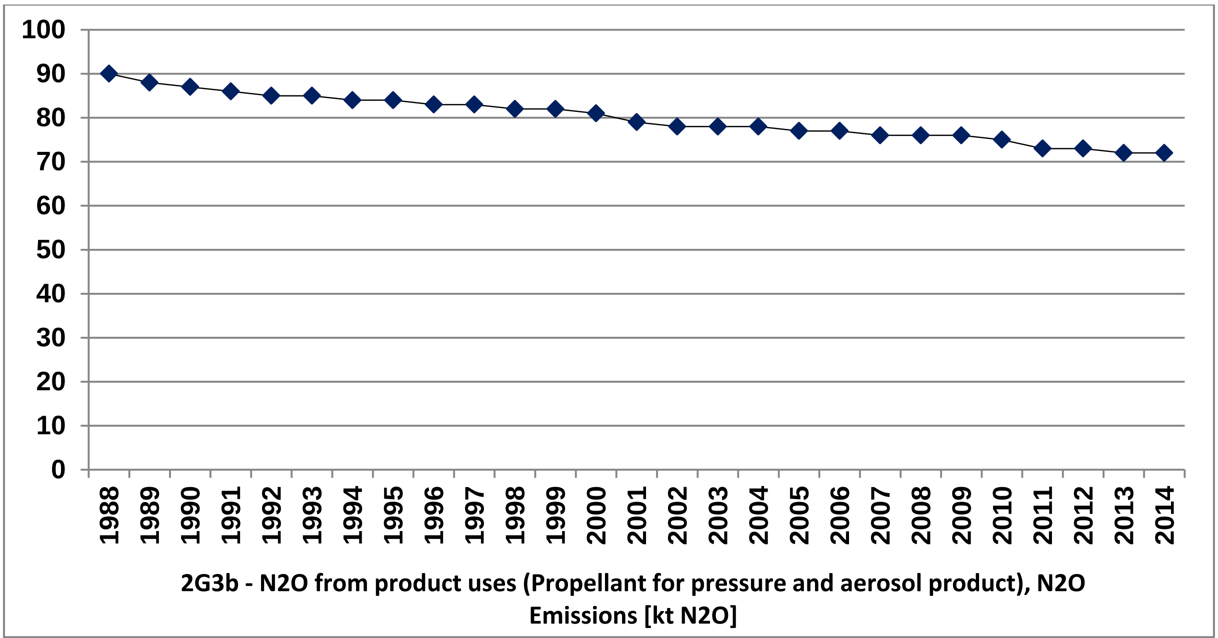


Figure 77 Propellants for pressure and aerosol product - N2O emissions.

4.8.4.3 Methodological issues.

4.8.4.3.1 Method

The estimation of emissions in 2G3b N_2O from Propellant for pressure and aerosol product (aerosol cans) is based on an assumption, that the intensity of using aerosols is the same as in Switzerland (10 grams per person per year of N_2O emissions). There is no activity data available by manufacturers and distributors of N_2O products for total quantity of N_2O supplied by application type. Thus the N_2O emissions from aerosol cans are estimated based on the assumption.

4.8.4.3.2 Emission Factor

The default emission factors used for assessment of emissions of N_2O from 2G3b

The emissions of N_2O from *2G3* N_2O from product use (2G3b Propellant for pressure and aerosol product), are estimated based on population and emission factor.

Emission factor for *2G3* N_2O from product use -*2G3b* Propellant for pressure and aerosol product (aerosol cans) are presented in Table 170.

Table 170 Emission factor N_2O for 2G3b is 10 g/person/year.

2G3 N_2O from product uses (Propellant for pressure and aerosol products)				
SNAP activity	Name of activity	Emission factor	Unit	Reference
2G3b	Propellant for pressure and aerosol product (aerosol cans)	10	g/person/year.	CORINAIR

4.8.4.3.3 Activity Data

The activity data for estimation of emissions in 2G3b_are provided by the NSI.

Table 171 AD for N_2O emissions from 2G3 N_2O from product use (2G3b - Propellant for pressure and aerosol product), Mg

2G3b - N_2O from product uses (Propellant for pressure and aerosol product)		
Year	N_2O Emissions [t N_2O]	Population [1000 number]
1988	0,090	8986,636
1989	0,088	8767,308
1990	0,087	8669,269
1991	0,086	8595,465
1992	0,085	8484,863
1993	0,085	8459,763
1994	0,084	8427,418
1995	0,084	8384,715
1996	0,083	8340,936
1997	0,083	8283,200
1998	0,082	8230,371
1999	0,082	8190,876
2000	0,081	8149,468
2001	0,079	7891,095
2002	0,078	7845,841
2003	0,078	7801,273
2004	0,078	7761,049
2005	0,077	7718,750
2006	0,077	7679,290
2007	0,076	7640,238
2008	0,076	7606,551
2009	0,076	7563,710

2G3b - N_2O from product uses (Propellant for pressure and aerosol product)		
Year	N_2O Emissions [t N_2O]	Population [1000 number]
2010	0,075	7504,868
2011	0,073	7327,224
2012	0,073	7284,552
2013	0,072	7245,677
2014	0,072	7202,198

4.8.4.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 172

Table 172 Uncertainty of subcategory 2G3 N_2O emissions from product uses (2G3b Propellant for pressure and aerosol products), %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2G3b	No	N_2O	10	100	100,5

4.8.4.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.8.4.6 Source specific recalculation

No source specific recalculation.

4.8.4.7 Source specific planned improvements

Check if it is possible to provide the necessary activity data for N_2O of aerosol cans from Bulgarian customs or other institution. At this moment there is no activity data.

4.8.5 DOMESTIC SOLVENT USE (CRF 2G4I)

4.8.5.1 Source category description

This category deals with the following activities:

- Domestic solvent use (other than paint application) (SNAP activity 060408)
- Domestic use of pharmaceutical products (SNAP activity 060411)

It comprises mainly the application of cleaning agents and solvents in private households for building and furniture cleaning and personal hygiene. The cleaning agents contain solvents which evaporate during use or after the application.

4.8.5.2 Trend description

The trend of emissions for sector 2.G.4.i Domestic solvent use is presented in the following chart.

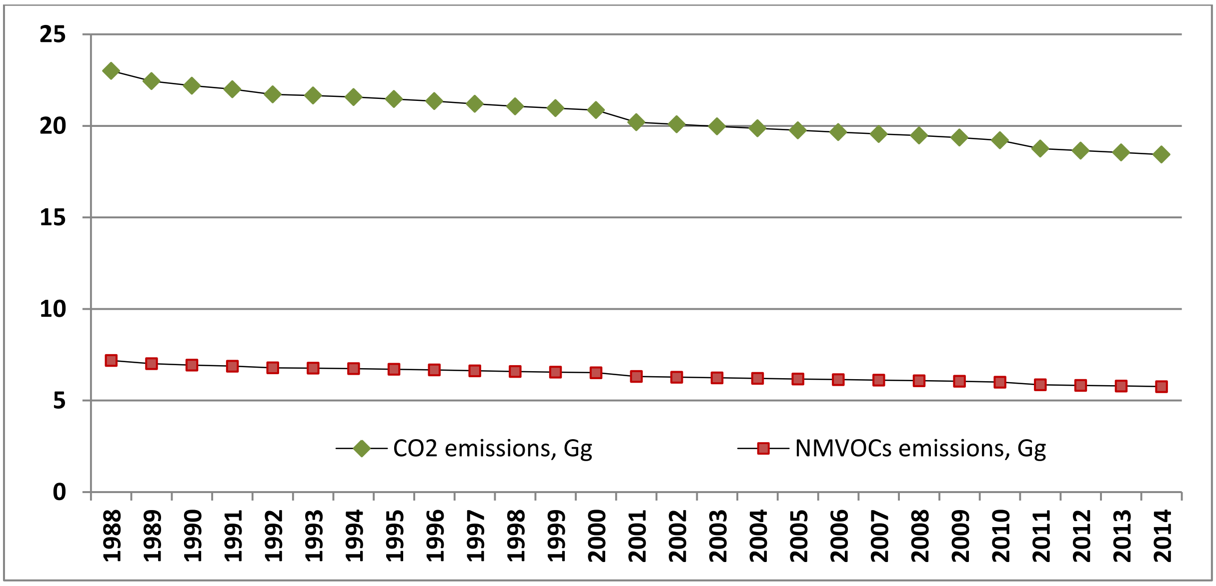


Figure 78 Trend of CO2 and NMVOC emissions in sector 2.G.4.i Domestic solvent.

4.8.5.3 Methodological issues.

4.8.5.3.1 Emission Factor

The emission factor has been derived from an assessment of the emission factors presented in GAINS model developed by IIASA. So, for Bulgaria we assume to use the EF of 0.8 kt/M people.

Converting of NMVOC into CO_2 with conversion factor is provided in the 2006 IPCC Guidelines, Volume 1, Chapter 7.2.1.5 Carbon Emitted in Gases Other than CO_2.

From NMVOC:

$$Inputs_{CO_2} = Emissions_{NMVOC} \times C \times \frac{44}{12}$$

Where C is the fraction carbon in NMVOC by mass (default = 0.6)

Reference for default: conversion- factor NMVOC – CO_2, the 2006 IPCC Guidelines , Volume 3, Chapter 5: Industrial Processes and Product Use, page 5.17, 2006 IPCC Guidelines s, Volume 1, Chapter 7: Precursors and Indirect Emissions, page 7.6

Time-series have been created due to application of EMEP/EEA Guidebook 2013.

4.8.5.3.2 Activity Data

All emissions related to domestic use of solvents and pharmaceuticals are calculated proportional to the Bulgarian population.

Table 173 Activity data of 2G4i Domestic solvent use in 1990-2014

Years	Inhabitants, 1000 person	NMVOCs emissions, Gg	CO_2 emissions, Gg
1988	8986,636	7,189309	15,81648
1999	8767,308	7,013846	15,43046
1990	8986,636	6,93542	15,25791
1991	8767,308	6,87637	15,12802
1992	8669,269	6,78789	14,93336
1993	8595,465	6,76781	14,88918
1994	8484,863	6,74193	14,83226
1995	8459,763	6,70777	14,75710
1996	8427,418	6,67275	14,68005
1997	8384,715	6,62656	14,57843
1998	8340,936	6,58430	14,48545
1999	8283,200	6,55270	14,41594
2000	8230,371	6,51957	14,34306
2001	8190,876	6,31288	13,88833
2002	8149,468	6,27667	13,80868
2003	7891,095	6,24102	13,73024
2004	7845,841	6,20884	13,65945
2005	7801,273	6,17500	13,58500
2006	7761,049	6,14343	13,51555
2007	7718,750	6,11219	13,44682
2008	7679,290	6,08524	13,38753
2009	7640,238	6,05097	13,31213
2010	7606,551	6,00389	13,20857
2011	7563,710	5,86178	12,89591
2012	7504,868	5,82764	12,82081
2013	7327,224	5,79654	12,75239
2014	7284,552	5,76176	12,67587

4.8.5.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 172

Table 174 Uncertainty of subcategory 2G4i Domestic solvent use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2G4i	No	CO_2	10	30	31.62

4.8.5.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.8.5.6 Source specific recalculation

No source specific recalculation.

4.8.5.7 Source specific planned improvements

No source specific improvements are planned.

4.8.6 OTHER PRODUCT USE (CRF 2G4I)

4.8.6.1 Source category description

This category deals with the following activities:

- Fat, edible and non-edible oil extraction (SNAP activity 060404)
- Application of glues and adhesives (SNAP activity 060405)
- Preservation of wood (SNAP activity 060406)
- Printing (SNAP activity 060403)

4.8.6.2 Trend description

The trend of emissions for sector 2.G.4.I Other product use is visualized in the following chart.

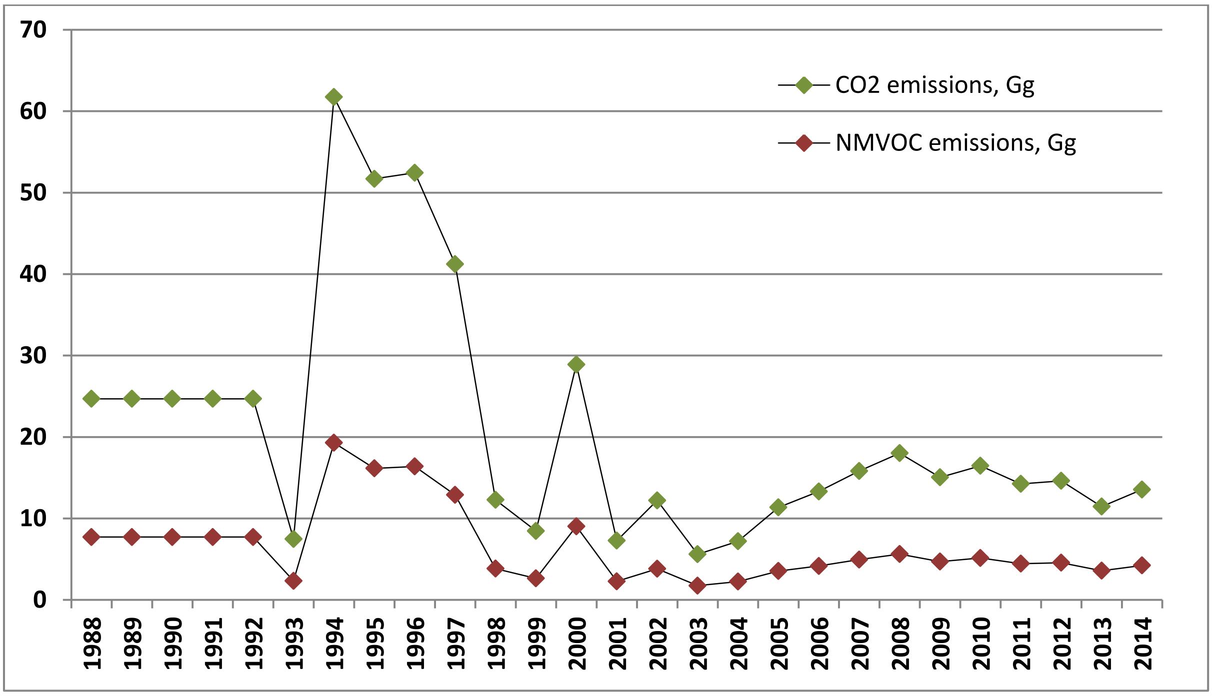


Figure 79 Trend of NMVOC and CO_2 emissions in sector 2.G.4.I Other product use.

4.8.6.3 Methodological issues.

4.8.6.3.1 Emission Factor

The Tier 1 default approach has been implemented. The general equation is:

$$E\ pollutant = AR\ production \times EF\ pollutant$$

where:

E pollutant = the emission of the specified pollutant,

AR production = the activity rate (consumption of paint, chemical production data, solvent consumption)

EF pollutant = the emission factor for this pollutant.

This equation is applied at the national level, using annual national total figures for the activity data.

TIER1 EFs provided in the EMEP/EEA 2013 Guidebook are used for NMVOC.

Table 175 Emission factors used for Other product use (CRF 2G4I)

SNAP activity	Name of activity	Emission factor	Unit	Reference
Other product use*				
060404	Fat, edible and non-edible oil extraction	3	g/kg seed	EMEP/EEA guidebook 2013

060405	Application of glues and adhesives	780	g/kg adhesives	EMEP/EEA guidebook 2013
060406	Preservation of wood	900	g/kg preservative	EMEP/EEA guidebook 2013
060403	Printing	730	g/kg ink	EMEP/EEA guidebook 2013

** The other SNAP activities under CRF 2G4I Other product use are not estimated due to lack of activity data.*

Converting of NMVOC into CO_2 with conversion factor is provided in the 2006 IPCC Guidelines, Volume 1, Chapter 7.2.1.5 Carbon Emitted in Gases Other than CO_2.

From NMVOC:

$$Inputs_{CO_2} = Emissions_{NMVOC} \times C \times \frac{44}{12}$$

Where C is the fraction carbon in NMVOC by mass (default = 0.6)

Reference for default: conversion- factor NMVOC – CO_2, the2006 IPCC Guidelines , Volume 3, Chapter 5: Industrial Processes and Product Use, page 5.17, 2006 IPCC Guidelines s, Volume 1, Chapter 7: Precursors and Indirect Emissions, page 7.6

4.8.6.3.2 Activity Data

Activity data for sector 2.G.4.I Other product use are provided by PROTCOM for the activity "Fat, edible and non-edible oil extraction" and by NSI for the following activities: "Application of glues and adhesives" (SNAP activity 060405), "Preservation of wood" (SNAP activity 060406) and "Printing" (SNAP activity 060403).

The activity data for sector 2.G.4.I Other product use are presented in the following table.

Table 176 Activity data for sector 2.G.4.i – Other product use

2.G.4.i – Other product use				
Year	Fat, edible and non-edible oil extraction	Application of glues and adhesives	Preservation of wood	Printing
	[kt]	[kt]	[kt]	[kt]
1988	2,2510	2,3020	6,4990	88,0000
1989	2,2510	2,3020	6,4990	88,0000
1990	2,2510	2,3020	6,4990	88,0000
1991	2,2510	2,3020	6,4990	88,0000
1992	2,2510	2,3020	6,4990	88,0000
1993	1,0460	1,8250	0,9400	88,0000

2.G.4.i – Other product use				
Year	Fat, edible and non-edible oil extraction	Application of glues and adhesives	Preservation of wood	Printing
	[kt]	[kt]	[kt]	[kt]
1994	2,5460	23,6930	0,7770	147,0000
1995	0,3070	19,6450	0,7800	176,0000
1996	39,3610	20,1290	0,5650	85,0000
1997	75,5340	14,8970	1,0610	116,0000
1998	61,6400	3,2350	1,1350	148,0000
1999	67,3450	2,1250	0,7460	154,0000
2000	110,2740	10,3980	0,5400	143,0000
2001	89,5010	1,9120	0,4450	154,0000
2002	41,4880	3,7640	0,6430	244,0000
2003	52,0090	1,3320	0,4330	228,2600
2004	45,0390	1,9291	0,4930	226,7090
2005	49,6728	3,0741	0,7104	496,0360
2006	63,7691	3,2570	0,9773	750,2610
2007	128,3496	3,3367	1,3494	1017,6350
2008	158,9258	4,2536	1,2631	956,9710
2009	373,5546	3,1478	0,2702	1211,3000
2010	350,1532	2,7539	0,4077	2161,9300
2011	370,4344	1,9601	0,6073	1732,0300
2012	349,8513	2,2075	0,5196	1819,1200
2013	516,1147	0,7159	0,6198	1252,9500
2014	721,6776	0,7257	0,5882	1334,4080

4.8.6.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented in Table 172

Table 177 Uncertainty of subcategory 2G4i Other product use, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2G4i	No	CO_2	10	30	31.62

4.8.6.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken in CRF sector Other product use.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors (time series)
- Time series consistency
- Plausibility checks of dips and jumps
- Documentation and archiving of all information required in NIR,
- Background documentation and archive.

4.8.6.6 Source specific recalculation

No source specific recalculations.

4.8.6.7 Source specific planned improvements

- Apply of higher tier method for estimation of emissions,
- Incorporation of national VOC data base,
- Improve the accuracy of the estimates in CRF sector Other product use,
- Improve transparency, completeness, consistency, including recalculations and time-series and comparability of national emission inventory.

4.9 OTHER: (CRF 2.H.4)

4.9.1 VEGETABLE OIL PRODUCTION (CRF 2.H.3.I)

4.9.1.1 Source category description

This chapter describes the methodology used for calculating greenhouse gas emissions from vegetable oil production in Bulgaria. Solvents are used also in vegetable oil production.

4.9.1.2 Trend description

Trend for NMVOC and CO_2 emissions from subcategory – 2H3i Other (vegetable oil production)

NMVOC emissions in Vegetable oil production 2H3i have been calculated for the period 1988 - 2014. The emission factor are in accordance with the EMEP/EEA air pollutant emission inventory guidebook –2006 and 2013[28]. The activity data are provided mainly by the National Statistics Institute – NSI.

The trend of NMVOC and CO_2 emissions is presented in the following figure.

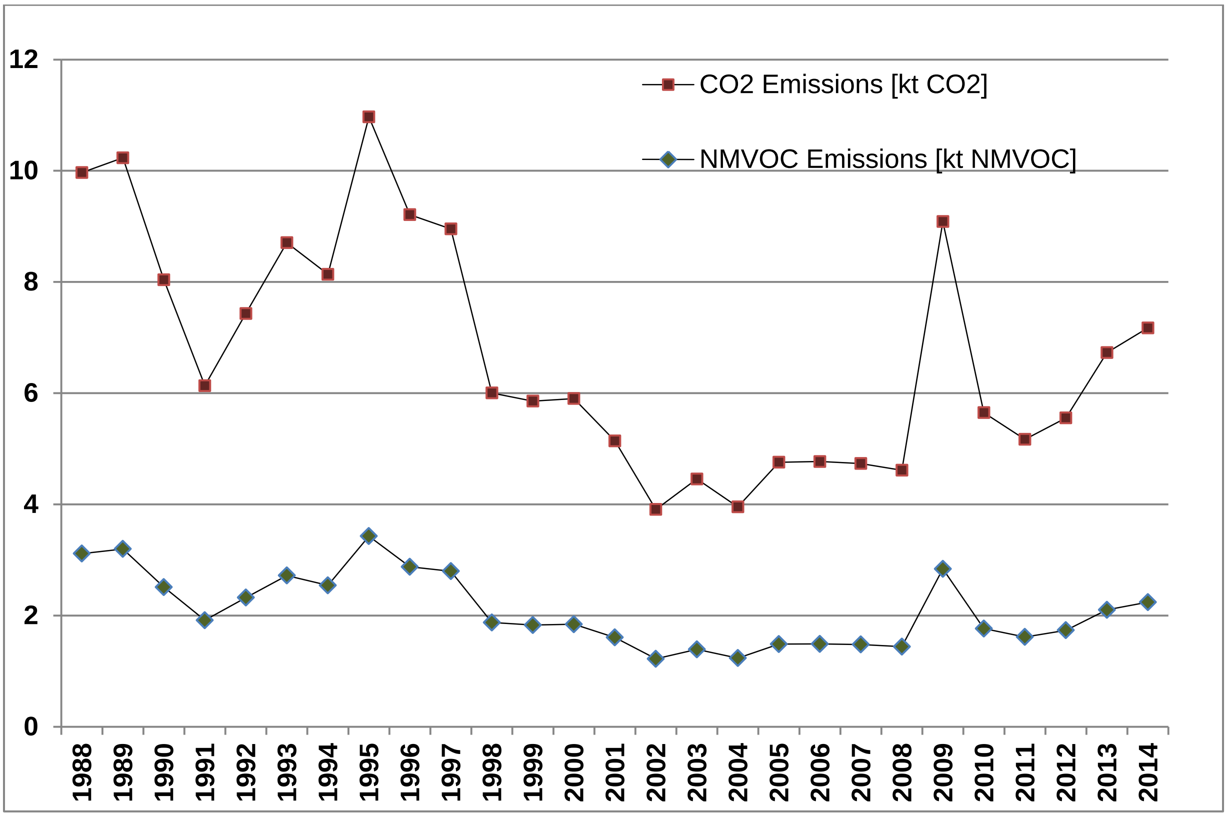


Figure 80 NMVOC and CO2 emissions in Vegateble oil production.

4.9.1.3 Methodological issues

4.9.1.3.1 Methods

The emissions of NMVOC from *2H3* Other (Vegetable oil production), are estimated based on the emission factor are in accordance with the EMEP/EEA air pollutant emission inventory guidebook –2006 and 2013[i]. The activity data are provided mainly by the National Statistics Institute – NSI.

CO_2 emissions from *2H3* Other (Vegetable oil production)

Converting of NMVOC into CO_2 with conversion factor is provided in the 2006 IPCC Guidelines, Volume 1, Chapter 7.2.1.5 Carbon Emitted in Gases Other than CO_2.

[28] In the following referred as EMEP/EEA Guidebook (2013)

From NMVOC:

$$Inputs_{CO_2} = Emissions_{NMVOC} \times C \times \frac{44}{12}$$

Where C is the fraction carbon in NMVOC by mass (default = 0.6)

Reference for default: conversion- factor NMVOC – CO_2, 2006 IPCC Guidelines , Volume 3, Chapter 5: Industrial Processes and Product Use, page 5.17, 2006 IPCC Guidelines s, Volume 1, Chapter 7: Precursors and Indirect Emissions, page 7.6

4.9.1.3.2 Emission Factor

The default emission factors used for assessment of emissions of NMVOC from 2H3 are presented in Table 178.

Table 178 Emission factor used for estimation of NMVOC emissions from *2H3* Other (Vegetable oil production)

SNAP activity	Name of activity	Emission factor	Unit	Reference
2H3	Vegetable oil production	18	kg/t	CORINAIR

4.9.1.3.3 Activity Data

The activity data for estimation of emissions in 2H3, are provided by the NSI.

Table 179 AD for NMVOC and CO_2 emissions from 2H3 - Other (Vegetable oil production), Gg.

2H3 Other - Vegetable Oil Production		
Year	NMVOC Emissions [kt NMVOC]	CO2 Emissions [kt CO2]
1988	3,115	6,852
1989	3,198	7,035
1990	2,512	5,527
1991	1,917	4,218
1992	2,323	5,110
1993	2,721	5,986
1994	2,543	5,596
1995	3,428	7,541
1996	2,878	6,332
1997	2,798	6,156
1998	1,876	4,128
1999	1,830	4,027
2000	1,845	4,059
2001	1,607	3,535
2002	1,222	2,688
2003	1,393	3,064
2004	1,236	2,719
2005	1,487	3,271
2006	1,491	3,280

2H3 Other - Vegetable Oil Production		
Year	NMVOC Emissions [kt NMVOC]	CO2 Emissions [kt CO2]
2007	1,480	3,255
2008	1,442	3,172
2009	2,840	6,247
2010	1,766	3,885
2011	1,616	3,554
2012	1,736	3,819
2013	2,103	4,627
2014	2,242	4,933

4.9.1.4 Uncertainties and time series consistency

The uncertainty of the GHG emissions is presented inTable 180 .

Table 180 Uncertainty of subcategory 2H3 Vegetable oil production, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
2.H.3.I	NO	CO_2	10	30	31.62

4.9.1.5 Source specific QA/QC verification

All activities regarding QC as described in QA/QC System have been undertaken.

The following sector specific QA/QC procedures have been carried out:

- Check of methodology, emissions, emission factors and IEF (time series);
- Time series consistency;
- Plausibility checks of the results (due to the national statistic);
- Documentation and archiving of all information required in NIR, background documentation and archive;
- QA procedures have been performed by the Sector expert in the MOEW (Order № RD-218/05.03.2010 by the Minister of Environment and Water).

4.9.1.6 Source specific recalculation

No source specific recalculation.

4.9.1.7 Source specific planned improvements

No source specific improvements are planned.

5 AGRICULTURE (CRF SECTOR 3)

5.1 OVERVIEW OF SECTOR

This chapter gives information about the estimation of greenhouse gas emissions from Sector Agriculture in correspondence to the data reported under the Sector 3 in the Common Reporting Format. The following sources exist in Bulgaria:

- domestic livestock activities with enteric fermentation and manure management,
- rice cultivation,
- agricultural soils,
- agricultural residue burning, and
- urea fertilisation.

The agricultural holdings surveyed during the census in 2010 were 371 100, which is a decrease of 44% compared to the number of holdings surveyed during the census in 2003. A trend of decrease has been maintained over the recent years. Conducted sample surveys of the structure of agricultural holdings in 2005 and 2007 show that the number of holdings decreased by 19.7% in 2005 compared to 2003, by 7.8% in 2007 compared to 2005 and by 24.7% in 2010 compared to 2007.

The holdings owned by individuals are 363 700 or 98% of all agricultural holdings; followed by those owned by commercial companies – 1%, sole traders – 0.6%, cooperatives – about 0.3% and other holdings – about 0.1%.

357 900 agricultural holdings use agricultural area to the amount of 3 620 900 ha. An agricultural holding manages the average of 10.1 ha of utilized agricultural area (UAA), this indicator being the highest in the Northeast region (17.6 ha) and lowest in the Southwest region (3.6 ha).

Natural persons manage 33.8% of the UAA. The commercial companies manage 31.6% of the UAA of the country, the cooperatives – 17.7%, sole traders – 14.9%, and the remaining holdings – 2%.

In the UAA of 3 620 900 ha of the agricultural holdings, the share of arable land of 86.5% is the highest, followed by permanent grassland – 10.4% of the UAA. Permanent crops occupy 2.8% of the UAA.

The arable land is 3 133 000 hectares and is divided into 250 900 agricultural holdings. Cereals are grown on 47.8% of the holdings, representing 58.1% of the arable land. Industrial crops occupy 33.9% of the arable land and are grown on 23.1% of the holdings possessing arable land. Most industrial plants are grown in the Northwest region – 250 300 ha or 23.6%. Vegetables occupy 1.2% of the arable land and are grown mainly in the South Central region - 44.6% of the land under vegetables. Fodder crops are grown in 30% of the holdings on an area of 106,300 ha. This area is only 3.4% of the arable land.

The agricultural holdings with UAA from 0.00 to 1.99 ha in 2010 were 83.2% of all holdings. Over 78.2% of the UAA is located in holdings with an area of 100.00 ha or more, the average UAA of these holdings was 534 ha.

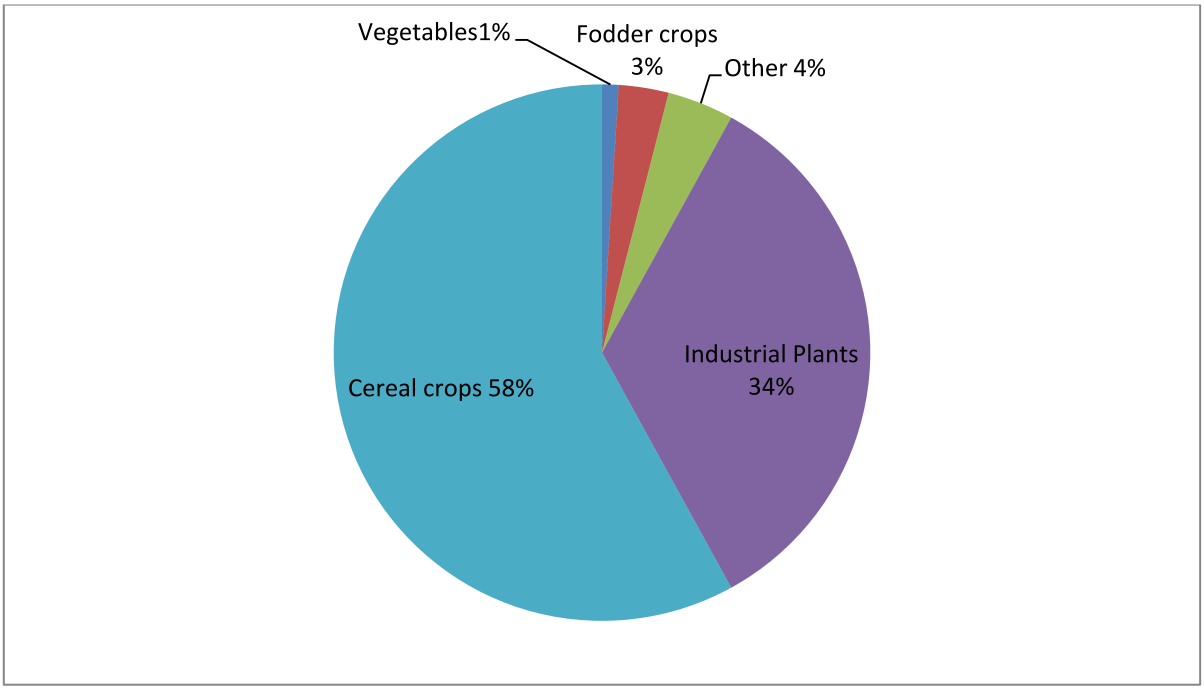
Around 280 300 were the holdings that kept livestock, poultry and bees as of 31 August 2010. Of these 91.5% used agricultural area from 0.01 ha to 10 ha (the analysis of the UAA of the holdings does not include collectively used common land for grazing animals). In the holdings with UAA from 0.01 ha to 10 ha 86.6% of equidae species, 82.5% of goats and 65.8% of sheep were raised. Cattle were raised in 34.1% of the holdings. Of these 4.4% did not have UAA and raised 7.7% of cattle, and the holdings with UAA from 0.01 ha to 10 ha were 89.1% and they raised 51.0% of the cattle. In the holdings without UAA 45.1% of the pigs and 47.6% of the birds were raised. 66.2% of the livestock holdings raised poultry. Over 10 ha of UAA were owned by 3.8% of the livestock breeding holdings. 5% of the holdings that raised pigs farmed more than 10 ha of the UAA and they raised 23.9% of the pigs.

About 100 of the surveyed agricultural holdings were engaged in activities for the production of mushrooms, growing of silkworms, hatcheries and others.

Labour force in agriculture

371 100 agricultural holdings employed 751 700 persons in 2010, the proportion of family labour force was 92.8% or 697 400 employed persons. 54 300 persons were employed in agriculture as paid workers. The total reduction of the persons employed in agriculture compared to those in 2007 was 20.8%. The annual work units (AWU) of all employed were 394 100, of these 343 100 were family labour force and 51 000 were paid labour force.

The proportion of men employed in agricultural holdings in 2010 was 55.7%. Employed men were by 22.1% less compared to 2007. Total of 61.0% of employed persons were aged 35 to 64 years. In the agricultural holdings 9.8% of the persons employed were aged between 15 and 34 years, and 29.2% were persons over 65 years of age.



Source: Ministry of Agriculture and Food, Agrostatistics Department

Figure 81 Arable land, used agricultural area and area of agricultural designation in the period in 2008 (ha)

5.2 EMISSION TRENDS

In the year 2014 the sector agriculture contributed 9% to the total of Bulgaria's greenhouse gas emissions (without LULUCF). The trend of GHG emissions from 1988 to 2014 shows a decrease of 64% for this sector due to decrease in activity data. (Figure 82)

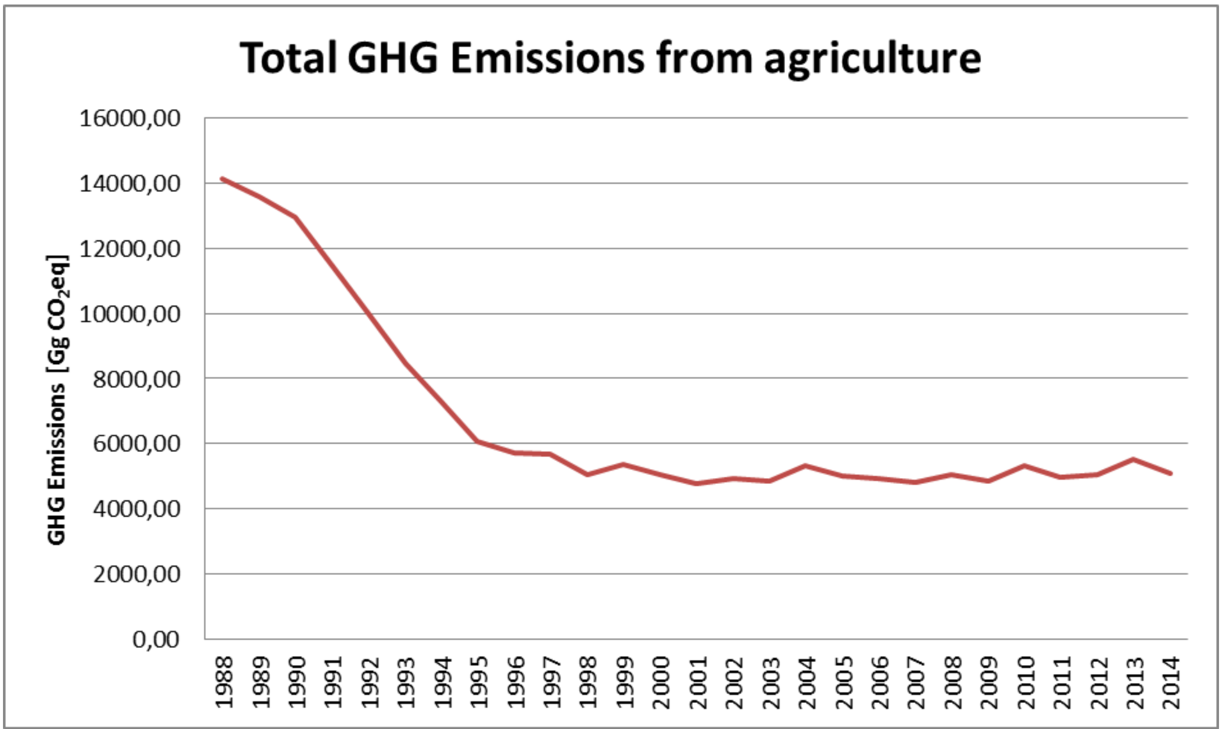


Figure 82 Trend of GHG Emissions from agriculture

5.3 EMISSION TRENDS PER GAS

CH_4 emissions are 37% from of the total emissions in the sector in CO_2-eq in 2014. A steady trend of emissions decrease is observed after 2004 due to reduction in animal numbers.

N_2O emissions from the sector are also significant. The biggest share belongs to the agricultural soils emissions. The share of N_2O emissions is 63% for the year 2014. The biggest share in these emissions has the Agricultural soils category with 86%. N_2O emissions from manure management and field burning of agricultural residues are of an order of magnitude smaller and in total are about 14% from the aggregated N_2O emissions of the sector.

Since 1988 CH_4 emissions from agriculture decreased by 73% and N_2O emissions by 56%. The trend is presented in Table 181.

CH_4 emissions were 75,05 Gg in the year 2014. The increase for the year 2014 is 2% compared to 2013. N_2O emissions decrease from 12,16 Gg in 2013 to 10,69 Gg in 2014 year

(12%). The decrease in N_2O emissions is mostly because of the lower consumption of synthetic fertilizers in 2014.

Table 181 Emissions of greenhouse gases from agriculture 1988 – 2014.

Year	GHG emissions [Gg]		
	CH_4	N_2O	CO_2
1988	273,67	24,40	17,12
1989	269,56	22,98	17,12
1990	265,90	21,11	17,12
1991	258,79	16,74	17,12
1992	234,30	13,88	17,12
1993	189,72	12,45	17,12
1994	148,40	11,94	17,12
1995	123,16	10,01	17,12
1996	115,75	9,47	17,12
1997	108,59	9,94	17,12
1998	100,54	8,48	17,12
1999	101,44	9,45	17,12
2000	95,22	8,84	17,12
2001	82,00	9,11	17,12
2002	85,41	9,35	17,12
2003	90,07	8,65	17,12
2004	89,86	10,24	17,12
2005	87,09	9,49	17,12
2006	86,70	9,21	17,12
2007	84,48	9,01	15,75
2008	82,57	9,97	20,30
2009	78,26	9,68	24,85
2010	77,80	11,26	18,05
2011	77,05	10,09	26,28
2012	72,71	10,71	31,32
2013	73,72	12,15	37,21
2014	75,05	10,69	30,86

5.3.1 EMISSION TRENDS PER SUB CATEGORY

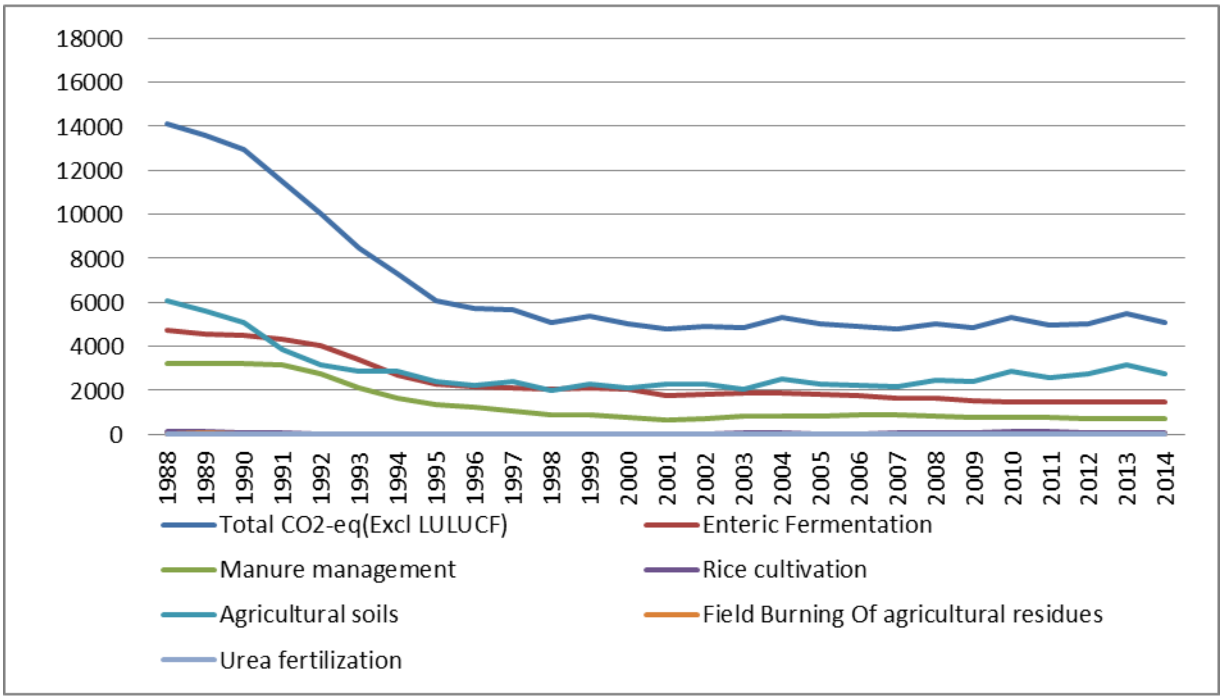


Figure 83 GHG emission trends 1988–2014 of agriculture by categories (Gg CO_2-eq)

Table 182 and Figure 83 present total GHG emissions and trend 1988–2014 from agriculture by sub-categories as well as the contribution to the overall inventory emissions. Important categories are 4.D Agricultural soils (54%) and 4.A Enteric Fermentation (29%) followed by 4.B Manure management (14%).

Table 182 GHG emissions 1988–2014 of agriculture by categories.

Year	GHG emissions [Gg CO_2 equivalent] by categories						
	3	3.A	3.B	3.C	3.D	3.F	3.H
1988	14131,18	4706,31	3194,26	126,99	6049,10	37,40	17,12
1989	13603,49	4586,82	3198,71	122,87	5630,28	47,69	17,12
1990	12954,14	4473,55	3227,46	95,37	5103,05	37,57	17,12
1991	11475,75	4305,23	3157,78	73,88	3879,67	42,07	17,12
1992	10011,09	4015,46	2757,38	40,75	3152,65	27,72	17,12
1993	8469,55	3387,75	2134,28	28,09	2881,54	20,77	17,12
1994	7285,40	2704,36	1648,11	7,45	2886,71	21,65	17,12
1995	6080,46	2283,77	1343,45	12,43	2400,07	23,62	17,12
1996	5732,23	2168,24	1261,17	23,47	2248,59	13,64	17,12
1997	5693,93	2114,19	1092,78	34,17	2414,82	20,84	17,12
1998	5056,71	2063,87	913,64	29,41	2014,11	18,56	17,12
1999	5368,34	2140,13	898,90	12,76	2281,00	18,44	17,12
2000	5030,88	2074,26	759,76	32,16	2132,24	15,34	17,12
2001	4780,53	1789,36	657,59	35,10	2262,08	19,28	17,12
2002	4937,44	1834,99	723,75	37,52	2301,12	22,95	17,12
2003	4847,74	1892,61	828,40	50,73	2043,90	14,98	17,12
2004	5314,59	1862,39	853,12	51,05	2505,79	25,12	17,12
2005	5023,30	1806,46	837,38	40,53	2301,47	20,33	17,12
2006	4929,65	1760,98	870,91	40,87	2219,60	20,17	17,12
2007	4813,98	1673,99	886,44	59,29	2167,11	11,41	15,75
2008	5055,58	1629,07	838,41	70,14	2473,38	24,27	20,30
2009	4865,27	1537,86	795,64	74,85	2409,59	22,47	24,85
2010	5318,84	1494,74	780,92	107,87	2891,09	26,17	18,05
2011	4959,57	1498,62	750,93	106,19	2551,75	25,79	26,28

Year	GHG emissions [Gg CO_2 equivalent] by categories						
	3	3.A	3.B	3.C	3.D	3.F	3.H
2012	5040,14	1452,67	697,14	88,91	2745,54	24,56	31,32
2013	5501,79	1467,59	698,93	91,99	3173,76	32,32	37,21
2014	5092,29	1488,60	701,77	99,45	2737,45	34,16	30,86
Share in Total 2014	-	29,23%	13,78%	1,95%	53,76%	0,67%	0,61%

As can be seen in Figure 83 and Table 182 the overall trend concerning emissions from all categories is decreasing. The reasons for the decrease are structural changes in agricultural holdings which lead to reduction in farm animal populations and decrease in arable land area.

5.3.2 KEY CATEGORIES

Table 183 Key sources of agriculture.

IPCC Category	Source Categories	Key Sources	
		GHG	KS-Assessment*
3.D.1	Direct N_2O emissions from Agricultural soils	N_2O	Yes
3.A.1	Enteric Fermentation - cattle	CH_4	Yes
3.A.2	Enteric Fermentation - sheep	CH_4	Yes
3.B1.1	Manure Management - cattle	CH_4	Yes
3.B.1.3	Manure Management - swine	CH_4	Yes
3.D.2	Indirect N_2O from Nitrogen used in Agriculture	N_2O	Yes
3.D.1.3	Pasture, Range and Paddock Manure	N_2O	Yes

5.3.3 COMPLETENESS

Table 184 gives an overview of the IPCC categories included in this chapter and provides information on the status of emission estimates of all subcategories. A "✓" indicates that emissions from this sub-category have been estimated.

Table 184 Overview of sub-categories of agriculture.

IPCC Category		CH_4		N_2O	CO_2
3.A	**ENTERIC FERMENTATION**	**ENTERIC FERMENTATION**	✓	**NA**	**NO**
3.A.1	Cattle	–	✓	NA	**NO**
3.A.1.	Dairy Cattle	Dairy cows	✓	NA	**NO**
3.A.1.	Non-Dairy Cattle	Other cattle	✓	NA	**NO**
3.A.1.	Young cattle	Calves and heifers	✓	NA	**NO**
3.A.2	Sheep	Sheep	✓	NA	**NO**

IPCC Category		CH_4		N_2O	CO_2
3.A.3	Swine	Swine	✓	NA	**NO**
3.A.4	Other livestock				**NO**
3.A.4	Buffalo	Buffalos	✓	NO	**NO**
3.A.4	Goats	Goats	✓	NA	**NO**
3.A.4	Camels and Lamas	Camels	NO	NO	**NO**
3.A.4	Horses	Horses	✓	NA	**NO**
3.A.4	Mules and Asses	Mules and asses	✓	NA	**NO**
3.A.4	Poultry	Laying hens, broilers, other poultry	NA	NA	**NO**
3.B.	**MANURE MANAGEMENT**	**MANURE MANAGEMENT REGARDING ORGANIC COMPOUNDS** **MANURE MANAGEMENT REGARDING NITROGEN COMPOUNDS**	✓ **NO**	**NO** ✓	**NO**
3.B.1.1 + 3.B.2.1	Cattle	–	✓	✓	**NO**
3.B.1.1 + 3.B.2.1	Dairy Cattle	Dairy cows	✓	✓	**NO**
3.B.1.1 + 3.B.2.1	Non-Dairy Cattle	Other cattle	✓	✓	**NO**
3.B.1.1 + 3.B.2.1	Young cattle	Calves and heifers	✓	✓	**NO**
3.B.1.4 + 3.B.2.4	Buffalo	Buffalos	✓	✓	**NO**
3.B.1.2 + 3.B.2.2	Sheep	Sheep	✓	✓	**NO**
3.B.1.4 + 3.B.2.4	Goats	Goats	✓	✓	**NO**
3.B.1.4 + 3.B.2.4	Horses	Horses	✓	✓	**NO**
3.B.1.4 + 3.B.2.4	Mules and Asses	Mules and asses	✓	✓	**NO**
3.B.1.3 + 3.B.2.3	Swine	Swine	✓	✓	**NO**

IPCC Category		CH_4		N_2O	CO_2
3.B.1.4 + 3.B.2.4	Poultry	Laying hens, broilers, Other poultry (ducks, gooses,…)	✓	✓	**NO**
3.B.2.5	Emissions per MMS	Emissions per MMS	-	✓	**NO**
3.C	**RICE CULTIVATION**	**Rice Field (with fertilizers) Rice Field (without fertilizers)**	✓	**NO**	**NO**
3.D	**AGRICULTURAL SOILS**	**CULTURES WITH FERTILIZERS CULTURES WITHOUT FERTILIZERS**	**NO**	✓	**NO**
3.D.1	Direct Soil Emissions	Cultures with and without fertilizers	NO	✓	**NO**
3.D.1.3	Pasture, Range and Paddock Manure	Cultures without fertilizers	NO	✓	**NO**
3.D.3	Indirect Emissions	Cultures with and without fertilizers	NO	✓	**NO**
3.E	**PRESCRIBED BURNING OF SAVANNAS**	**–**	**NO**	**NO**	**NO**
3.F	**FIELD BURNING OF AGRICULTURAL RESIDUES**	**ON-FIELD BURNING OF STUBBLE, STRAW, …**	✓	✓	**NO**
3.F.1	Cereals	Cereals	✓	✓	**NO**
3.F.2	Pulses	Pulse	✓	✓	**NO**
3.F.3	Tubers and Roots	Tuber and Root	✓	✓	**NO**
3.F.4	Sugar Cane	Sugar Cane	✓	✓	**NO**
3.G	**LIMING**	**NO**	**NO**	**NO**	**NO**
3.H	**UREA FERTILIZATION**	**NO**	**NO**	**NO**	✓

5.3.4 QA/QC ACTIVITIES

- Sector specific QA/QC procedures are to be intensified;
- Comparison of emissions using alternative approaches;
- Food and Agriculture Organization of the United Nations (FAO);
- Documentation and archiving of all information required in NIR, background documentation and archive.

5.3.5 RECALCULATIONS AND TIME-SERIES CONSISTENCY

In the submission 2016, emissions from the Agriculture sector have been recalculated for the entire time series. With the recalculations emissions of the sector decrease from 5939,35 CO2-eq in 2013, to 5501,79 CO2-eq.

Recalculations are mainly as a result of the implementation of 2006 IPCC GL, but also due to corrections of some technical mistakes and implementation of the recommendations of the FCCC/ARR/2014/BGR:

- Productions of feetbeat have been recalculated for the entire time series due to revision of the statistical data – new data was provided from Ministry of Agriculture and Food and from National Statistics Institutes' yearbooks 1990-2014.
- In submissions 2016 productions of alfalfa were included – data was provided form Ministry of Agriculture and Food and from National Statistics Institutes' yearbooks 1990-2014.
- Emissions of CH_4 from Enteric fermentation have been racalculated for the cattle due to implemntation of new values of digestibility of feed and CH_4 conversion factor (please see 1.4. Enteric fermentation).
- Emissions of CH_4 from Manure Management have been recalculated for the entire time series due to revised estimates of Volatile solid excreted for swine (see 5.5.Manure Management);
- Direct emissions of N_2O from Manure management have been recalculated for the entire time series due to revised estimates of Nitrogen extration rate for Mature non-dairy cattle (see 5.5 Manure Management);
- Indirect emissions of N_2O from Manure management have been recalculated for the entire time series due to corrections of technical mistakes (see 5.5 Manure Management);
- Direct emissions of N_2O from Agriculture soils have been recalculated for the entire time series due to implementation of new estimates for Nitrogen in crop residues returned to soils and Nitrogen input of manure applied to soils according 2006 IPCC GL (see 5.7 Agricultural Soils (CRF sector 3D));
- Indirect emissions of N_2O from Agriculture soils have been recalculated for the entire time series due to implementation of new estimates for $Frac_{GASF}$ (Volatilisation from synthetic fertiliser), according recommendations of the FCCC/ARR/2014/BGR (see 5.7.Agricultural Soils (CRF sector 3D)).
- According 2006 IPCC GL, CO_2 emissions from Urea fertilization have been estimated.

5.4 ENTERIC FERMENTATION (CRF SECTOR 3A)

Emissions from this key source are result from fermentation in ruminant animals' digestive system (e.g., cattle, sheep, goats). Non – ruminant livestock (horses, mules and asses) and monogastric livestock (swine) produce lower methane emissions. The amount of methane that is released depends on age, weight of the animal, and the quality and quantity of the feed consumed. All domestic animals indicated in 2006 IPCC GL except for llamas and camels are bred in Bulgaria.

In 2014, this source category was responsible for 29% of the total GHG emissions from the agriculture sector.

5.4.1 SOURCE CATEGORY DESCRIPTION

CH_4 emissions in CO_2-eq. were 1488,60 Gg in the year 2014. The increase for the year 2014 is 1,43% compared to 2013. Compared to base year a decrease of 68% is observed.

CH_4 emissions from the enteric fermentation of domestic livestock are given in Table 185**.**

Table 185 Greenhouse gas emissions from enteric fermentation 1988–2014.

Year	CH_4 emissions [Gg] per Livestock Category								
	3.A	3.A.1	3.A.1	3.A.1	3.A.4	3.A.2	3.A.4	4.A.4	3.A.3
	Total	Mature Dairy	Mature Non-Dairy	Young	Buffalo	Sheep	Goats	Horses, Mules & asses	Swine
1988	188,25	69,03	9,71	29,87	1,39	64,20	2,17	5,82	6,06
1989	183,47	69,05	9,40	28,92	1,31	60,76	2,16	5,76	6,11
1990	178,94	67,99	9,14	28,14	1,28	58,20	2,17	5,68	6,34
1991	172,21	66,02	8,58	26,40	1,34	55,56	2,33	5,60	6,39
1992	160,62	64,27	7,49	23,04	1,39	50,76	2,63	5,54	5,50
1993	135,51	58,24	5,74	17,66	1,30	39,90	2,91	5,40	4,37
1994	108,17	49,72	3,84	11,81	1,08	29,68	3,22	5,26	3,56
1995	91,35	42,18	2,91	8,95	0,85	24,46	3,68	5,27	3,04
1996	86,73	39,48	2,58	7,95	0,75	23,30	4,07	5,50	3,09
1997	84,57	39,88	2,29	7,03	0,69	21,84	4,21	5,90	2,73
1998	82,55	40,83	2,11	6,49	0,60	20,34	4,54	5,40	2,24
1999	85,61	44,39	2,23	6,85	0,58	19,40	5,03	4,73	2,40
2000	82,97	44,10	2,29	9,16	0,53	15,73	4,47	4,77	1,91
2001	71,57	38,73	2,09	9,27	0,43	11,61	3,54	4,70	1,21
2002	73,40	39,47	2,52	10,14	0,39	11,50	3,57	4,48	1,34
2003	75,70	39,52	3,09	11,87	0,42	11,49	3,70	4,09	1,52
2004	74,50	40,22	2,83	10,94	0,44	11,33	3,61	3,66	1,47
2005	72,26	39,57	2,60	10,04	0,44	11,43	3,32	3,45	1,41
2006	70,44	38,64	2,62	9,66	0,45	11,21	2,89	3,49	1,47
2007	66,96	36,82	2,71	8,44	0,47	10,92	2,61	3,56	1,43
2008	65,16	35,76	2,81	8,44	0,50	10,46	2,31	3,63	1,25
2009	61,51	33,60	2,84	7,79	0,48	10,00	1,98	3,70	1,14
2010	59,79	33,31	2,81	7,84	0,48	9,52	1,79	2,98	1,05
2011	59,94	33,91	3,06	7,94	0,53	9,70	1,74	2,11	0,95
2012	58,11	32,51	3,36	7,62	0,53	9,70	1,59	1,94	0,85
2013	58,70	32,75	3,55	8,13	0,53	9,57	1,46	1,88	0,84
2014	59,54	33,09	4,11	8,06	0,54	9,62	1,45	1,81	0,85
Share 2014		55,58%	6,90%	13,54%	0,90%	16,15%	2,44%	3,05%	1,44%
Trend 1988–2014	-68,37%	-52,06%	-57,67%	-73,00%	-61,45%	-85,02%	-33,07%	-68,84%	-85,90%

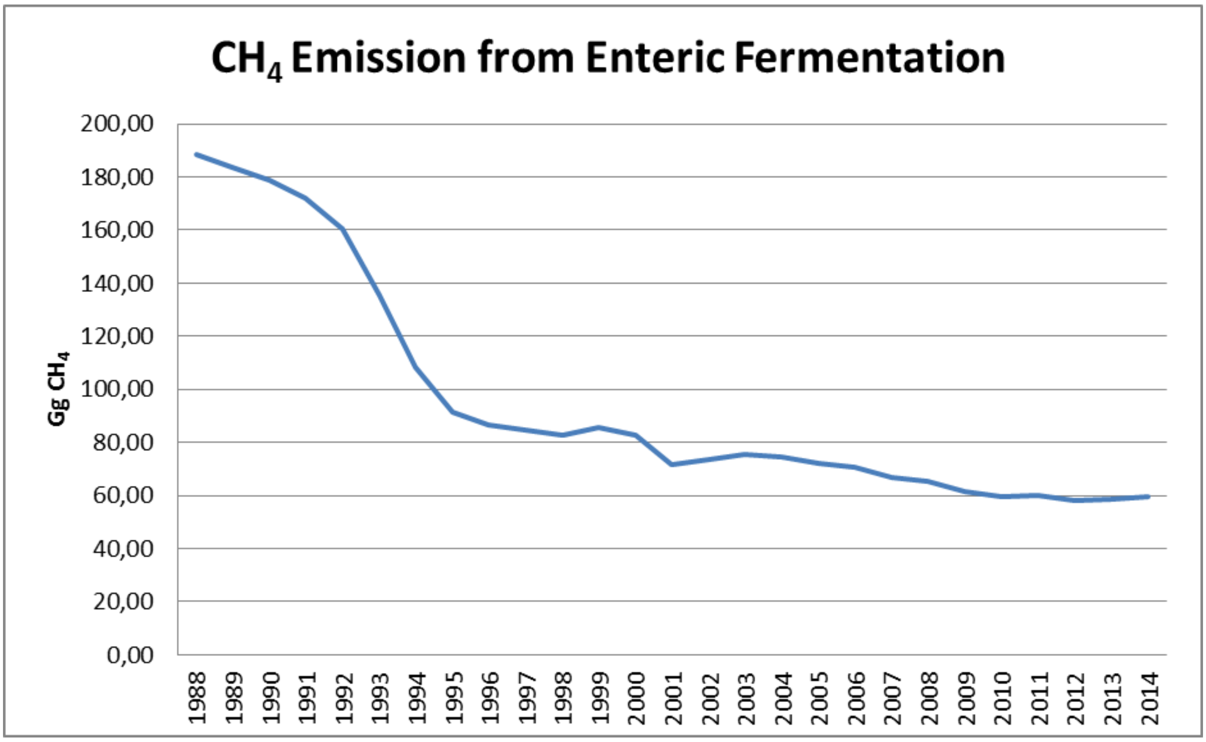


Figure 84 CH_4 emission from enteric fermentation

Figure 84 shows steady decrease in CH_4 emissions after 2002. The rapid decrease in the period 1991-1995 is consequence of a reform in agricultural holdings during this period. The overall reduction is caused by a decrease in total numbers of animals.

5.4.2 METHODOLOGICAL ISSUES

5.4.2.1 Methods

The IPCC Tier 1 method has been used to estimate the emissions from all farm animal categories with the exception of cattle (IPCC Sub-category 3A1) and sheep (IPCC Sub-category 3A2) for which Tier 2 method is used and option B for cattle.

5.4.2.2 Emission factors

Country specific emission factors are used. They are calculated from the specific gross energy intake and the methane conversion rate.

$EF_i = [GE_i \bullet Ym_i \bullet 365] / 55.65$

With *i = each livestock category*

EF_i expressed in kg CH_4/head/year

Y_m Methane conversion rate

Ge =Gross energy intake

The factor 55.65 expressed in MJ/kg of CH_4

➔ See equation 10.21 in the 2006 IPCC GL.

For the Tier 1 method, default GE is usually provided in the 2006 IPCC GL. For the Tier 2 method, GE is the combination of various feed intake – or net energy – estimates relating to maintenance, activity, growth, etc. of the animals.

The methane conversion rate (Y_m) is taken from the 2006 IPCC GL.

Tier 2 method – cattle

The IEF for cattle and sheep are representing in

Table 188.

For dairy cattle, the EF has been calculated by combining activity data, coefficients and parameters shown in Table 186. Bulgarian specific values for dairy cows were derived from feed intake data and energy content of food in dependency of annual milk yields.

Table 186 Activity data and parameters used for IPCC Sub-category 3A1 – Cattle – Mature Dairy Cattle

Parameter	Unit	Source
Livestock (# of animals)	#	Ministry of Agriculture and Food (see Table 191- Table 192)
Live Weight	kg	Executive Agency for Selection and Reproduction in Animal Breeding (see Table 194)
Calf Birth weight	kg	Ministry of Agriculture and Food
Daily Weight Gain	kg/day	NA
Annual Milk Yield	kg/cow/year	Ministry of Agriculture and Food (see Table 193)
Daily Milk Yield	kg/cow/day	Calculated using division by 365 days/yr
Fat Content of Milk	%	Ministry of Agriculture and Food (see Table 193)
Digestible Energy	%	based on Table 10.2 - 2006 IPCC GL
Net Energy for Maintenance	MJ/day	Eq. 10.3 & Table 10.4 - 2006 IPCC GL
Net Energy for Activity	MJ/day	Eq. 10.5 & Table 10.5 - 2006 IPCC GL
Net Energy for Growth	MJ/day	Eq. 10.6 - 2006 IPCC GL
Net Energy for Lactation	MJ/day	Eq. 10.8 - 2006 IPCC GL
Net Energy for Work	MJ/day	Eq. 10.11 - 2006 IPCC GL
Net Energy for Pregnancy	MJ/day	Eq. 10.13 & Table 10.7 - 2006 IPCC GL
Ratio of Net Energy in a Diet for Maintenance to Digestible Energy Consumed		Eq. 10.14 - 2006 IPCC GL
Ratio of Net Energy Available for Growth in a Diet to Digestible Energy Consumed		Eq. 10.15 - 2006 IPCC GL
Gross Energy Intake (average)	MJ/day	Eq. 10.16 - 2006 IPCC GL

Parameter	Unit	Source
CH4 conversion rate (average)	%	Table 10.12 - 2006 IPCC GL
Implied Emission Factor - CH4	kg CH_4/head/ year	Eq. 10.21 - 2006 IPCC GL

For the other cattle categories, IEF's are obtained by combining slightly different parameters which are listed in Table 187.

Table 187 Activity data and parameters used for IPCC Sub-category 3A1 – Cattle – Non-Dairy Cattle

Parameter	Unit	Source
Livestock	#	Ministry of Agriculture and Food (see Table 191-Table 192)
Live weight	kg	Executive Agency for Selection and Reproduction in Animal Breeding (see Table 194)
Live body weight	kg	Agrostatistics bulletins
Daily weight gain	kg/day	- mature non-dairy cattle: NA - young cattle: Default
Digestible energy	%	- mature non-dairy cattle: 60% - young cattle: Table 10.2 IPCC 2006
Net energy for maintenance	MJ/day	equation 10.3 & table 10.4 – 2006 IPCC GL
Net energy for activity	MJ/day	equation 10.5 & table 10.5 – 2006 IPCC GL
Net energy for growth	MJ/day	equation 10.6 – 2006 IPCC GL
Net energy for lactation	MJ/day	Equation 10.8 – 2006 IPCC GL
Net energy for work	MJ/day	equation 10.11 – 2006 IPCC GL
Net energy for pregnancy	MJ/day	Equation 10.13& table 10.7 – 2006 IPCC GL
Ratio of Net Energy in a Diet for Maintenance to Digestible Energy Consumed	#	equation 10.14 – 2006 IPCC GL
Ratio of Net Energy Available for Growth in a Diet to Digestible Energy Consumed	#	equation 10.15 – 2006 IPCC GL
Gross Energy Intake (average)	MJ/day	equation 10.16 – 2006 IPCC GL
CH4 Conversion Rate (average)	%	table 10.12 – 2006 IPCC GL

Table 188 Enteric fermentation emission factors for cattle and sheep:

	Emission Factor [kg CH_4/head*yr]			
Year	Mature Diary Cattle	Mature Non-Diary Cattle	Young Cattle	Sheep
2000	112,50	62,97	40,01	7,06
2001	107,38	62,74	37,85	7,08
2002	110,11	63,15	38,33	6,97
2003	109,77	63,32	39,45	6,91
2004	110,11	63,45	37,70	6,89
2005	110,45	63,62	40,56	6,94
2006	110,74	63,47	41,15	6,93
2007	107,33	63,08	36,85	6,91

Year	Emission Factor [kg CH_4/head*yr]			
	Mature Diary Cattle	Mature Non-Diary Cattle	Young Cattle	Sheep
2008	109,94	63,13	39,48	6,97
2009	109,91	63,56	38,58	6,95
2010	110,12	63,05	40,30	6,88
2011	110,26	62,60	40,81	6,87
2012	109,17	62,55	40,06	6,89
2013	109,93	62,57	41,44	7,01
2014	109,85	62,32	40,93	7,11

Over the period 2000-2014, the milk yield has decreased by 6,49% (see Table 193). At the same time the dairy cattle population declined by 23%. As these two parameters are the main drivers for the calculation of the EF under the Tier 2 method, it is the reason to have slight fluctuations in the EF expressed in CH_4/head/year for mature dairy cattle.

The slight fluctuations in EFs for mature non-dairy cattle and sheep are because those are weight average EF between several categories (mature males and females for the cattle and females, males and young for sheep).

The main driver for the calculation of the EF for young cattle is the live-weight, and for them this weight is not constant (see Table 195), so this is the reason for the differences in EF.

Emissions factors are recalculated in this submission due to recalculated digestibility and CH_4 conversation factor (please see **Error! Reference source not found.**.**Error! Reference source not found.**).

Tier 1 method – all farm animal categories except cattle and sheep

For farm animals, other than cattle and sheep, the IEFs are the default enteric fermentation EFs for developed countries represent in

Table 190. More details are provided in **.**

Table 189 **.**

Table 189 Activity data, coefficients and parameters used for IPCC Sub-categories

Parameter name	Unit	Parameter source
Livestock	#	-Ministry of Agriculture and Food – Agrostatistics department -Bulgarian Foodsafety Agency, Animal Health and Welfare Directorate (see Table 191-Table 192)
Live Weight	kg	- Ministry of Agriculture and Food – Agrostatistics department (see Table 194) - Executive Agency for Selection and Reproduction in Animal Breeding

Table 190 Enteric fermentation emission factors for farm animals, other than cattle and sheep

Livestock category	Emission factor [kg CH_4 $HEAD^{-1}$ YR^{-1}]	Reference
Buffalo	55	Table 10.10 - 2006 IPCC GL
Goats	5	Table 10.10 - 2006 IPCC GL
Horses	18	Table 10.10 - 2006 IPCC GL
Mules and Asses	10	Table 10.10 -2006 IPCC GL
Swine	1,5	Table 10.10 - 2006 IPCC GL

5.4.2.3 Activity data

The average number of animals per year is shown in Table 191 and

Table 192.

Data is collected from the Agricultural Statistics Department of the Ministry of Agriculture and Food, Bulgarian Food Safety Agency, FAO Database and National Statistics Institutes' yearbooks 1990-2014.

Table 191 Domestic livestock populations 1988–2014 (1000 number) (I).

	Dairy cattle	Non-dairy cattle-females	Non-dairy cattle - bulls	Young cattle - <1yr	Young cattle 1-2yrs	Goats	Buffalo
1988	628,64	134,37	18,97	688,06	193,45	434,78	25,31
1989	628,78	130,11	18,37	666,28	187,32	431,98	23,89
1990	619,14	126,59	17,87	648,25	182,25	434,28	23,27
1991	601,25	118,77	16,77	608,21	171,00	465,51	24,28
1992	585,30	103,66	14,64	530,84	149,24	525,41	25,34
1993	530,33	79,43	11,21	406,75	114,36	581,98	23,64
1994	452,79	53,14	7,50	272,12	76,51	643,83	19,68
1995	384,11	40,28	5,69	206,25	57,99	735,93	15,46
1996	359,52	35,77	5,05	183,15	51,49	814,38	13,69
1997	363,21	31,64	4,47	162,03	45,55	841,03	12,57
1998	371,85	29,22	4,13	149,63	42,07	907,43	11,00
1999	404,24	30,81	4,35	157,78	44,36	1006,86	10,46
2000	392,02	32,40	3,97	183,50	45,42	893,82	9,67
2001	360,63	30,01	3,27	206,41	38,52	707,66	7,76
2002	358,41	35,22	4,68	219,26	45,26	714,88	7,01
2003	360,01	42,72	6,11	237,08	63,86	739,89	7,68
2004	365,28	38,76	5,83	224,58	65,50	721,71	7,92
2005	358,24	35,15	5,66	190,67	56,97	663,27	8,09
2006	348,95	35,81	5,44	180,61	54,23	578,75	8,22
2007	343,02	38,12	4,91	174,20	54,91	522,28	8,61
2008	325,28	39,32	5,18	160,90	52,80	462,66	9,10

2009	305,71	38,56	6,07	148,90	52,99	395,33	8,77
2010	302,46	39,58	5,02	141,36	53,22	358,58	8,78
2011	307,50	44,42	4,49	139,75	54,88	348,85	9,56
2012	297,80	48,96	4,82	129,78	60,52	317,50	9,55
2013	297,92	51,58	5,13	133,91	62,29	291,47	9,58
2014	301,24	60,68	5,24	133,53	63,51	290,98	9,76

The FAO agricultural data base (FAOSTAT) provides worldwide harmonized data. In the case of Bulgaria, this data comes from the national statistical system. FAOSTAT data are seemingly based on the official data but there is an annual attribution error. The rapid decline in cattle numbers in the period 1992-1994 is due to reforms in agricultural holdings in this period.

Table 192 Domestic livestock populations 1988–2014 (1000 number) (II).

	Mature sheep			Young sheep	Horses	Swine	Mules & Asses	Poultry	
	For meat or wool production or both	commercial milk production	Other (males)	Intact males, castrates & Females				Chicken (1)	ducks, geese, etc.(2)
1988	590,22	6.838,09	217,21	1.579,05	122,13	4042,20	362,20	35856,16	4723,47
1989	559,69	6484,38	205,97	1497,37	122,41	4076,47	355,27	36770,38	4843,90
1990	535,52	6204,34	197,08	1432,71	120,45	4225,23	351,51	34523,50	4547,91
1991	514,06	5955,66	189,18	1375,28	117,16	4259,10	349,19	28423,85	3744,38
1992	468,41	5426,78	172,38	1253,15	114,85	3663,99	347,42	21959,95	2892,87
1993	368,47	4268,97	135,60	985,79	113,99	2910,56	335,32	18369,90	2419,94
1994	274,41	3179,21	100,99	734,14	113,44	2375,53	322,03	16825,50	2216,49
1995	229,09	2654,12	84,31	612,89	123,11	2028,76	305,86	16495,86	2173,06
1996	216,93	2513,21	79,83	580,35	141,78	2063,10	294,69	16671,62	2196,22
1997	204,83	2373,11	75,38	548,00	160,50	1820,23	301,10	15390,86	2027,50
1998	187,70	2174,62	69,08	502,16	148,34	1490,09	273,06	13692,69	1803,79
1999	179,04	2074,24	65,89	478,98	129,79	1600,62	239,41	13453,35	1772,26
2000	142,63	1652,50	52,49	381,60	137,20	1276,43	230,12	13540,63	1783,76
2001	106,45	1233,33	36,37	264,40	140,67	809,90	216,38	13233,72	1743,33
2002	106,54	1234,38	37,36	271,60	145,50	892,46	185,77	14636,46	1928,12
2003	105,59	1223,32	42,21	292,34	142,85	1014,39	151,50	17673,16	1849,54
2004	104,48	1210,50	39,47	291,08	130,66	981,85	130,75	18239,40	1970,25
2005	99,63	1233,17	36,14	278,44	130,66	937,20	110,00	17182,20	2331,35
2006	97,55	1207,74	36,87	276,68	141,50	977,82	94,00	17582,00	2254,00
2007	106,91	1157,90	36,48	279,61	151,50	950,63	83,00	17192,50	2235,00
2008	102,40	1113,38	35,54	249,31	161,64	836,13	71,90	16095,50	2028,00
2009	79,07	1087,72	33,64	237,11	171,68	756,72	60,90	15883,50	1591,50
2010	72,49	1041,76	27,20	242,67	134,39	696,90	56,52	15032,50	1635,00
2011	78,62	1054,48	27,19	251,01	87,17	636,13	54,19	13606,00	1688,50
2012	80,94	1048,25	30,61	248,28	79,94	569,61	50,51	13493,00	1464,50
2013	87,47	1031,56	30,58	215,93	77,52	558,68	48,44	12751,50	1485,50
2014	84,63	1046,34	31,76	189,69	75,74	569,77	45,05	12318,00	1593,50

(1) broiler and layer chickens, roosters, chicks
(2) ducks, geese, turkeys, guinea-fowls, wild poultry

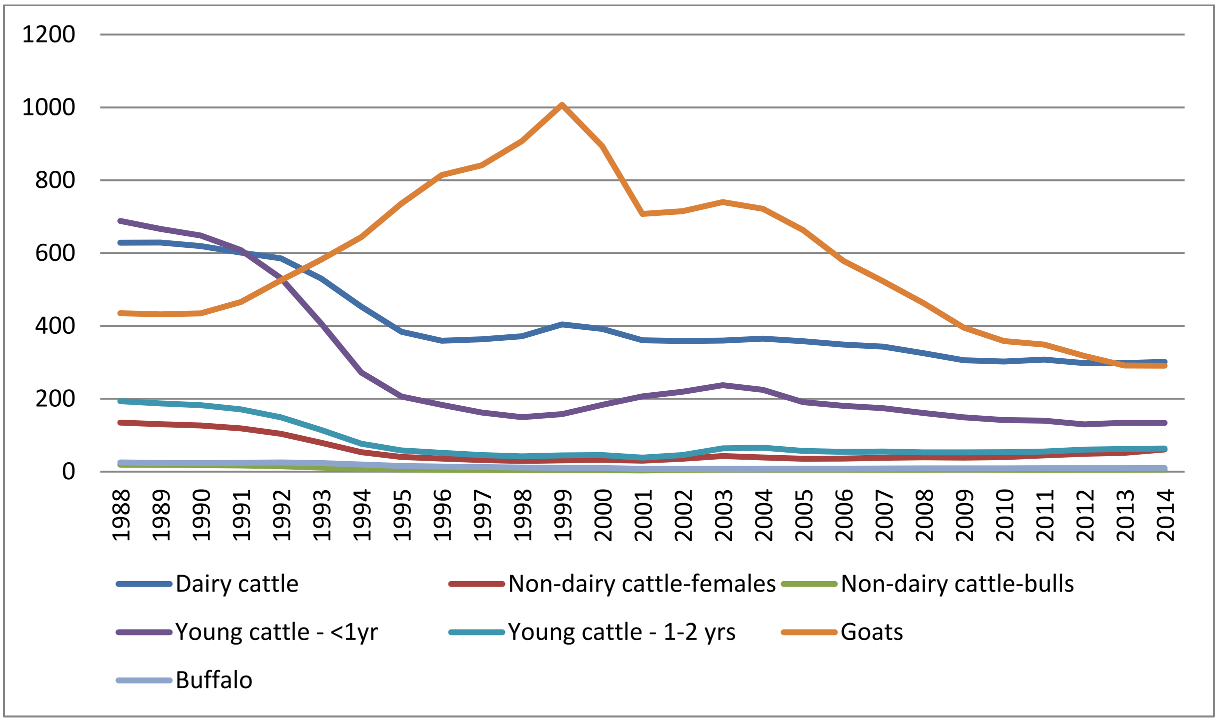


Figure 85 Domestic livestock populations (I)

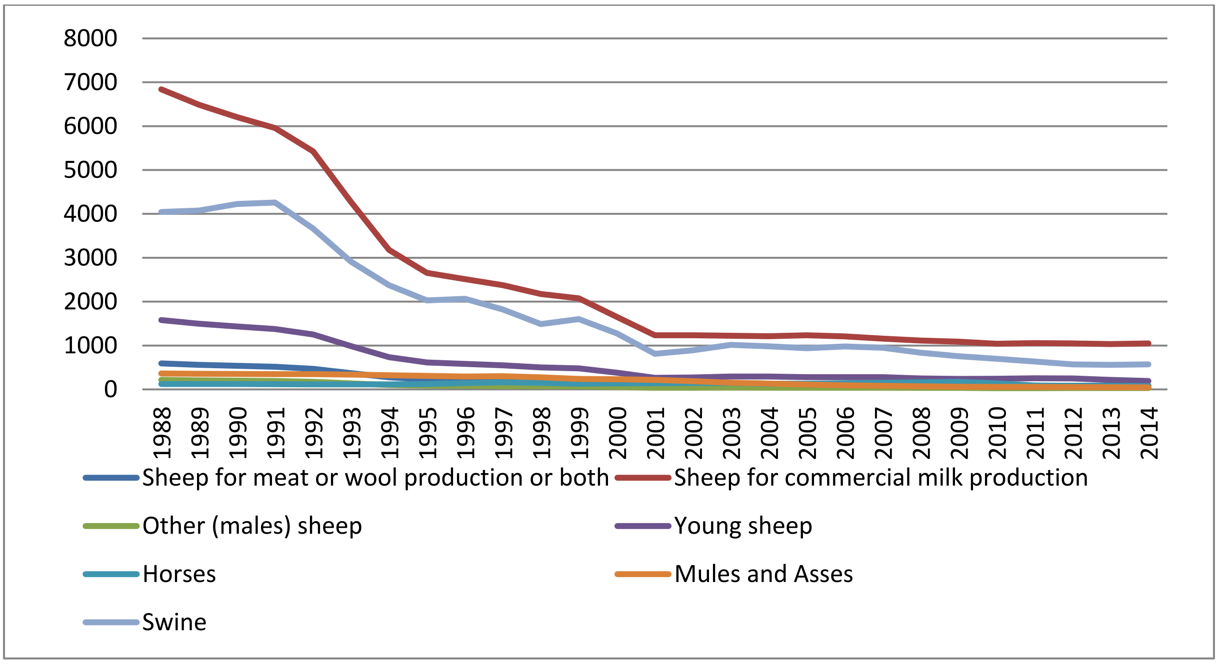


Figure 86 Domestic livestock populations (II)

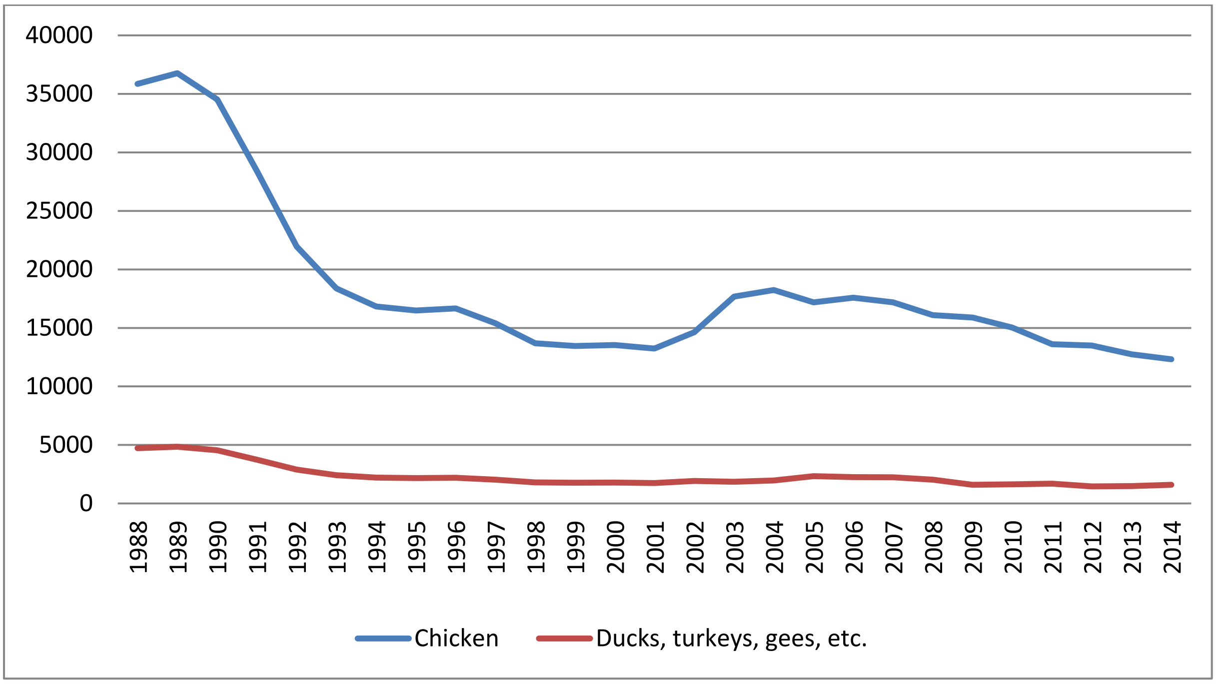


Figure 87 Domestic livestock populations (III)

5.4.2.3.1 Milk yield and fat content

The milk yield is obtained by dividing the milk production by the number of dairy cows. It is measured in kg per head. The Agrostatistics department at the Ministry of Agriculture and Food calculates the milk production by adding up the amount of milk collected by the dairy industry directly from the farmers;

Over the period 2000-2014, the milk yield has decreased by 6,49%. This is the reason for the slight fluctuations in Gross energy intake expressed in MJ/head/day.

The average fat content of milk for 2014 is 3.76%

Table 193 Milk yield, gross energy intake for dairy cattle: 2000 – 2014:

Year	Milk Yield [kg/cow*yr]	Gross Energy Intake [MJ/head*day]
2000	4639	263,89
2001	4091	251,88
2002	4383	258,28
2003	4346	257,48
2004	4383	258,28
2005	4420	259,08
2006	4456	259,75
2007	4091	251,76
2008	4346	257,87
2009	4344	257,80

Year	Milk Yield [kg/cow*yr]	Gross Energy Intake [MJ/head*day]
2010	4366	258,31
2011	4381	258,64
2012	4265	256,07
2013	4345	257,84
2014	4338	257,67

Source: Ministry of Agriculture and Food, Agrostatistics Department

5.4.2.3.2 Live weight

Live-weight for most animal categories has been provided by the Agrostatistics department of Ministry of Agriculture and Food. The live weight of mature dairy cattle, mature non-diary These data are not published as such and, therefore, might be considered as expert judgments. However, they rely on measurements and are not purely speculative. These weights are constant over time and are provided in Table 194. For buffalo, goats, horses and mules and asses the live-weight is default from Table 10A-6 and Table 10A-9 - 2006 IPCC GL.

Table 194 Live-weight for farm animals reported in the inventory

Livestock category	Live-weight in kg used for estimating enteric fermentation emissions	
Cattle – Mature Dairy Cattle	588	
Cattle – Mature Non-Dairy Cattle – Females	613	
Cattle – Mature Non-Dairy Cattle – Males	880	
Cattle – Young Cattle – Calves	199	
Cattle – Young Cattle – Growing Heifers	390	
Sheep-Mature ewes where either meat or wool production or both is the primary purpose	61.00	
Sheep-Mature ewes where commercial milk production is the primary purpose	45.20	
Mature Sheep-Other(males)	65.00	
Young sheep - Intact males, castrates & Females	Slaughter body weight	14,50
	Weight at weaning	12.90
Swine	104.00	
Poultry – Chickens	2.10	
Other – Other Poultry	5,04	
Buffalo	380,00	
Goats	38,50	
Horses	377,00	
Mules and asses	130,00	

Source: Ministry of agriculture and Food, Agrostatistics department

Live-weight for young cattle is not constant over the time. The live-weight for calves and growing heifers has been provided by the Agrostatistics department of Ministry of Agriculture and Food (see Table 195)

Until 2012 year, in the inventory has been used the slaughter body weight of young cattle for estimations of the CH_4 emissions from Enteric fermentation and with this calculations the IEF for young cattle is among the highest in EU. After ESD revision in 2012 year, the TERT determined that this slaughter weight, that been used can explain the high IEF for Bulgaria compared to other countries and recommends that Bulgaria should be using average live-weight rather than slaughter weight. In 2012, Bulgaria recalculated these emissions due the reasons above and started to use the live-weight for the next inventories.

Table 195 Live-weight for young cattle 2000 – 2014:

Year	Live-weight Cattle – Young Cattle – Calves	Live-weight Cattle – Young Cattle – Growing Heifers
2000	211,30	361,05
2001	200,65	326,25
2002	202,00	339,00
2003	206,40	353,40
2004	195,95	319,30
2005	209,75	379,45
2006	211,85	395,70
2007	177,35	362,05
2008	197,45	378,95
2009	189,35	368,45
2010	200,60	385,15
2011	203,00	391,20
2012	195,00	375,50
2013	203,00	396,00
2014	198,95	389,55

5.4.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty from methane emissions from this source is 50%.

Table 196 Uncertainty of sub-sector Enteric Fermentation for 2014, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty

3.A.1	Cattle	CH_4	2	20	20
3.A.4	Buffalo	CH_4	2	50	50
3.A.2	Sheep	CH_4	2	20	20
3.A.4	Goats	CH_4	2	50	50
3.A.4	Horses	CH_4	2	50	50
3.A.4	Mules and Asses	CH_4	2	50	50
3.A.3	Swine	CH_4	2	20	20
3.A.4	Poultry	CH_4	2	50	50

Uncertainty values are the default ones from the 2006 IPCC GL

5.4.4 SOURCE-SPECIFIC QA/QC AND VERIFICATION

All activities regarding QC as described in QA/QC System have been undertaken.

Data were checked for transcription errors between input data and calculation sheets. Calculations were examined focusing on units/scale and formulas. Quality Control following the 2006 IPCC GL is described in the chapters of the sub-categories.

Activity data check

The inventory compiler reviews livestock data collection methods, in particular checking that livestock subspecies data were collected and aggregated correctly. The data is cross-checked with previous years to ensure the data are reasonable and consistent with the expected trend. Inventory compilers documents data collection methods, identifies potential areas of bias, and evaluate the representativeness of the data.

Review of emission factors

- Cross-check country-specific factors against the IPCC defaults;
- Sector specific QA/QC procedures are intensified according to QMS;
- Comparison of emissions using alternative approaches (Tier 1 method);
- Compared national statistics activity data with data from Food and Agriculture Organization of the United Nations (FAO);
- Documentation and archiving of all information required in NIR, national statistic of agriculture and food provided by MAF, background documentation and archive.

Revision of activity data and emission factors:

- Animal population and animal categories;
- Correction of notation key and cross-check with CRF tables;

In general the TACCC is improved.

5.4.5 SOURCE-SPECIFIC RECALCULATIONS

In submission 2016, CH_4 emissions have been recalculated for the entire time series due to implementation of new values for degistebility (DE%) and CH_4 conversation factors (YM) for cattle.

2006 IPCC GL (Table 10.2) suggests that cattle have a DE of 75-85% for feedlot animals with over 90% concentrate diet and a DE of 55-75% for pasture fed animals. With, in Bulgaria, 50% of the time cattle grazing and 50% are in stalls, the average is 70%.

Y_M are based on Table 10.12 from 2006 IPCC GL (average values).

Recalculations decrease emissions in the category with 21,30 % in 2013 year.

Table 197 Recalculations in Enteric fermentation

Sub- category	DE%		Y_M	
	Old data	New data	Old data	New data
Cattle	60%	70%	7%	6,5%

5.4.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements for this category.

5.5 MANURE MANAGEMENT

The section describes the estimation of methane and nitrous oxide emissions produced during the storage and treatment of manure, and from manure deposited on pasture (CH_4), and treatment of manure before it is applied to land (N_2O). In accordance with the IPCC guidelines, the term "manure" is used here collectively to include both dung and urine produced by livestock.

In 2014, this source category was responsible for 14% of the total GHG emissions from the agriculture sector.

5.5.1 SOURCE CATEGORY DESCRIPTION

CH_4 and N_2O emissions from manure management are given in Table 198 and Table 199**.**

Table 198 CH_4 emissions from Manure management 1988 –2014, Gg

CH_4 emissions from manure management [Gg]										
Livestock categories										
Year	3.B.1 Total	3.B.1.1 Dairy	3.B.1.1 Non Dairy	3.B.1.1 Young	3.B.1.4 Buffalo	3.B.1.2 Sheep	3.B.1.4 Goats	3.B.1.4 Horses &Mules and asses	3.B.1.3 Swine	3.B.1.4 Poultry
1988	79,18	2,15	0,22	0,80	0,15	1,87	0,06	0,47	72,34	1,11
1989	79,67	2,15	0,22	0,77	0,14	1,77	0,06	0,46	72,96	1,14
1990	81,95	2,12	0,20	0,62	0,14	1,70	0,06	0,46	75,62	1,04
1991	82,31	2,06	0,20	0,71	0,15	1,62	0,06	0,45	76,22	0,85
1992	71,19	2,00	0,17	0,62	0,15	1,48	0,07	0,44	65,57	0,67
1993	52,42	1,84	0,13	0,39	0,14	1,16	0,08	0,43	47,67	0,57
1994	39,23	1,59	0,09	0,32	0,12	0,87	0,08	0,42	35,17	0,57

CH$_4$ emissions from manure management [Gg]										
Livestock categories										
Year	3.B.1 Total	3.B.1.1 Dairy	3.B.1.1 Non Dairy	3.B.1.1 Young	3.B.1.4 Buffalo	3.B.1.2 Sheep	3.B.1.4 Goats	3.B.1.4 Horses &Mules and asses	3.B.1.3 Swine	3.B.1.4 Poultry
1995	30,57	1,36	0,07	0,25	0,09	0,71	0,10	0,42	27,00	0,57
1996	27,66	1,29	0,06	0,18	0,08	0,68	0,11	0,45	24,28	0,53
1997	21,99	1,32	0,06	0,20	0,08	0,64	0,11	0,48	18,63	0,49
1998	16,21	1,36	0,05	0,19	0,07	0,59	0,12	0,44	12,96	0,43
1999	14,75	1,50	0,05	0,16	0,06	0,57	0,13	0,38	11,46	0,43
2000	10,48	1,51	0,06	0,27	0,06	0,46	0,12	0,39	7,19	0,43
2001	8,39	1,31	0,05	0,28	0,05	0,34	0,09	0,38	5,48	0,41
2002	9,77	1,32	0,06	0,24	0,04	0,34	0,09	0,37	6,87	0,44
2003	11,87	1,31	0,08	0,34	0,05	0,34	0,10	0,34	8,83	0,49
2004	12,52	1,32	0,07	0,31	0,05	0,33	0,09	0,30	9,53	0,51
2005	12,57	1,29	0,06	0,23	0,05	0,33	0,09	0,29	9,73	0,50
2006	13,99	1,23	0,06	0,26	0,05	0,33	0,08	0,29	11,18	0,51
2007	14,78	1,15	0,06	0,23	0,05	0,32	0,07	0,30	12,11	0,49
2008	13,83	1,11	0,06	0,19	0,05	0,31	0,06	0,31	11,29	0,45
2009	13,04	1,01	0,06	0,17	0,05	0,29	0,05	0,31	10,67	0,43
2010	12,89	0,98	0,06	0,20	0,05	0,28	0,05	0,25	10,61	0,40
2011	12,04	1,00	0,06	0,16	0,06	0,28	0,05	0,18	9,89	0,36
2012	10,27	0,96	0,07	0,16	0,06	0,28	0,04	0,16	8,20	0,34
2013	10,32	0,97	0,08	0,17	0,06	0,28	0,04	0,16	8,25	0,32
2014	10,46	0,98	0,08	0,17	0,06	0,28	0,04	0,15	8,38	0,33
Share 2014		9,34%	0,81%	1,59%	0,56%	2,67%	0,36%	1,46%	80,09%	3,12%
Trend 1988–2014	-86,79%	-54,61%	-62,23%	-79,19%	-61,45%	-85,08%	-33,07%	-67,28%	-88,42%	-70,65%

Table 199 N$_2$O emissions from Manure management 1988 –2014, Gg

Year	N$_2$O emissions from manure management (without indirect emissions) [Gg]									
	Livestock categories									
	3.B.2 Total	3.B.2.1 Dairy	3.B.2.1 Non Dairy	3.B.2.1 Young	3.B.2.4 Buffalo	3.B.2.2 Sheep	3.B.2.4 Goats	3.B.2.4 Horses, Mules & Asses	3.B.2.3 Swine	3.B.2.4 Poultry
1988	2,94	1,09	0,18	0,59	0,003	0,36	0,02	0,03	0,03	0,63
1989	2,91	1,09	0,17	0,57	0,003	0,34	0,02	0,03	0,03	0,65
1990	2,83	1,08	0,17	0,55	0,003	0,32	0,02	0,03	0,03	0,62
1991	2,64	1,04	0,16	0,52	0,003	0,31	0,03	0,03	0,03	0,51
1992	2,37	1,02	0,14	0,45	0,003	0,28	0,03	0,03	0,03	0,39
1993	2,01	0,89	0,10	0,33	0,003	0,22	0,03	0,03	0,08	0,32
1994	1,63	0,73	0,07	0,22	0,002	0,17	0,04	0,03	0,11	0,28
1995	1,41	0,60	0,05	0,16	0,002	0,14	0,04	0,03	0,13	0,27
1996	1,38	0,54	0,04	0,13	0,002	0,13	0,05	0,03	0,16	0,29
1997	1,32	0,52	0,04	0,11	0,001	0,12	0,05	0,03	0,18	0,27
1998	1,25	0,51	0,03	0,10	0,001	0,11	0,05	0,03	0,17	0,24
1999	1,31	0,53	0,03	0,10	0,001	0,11	0,06	0,03	0,21	0,23
2000	1,23	0,49	0,03	0,11	0,001	0,09	0,05	0,03	0,19	0,23
2001	1,12	0,48	0,03	0,12	0,001	0,06	0,04	0,03	0,11	0,23

Year	N_2O emissions from manure management (without indirect emissions) [Gg]									
	Livestock categories									
	3.B.2 Total	3.B.2.1 Dairy	3.B.2.1 Non Dairy	3.B.2.1 Young	3.B.2.4 Buffalo	3.B.2.2 Sheep	3.B.2.4 Goats	3.B.2.4 Horses, Mules & Asses	3.B.2.3 Swine	3.B.2.4 Poultry
2002	1,19	0,51	0,04	0,14	0,001	0,06	0,04	0,03	0,11	0,26
2003	1,33	0,54	0,05	0,17	0,001	0,06	0,04	0,03	0,11	0,31
2004	1,35	0,58	0,05	0,18	0,001	0,06	0,04	0,02	0,10	0,32
2005	1,32	0,60	0,05	0,16	0,001	0,06	0,04	0,02	0,08	0,31
2006	1,31	0,61	0,05	0,16	0,001	0,06	0,03	0,02	0,07	0,31
2007	1,31	0,62	0,05	0,16	0,001	0,06	0,03	0,02	0,06	0,30
2008	1,26	0,61	0,06	0,15	0,001	0,06	0,03	0,02	0,05	0,29
2009	1,21	0,59	0,06	0,15	0,001	0,05	0,02	0,02	0,04	0,28
2010	1,19	0,60	0,06	0,15	0,001	0,05	0,02	0,02	0,03	0,26
2011	1,17	0,61	0,07	0,15	0,001	0,05	0,02	0,01	0,02	0,24
2012	1,15	0,59	0,07	0,15	0,001	0,05	0,02	0,01	0,02	0,24
2013	1,14	0,59	0,08	0,15	0,001	0,05	0,02	0,01	0,02	0,23
2014	1,16	0,59	0,09	0,15	0,001	0,05	0,02	0,01	0,02	0,22
Share 2014	-	51,47%	7,63%	13,39%	0,10%	4,48%	1,42%	1,02%	1,44%	19,05%
Trend 1988–2014	-60,63%	-45,53%	-50,91%	-73,57%	-61,45%	-85,44%	-33,07%	-63,05%	-47,46%	-65,14%

The analysis of Table 198 shows an increase of 1,36% in CH_4 emission for the present year, compared to the emissions from the preceding year and maintaining the low level compared to the base 1988 year – i.e. 86,79% reduction. Direct N_2O emissions have decreased under 1% compared to the previous year and have decreased 60,63% compared to the base year.

5.5.2 METHODOLOGICAL ISSUES

5.5.2.1 CH_4 emissions from manure management

Sheep, goats, horses, mules, asses, and other animals are of minor importance in Bulgaria, therefore the CH_4 emissions of these livestock categories are estimated with the Tier 1 approach with default EFs from the 2006 IPCC GL.

The 2006 IPCC GL Tier 2 methodology has been applied to estimate CH_4 emissions from manure management of cattle and swine as these are key sources. This method requires detailed information on animal characteristics and the manner in which manure is managed.

The following formula has been used (2006 IPCC GL, Equation 10.23):

$$EF_i = VS_i * 365\ [days\ yr^{-1}] * B_{0i} * 0.67\ [kg\ m^{-3}] * \Sigma_{jK}\ MCF_{jK} * MS\%_{ijK}$$

EF_i = annual emission factor (kg) for animal type i (e.g. dairy cows)

VS_i = Average daily volatile solids excreted (kg) for animal type i

B_{0i} = maximum methane producing capacity (m³ per kg of VS) for manure produced by animal type I

MCF_{jK} = methane conversion factors for each manure management system j by climate region K

$MS\%_{ijK}$ = fraction of animal type i`s manure handled using manure systems j in climate region K

Maximum methane producing capacity **(B_0)** values are from 2006 IPCC GL for all farm animals (Table 10A-4 to Table 10A-9).

Average daily volatile solids excreted **(VS)** is estimate by using equation 10.24 in 2006 IPCC GL. The estimations are based on digestibility of the feed, gross energy intake and the ash content of manure.

$$VS = [GE * (1 - \frac{DE\%}{100}) + (UE * GE)] * [(\frac{1 - ASH}{18.45})]$$

VS = volatile solid excretion per day on a dry-organic matter basis, kg VS day-1

GE = gross energy intake, MJ day-1(see Table 14)

DE% = digestibility of the feed in present (based on Guidelines IPCC 2006)

(UE•GE) = urinary energy expressed as fraction of GE (0.04GE for ruminants and 0.02GE for swine).

ASH = the ash content of manure calculated as a fraction of the dry matter feed intake

18.45 = conversion factor for dietary GE per kg of dry matter (MJ kg-1)

The values of VS for **cattle** have been determinate from country-specific gross energy intake. Values for DE% and GE are the same as used in Enteric fermentation. Values for UE (0,04) and ASH (8%) are according 2006 IPCC GL.

For the **swine**, VS was recalculated in this submission.

2006 IPCC GL presented default values for VS for breeding and market swine (normally 90% of the pig population is market swine and 10% - breeding). An average default value is 0,32 kg VS kg dry matter/head/day. Bulgaria use country-specific value of 0,23 kg dry matter/head/day. In order to estimate more accurately VS, swine were divided into sub-categories (see Table 209), not only on breeding and market pigs... For each sub-category were determined different country-specific values for the DE% and GE. Data were provided from scientific studies published in Global Journal of Science Frontier Research (volume 14, issue 5).

The ASH contain (ASH = 12,21%) is provided from the same scientific studies. Data about pig excrements, are based on own studies and represent the average values of 6 samples of different origin – pig-fattening farms. Pig dung (without urine) – taken by Ampulla recti for pigs – 110 kg from slaughter-houses – pure (without being in contact with the floor).

Value for UE (0.02) is default from 2006 IPCC GL.

Methane conversation factors (MCF) are default 2006 IPCC GL presented in Table 200, and are based on cool allocation by climate. In the future, Bulgaria will try to make efforts to develop country-specific value, especially for the anaerobic lagoon, because most of the manure of swine is treated in anaerobic lagoons and the swine are significant source of CH_4 emissions from manure.

Table 200 Methane conversion factors

AWMS	Allocation by climate	MCF
Anaerobic lagoon	Cool	70%
Liquid system	Cool	13%
Daily spread	Cool	0.1%

AWMS	Allocation by climate	MCF
Solid storage	Cool	2
Dry lot	Cool	1
Pasture range and paddock	Cool	1%
Other	Cool	1%

A survey conducted with the Agricultural University of Plovdiv, provided data about the distribution of AWMS. The survey provided data for 4 pillar years – 1995, 2000, 2005 and 2010. This data as well as interpolated data is provided in Table 201.

In the next submission, Bulgaria will provide new data for the period to 2015 year and will recalculate the period 2010 – 2015 year.

A survey was based on following components:

- Identification of the number of animals per species and categories;
- Determining the quantity fresh manure and nitrogen in animal categories;
- Determining the nitrogen emitted into different parts of the ecosystem.

The data collection methodology is based on the methodologies used by EUROSTAT since the raw data is collected by the Agrostatistics department at the Ministry of Agriculture and Food (MAF). On every 5 years there is a complete survey on all farms.

Finally all of these determinations were used to calculate the animal waste management systems distribution data.

In Bulgaria all farms with more than 50 sows, store the manure in anaerobic lagoons, all farms with 10-50 sows store the manure in dry lot and for all farms with up to 10 sows (small private farms) is accepted (conditionally) that manure is collect in solid storage.

The AWMS variation in the period 1988 – 2014 provided in Table 201 shows that 90% of manure is tread in anaerobic lagoons for swine, decreasing to 27% in 2000 and increasing back to 83% in 2011.

Reasons for these variations are reforms in agricultural holdings. In the period 1993 – 2000 the agriculture sector is in a crisis. Most of the farms are small and this is the reason for higher per cent for solid storage and dry lot management system in this years.

After 2005 there is stabilization in the sector and the farms with more than 50 sows increase.

Table 201 AWMS distribution for cattle, swine, and poultry:

	Cattle			Swine			Poultry	
	Solid storage	Dry lot	Pasture range paddock	Anaerobic lagoon	Solid storage	Dry lot	Solid storage	Dry lot
1988	33,50%	47,00%	19,50%	92,00%	8,00%	0,00%	50%	50%
1989	33,50%	47,00%	19,50%	92,00%	8,00%	0,00%	50%	50%

1990	33,50%	47,00%	19,50%	92,00%	8,00%	0,00%	50%	50%
1991	33,50%	47,00%	19,50%	92,00%	8,00%	0,00%	50%	50%
1992	33,50%	47,00%	19,50%	92,00%	8,00%	0,00%	50%	50%
1993	35,20%	44,60%	20,20%	84,00%	12,50%	3,50%	50%	50%
1994	36,70%	42,30%	21,00%	75,70%	17,30%	7,00%	50%	50%
1995	38,40%	40,00%	21,60%	67,80%	22,00%	10,20%	50%	50%
1996	40,00%	37,70%	22,30%	59,70%	26,60%	13,70%	50%	50%
1997	41,60%	35,40%	23,00%	51,60%	31,30%	17,10%	50%	50%
1998	43,20%	33,10%	23,70%	43,50%	36,00%	20,50%	50%	50%
1999	44,80%	30,70%	24,50%	35,40%	40,60%	24,00%	50%	50%
2000	46,40%	28,40%	25,20%	27,40%	45,30%	27,40%	50%	50%
2001	45,00%	31,50%	23,50%	32,60%	42,80%	24,60%	50%	50%
2002	43,60%	34,30%	22,10%	37,90%	40,30%	21,80%	50%	50%
2003	42,20%	37,50%	20,30%	43,20%	37,80%	19,00%	50%	50%
2004	40,70%	40,60%	18,70%	48,40%	35,30%	16,30%	50%	50%
2005	39,30%	43,60%	17,10%	53,60%	32,90%	13,50%	50%	50%
2006	36,80%	46,10%	17,10%	58,70%	29,30%	12,00%	50%	50%
2007	34,30%	48,70%	17,00%	63,60%	25,70%	10,70%	50%	50%
2008	32,80%	51,10%	16,10%	68,60%	22,10%	9,30%	50%	50%
2009	29,20%	53,70%	17,10%	73,50%	18,60%	7,90%	50%	50%
2010	26,70%	56,10%	17,20%	78,60%	15,00%	6,40%	50%	50%
2011	26,50%	56,30%	17,30%	83,60%	11,50%	5,00%	50%	50%
2012	26,50%	56,30%	17,30%	83,60%	11,50%	5,00%	50%	50%
2013	26,50%	56,30%	17,30%	83,60%	11,50%	5,00%	50%	50%
2014	26,50%	56,30%	17,30%	83,60%	11,50%	5,00%	50%	50%

5.5.2.2 Direct N_2O emissions from manure management

Following the guidelines, all emissions of N_2O taking place before the manure is applied to soils are reported under manure management.

For the estimation of N_2O emissions from manure management systems only a Tier 1 approach is available. The 2006 IPCC GL 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. Emissions are then summed over all manure management systems (see formulas below).

<u>N excretion per animal waste management system:</u>

$$Nex_{(AWMS)} = \sum_{(T)}[N_{(T)} \times Nex_{(T)} \times AWMS_{(T)}]$$

$Nex_{(AWMS)}$ = N excretion per animal waste management system [kg yr^{-1}]

$N_{(T)}$ = number of animals of type T in the country

$Nex_{(T)}$ = N excretion of animals of type T in the country [kg N animal^{-1} yr^{-1}]

$AWMS_{(T)}$ = *fraction of $Nex_{(T)}$ that is managed in one of the different distinguished animal waste management systems for animals of type T in the country*
T = *type of animal category*

N2O emission per animal waste management system:

$$N_2O_{(AWMS)} = \sum[Nex_{(AWMS)} \times EF_{3(AWMS)}]$$

$N_2O_{(AWMS)}$ = *N_2O emissions from all animal waste management systems in the country [kg N yr^{-1}]*
$Nex_{(AWMS)}$ = *N excretion per animal waste management system [kg yr^{-1}]*
$EF_{3(AWMS)}$ = *N_2O emissions factor for an AWMS [kg N_2O-N per kg of Nex in AWMS]*

AWMS

The animal waste management systems distribution data applied to estimate N_2O emissions from Manure Management is the same as used for the estimation of CH_4 emissions from Manure Management (see Table 201).

5.5.2.3 Nitrogen excretion

Bulgaria used country-specific data for nitrogen excretion from swine and cattle.

Calculations have been made by combining activity data for the feeding situation of these farm animals. The main drivers for the estimations are the daily protein intake by cattle and average protein content in swine feed, amount of nitrogen in protein content, undigested N provided by the experts from the Agricultural University of Plovdiv and Trakia University of Stara Zagora (see Table 209) and

Table 210).

- Swine:

The values are calculated based on the animal's food intake.

The equation used is:

Daily N intake x Amount of non-digested N(%) x 365 = Annual Nex

This general equation is used for each swine categories and is slightly modified to meet the features of smallest piglet with body weight below 20 kg and also the features of pregnant and lactating sows.

The adjustment for piglets below 20 kg is that 8 grams of N are added to the daily N taken with the fodder. These 8 grams are from the mother's milk.

The adjustment for pregnant and lactating sows is to reflect the fact that each sow goes through pregnancy and the lactates. During these two periods the amount of feed given to the animal is adjusted according to the national swine growing standards.

The equation for piglets below 20 kg is:

(Daily N intake + 8) x amount of non-digested N(%) x 365 = Annual Nex

The equation for sows is:

Daily N intake (in pregnancy) x amount of non-digested N (%) x 302 + Daily N intake (when lactating) x amount of non-digested N (%) x 63 = Annual Nex.

The ratios of undigested N are as follows:

Table 202 Undigested N (swine)

Animal weight/condition	Undigested N(%)
<20 kg	50%
20-50 kg	60%
50-80 kg	60%
80-110 kg	60%
>110 kg and boars	60%
Pregnant	70%
lactating	65%

The amount of N the animals receive with the food is as follows:

Table 203 Amount of nitrogen per day in swine food

Animal weight/condition	Amount of N per day(g)
<20 kg	40,00
20-50 kg	47,60
50-80 kg	54,91
80-110 kg	59,39
>110 kg and boars	73,92
Pregnant	58,24
lactating	184,80

- Cattle:

The values are calculated based on the animal's food intake.

The equation used is:

Daily N intake x amount of non-digested N(%) x 365 = Annual Nex

The daily N intake for the different cattle categories is as follows:

Table 204 Amount of nitrogen per day in cattle food

Animal type	Amount of N per day(g)
Dairy cattle	2138
Mature non-dairy cattle	1213
Young cattle <1 year	650
Young cattle 1-2years	893

Amount of N per day for the mature non-dairy cattle have been recalculated from 2138 g to 1213 g. In the previous submissions Bulgaria used amount of N per day for dairy cattle, but non-dairy cattle do not have a high feed intake because they do not producing milk. So, the N intake was overestimated. Bulgaria will try to find data on this amount for mature non-dairy cattle, until then correction is based on relationship between the energy intake between mature dairy cattle and other mature cattle.

The value for the fraction of N which is retained by the animals is taken from table 10.20 from the 2006 IPCC GL and is assumed the rest is excreted.

- Farm animal other than swine and cattle:

For estimation of nitrogen excretion from buffalo, sheep, goats, horses and mules and asses default values for nitrogen excretion rate were used represented in Table 10.19 in the 2006 IPCC GL. Estimations for these farm animals are based to eq. 10.30 (2006 IPCC GL):

$$Nex_{(T)} = Nrate_{(T)} \times TAM/1000 \times 365$$

$Nex_{(T)}$ = N excretion of animals of type T in the country [kg N animal-1 yr-1]
$N_{rate(T)}$ = default N excretion rate, kg N (1000 kg animal mass) $^{-1}$day^{-1} (table 10.19, IPCC 2006)
TAM = typical animal mass, kg animal -1 (see Table 194, chapter Enteric fermentation)

Values of nitrogen excretion of animal of type are present in Table 205.

Table 205 Nitrogen excretion of animal livestock categories.

Livestock category	Nitrogen excretion [kg/animal*yr.]
Mature Dairy Cattle	99.89
Mature Non Dairy Cattle Females	65,88
Mature Non Dairy Cattle Males	65,88
Young Cattle - Calves	35.30
Young Cattle - Growing Heifers	48.47
Buffalo	44.38
Sheep	13.71
Goats	17.99
Horses	41.28
Mules & Asses	14.24
Swine(average)	11.89
- Pigs <20 kg	7.30
- Pigs20-50 kg	10.42
- Pigs 50-80 kg	12.03
- Pigs 80-110 kg	13.01
- Pigs >110 kg and boars	16.19
- Breeding pigs	19.88
Poultry average	0,93
Poultry Chickens	0,81
Other Poultry	1,87

5.5.2.4 Emission factors

N_2O emission factors of the 2006 IPCC GL have been used for all AWMS.

Emission factors applied in the Bulgarian inventory are listed in the following table:

Table 206 Emission factors for N_2O from manure management

Animal Waste Management System	Emission factor [kg N_2O-N per kg N excreted]	Reference
Anaerobic lagoon	0.00	Table 10.21 - 2006 IPCC GL

Liquid system	0.005	Table 10.21 - 2006 IPCC GL
Solid storage	0.005	Table 10.21 - 2006 IPCC GL
Dry lot	0.02	
Pasture range, paddock - Cattle, poultry and pigs - Sheep and "other animal"	 0.02 0.01	Table 11.1 - 2006 IPCC GL
Other	0.001	Table 10.21 - 2006 IPCC GL

5.5.2.5 Indirect N_2O emissions from manure management

Table 207 Indirect N_2O emissions from Manure Management

Year	Total N volatilised as NH_3 and NOx (kg N/year)	N_2O emissions (Gg)
1988	72590658	1,14
1989	72584682	1,14
1990	71593979	1,13
1991	67046857	1,05
1992	57925681	0,91
1993	47879918	0,75
1994	38918798	0,61
1995	34086832	0,54
1996	34020715	0,53
1997	31761209	0,50
1998	28906506	0,45
1999	30149873	0,47
2000	28199543	0,44
2001	24634311	0,39
2002	26357327	0,41
2003	29160712	0,46
2004	29181923	0,46
2005	27986266	0,44
2006	27698156	0,44
2007	27053185	0,43
2008	25205220	0,40
2009	23347805	0,37
2010	22303480	0,35
2011	21414330	0,34
2012	20686962	0,33
2013	21336157	0,34
2014	20463171	0.32

Indirect N_2O emissions from manure management are result from diffusion into the surrounding air (volatilisation) and from leaching and runoff. All indirect N_2O emissions for the pasture, range and paddock manure management systems are reported under the Agricultural soils category.

The 2006 IPCC GL Tier 1 methodology is used for calculating N_2O emissions resulting from volatilisation:

$$N_2O_{\,G(mm)} = (N_{volatilization\text{-}MMS} \times EF_4) \times \frac{44}{28}$$

$N_2O_{G(mm)}$ – indirect N_2O emissions due to volatilization of N from Manure Management, kg N2O/year

EF_4 – emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N2O-N/kg NH3-N + NOx-N volatilised – default value is 0,01 kg N_2O-N/kg NH_3-N + NOx-N volatilised (table 11.3, 2006 IPCC GL);

$$N_{volatilization\text{-}MMS} = \sum_S[\sum_T[(N \times Nex \times MS) \times (\frac{FracGasMS}{100})]]$$

$N_{volatilization\text{-}MMS}$ - amount of manure nitrogen that is lost due to volatilization of NH3 and NOx, kg N/year;

N – number of head of livestock species (see Table 191 and Table 192);

Nex – annual average N excretion per head of species, kg N/animal/year (see Table 205);

MS – fraction of total annual nitrogen excretion for each livestock that is managed in manure management system;

$Frac_{GasMS}$ – present of managed manure nitrogen for livestock category that volatilises as NH3 and NOx in the manure management system, % (see below).

Table 208 2006 IPCC GL values for nitrogen loss due to volatilisation of NH_3 and NOx from Manure management (source: Table 10.22, 2006 IPCC GL):

Animal type	Manure Management system	$Frac_{GasMS}$
Swine	Anaerobic lagoon	40 %
	Solid storage	45 %
Dairy Cow	Dry lot	20 %
	Solid storage	30 %
Poultry	Poultry without litter	55 %
Other cattle	Dry lot	30 %
	Solid storage	45 %
Other	Solid storage	12 %

The 2006 IPCC GL Tier 1 methodology for determining indirect N_2O emissions does not provide a methodology for leaching and runoff. There has been no country-specific emission factors derived for leaching and runoff from manure management systems in Bulgaria. Therefore, all indirect N_2O emissions from leaching and runoff are reported under the Agricultural soils category.

5.5.2.6 Activity data

The time series for the different types of domestic animals has been consistent despite the change of the survey methodology in the year 2006. Data is collected from the Agricultural Statistics Department of the MAF, FAO Database and National Statistics Institutes' yearbooks 1990-2012.

Animal numbers are the same as the ones used for calculating emissions from enteric fermentation and are presented in Table 191 and

Table 192, except pigs are divided into sub-categories in order to estimate more accurately the nitrogen excretion. Division of pigs is presented in

Table 209. Data for estimating nitrogen excretion from cattle is shown in

Table 210 and for poultry in Table 211.

Table 209 Activity data for estimating nitrogen excretion from swine

		2008	2009	2010	2011	2012	2013	2014
Pigs < 20 kg	Population size	146496	135654	127246	129926	119 371	104 505	120 975
	Daily N excretion (g)	20	20	20	20	20	20	20
Pigs 20-50 kg	Population size	163994	162787	141764	131418	147 203	147 796	140 692
	Daily N excretion (g)	28,56	28,56	28,56	28,56	28,56	28,56	28,56
Pigs 50 - 80 kg	Population size	126151	117215	107584	106988	103 933	92 881	87 072
	Daily N excretion (g)	32,95	32,95	32,95	32,95	32,95	32,95	32,95
Pigs 80 - 110 kg	Population size	198574	161380	142807	124380	93 856	114 230	127 997
	Daily N excretion (g)	35,64	35,64	35,64	35,64	35,64	35,64	35,64
Pigs > 110 kg, and boars	Population size	119777	105562	108823	78462	44055	42375	35 598
	Daily N excretion (g)	44,35	44,35	44,35	44,35	44,35	44,35	44,35
Breeding pigs	Population size	81 139	74 127	68 677	64 961	61 188	56 896	55 277
	Daily N excretion (g) - pregnant	40,77	40,77	40,77	40,77	40,77	40,77	40,77
	Daily N excretion (g) - lactating	120,12	120,12	120,12	120,12	120,12	120,12	2 157
Weighted Nex		12.48	12.39	12.46	12.24	11.95	12.03	12.03

Table 210 Activity data for estimating nitrogen excretion from cattle

		2008	2009	2010	2011	2012	2013	2014
Mature dairy cattle	Population size	325277	305713	302461	307504	297796	297923	301236
	Daily N excretion (g)	273,66	273,66	273,66	273,66	273,66	273,66	273,66
Mature non-dairy cattle	Population size	44506	44635	44607	48911	53782	56719	65921
	Daily N excretion (g)	180,49	180,49	180,49	180,49	180,49	180,49	180,49
Young cattle under 1 year	Population size	160900	148896	141362	139755	129778	133915	133530
	Daily N excretion (g)	96,72	96,72	96,72	96,72	96,72	96,72	96,72
Heifers 1-2years	Population size	52797	52987	53215	54879	60522	62292	63510
	Daily N excretion (g)	132,80	132,80	132,80	132,80	132,80	132,80	132,80

Table 211 Activity data for estimating nitrogen excretion from poultry

		2008	2009	2010	2011	2012	2013	2014
Layer hen	Population size	9025500	8788000	8289000	7213500	6482500	6465000	6703500
	Kg Manure/day	0,13	0,13	0,13	0,13	0,13	0,13	0,13
	Kg N in 1000 Kg manure	14,20	14,20	14,2	14,20	14,20	14,20	14,20
Broilers	Population size	7070000	7095500	6743500	6392500	7010500	6286500	5614500
	Kg Manure/day	0,15	0,15	0,15	0,15	0,15	0,15	0,15
	Kg N in 1000 Kg manure	18,30	18,30	18,30	18,30	18,30	18,30	18,30
Other Poultry *	Population size	2028000	1591500	1635000	1688500	1464500	1485500	1593500
	Kg Manure/day	0,23	0,23	0,23	0,23	0,23	0,23	0,23
	Kg N in 1000 Kg manure	22,30	22,30	22,30	22,30	22,30	22,30	22,30
Weighted Nex Poultry		0,93	0,91	0,92	0,93	0,94	0,93	0,93

* Ducks, Geese, Turkeys

5.5.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty of CH_4 emissions from this source is 50% and of N_2O emissions - 300%.

Table 212 Uncertainty of sub-sector Manure Management for 2014, %

CRF categories	Key Category	GHG	Activity data uncertainty, %	Emission factor uncertainty, %	Combined uncertainty, %
3B.2	N_2O emission from Manure Management	N_2O	2	300	300
3.B.1.1	Cattle	CH_4	2	20	20
3.B.1.4	Buffalo	CH_4	2	50	50
3.B.1.2	Sheep	CH_4	2	20	20
3.B.1.4	Goats	CH_4	2	50	50
3.B.1.4	Horses	CH_4	2	50	50
3.B.1.4	Mules and Asses	CH_4	2	50	50
3.B.1.3	Swine	CH_4	2	20	20
3.B.1.4	Poultry	CH_4	2	50	50

Default values from the IPCC guidelines

5.5.4 SOURCE-SPECIFIC QA/QC AND VERIFICATION

All activities regarding QC as described in QA/QC System have been undertaken.

Activity data check

The inventory compiler reviews livestock data collection methods, in particular checking that livestock subspecies data were collected and aggregated correctly. The data is cross-checked with previous years to ensure it is reasonable and consistent with the expected trend. Inventory compilers document data collection methods, identify potential areas of bias, and evaluate the representativeness of the data. Population modelling can be used to support this approach.

Review of emission factors

If cross-check country-specific factors against the IPCC defaults finds significant differences between country-specific factors and default factors are explained and documented.

5.5.5 SOURCE-SPECIFIC RECALCULATIONS

- CH_4 emissions have been recalculated for the enthire time series due to the implementation of new VS values for swine (see above);
- Direct N_2O emissions have been recalculated for the full time series due to the new value for nitrogen excretion for mature non-dairy cattle (see above).
- Indirect N_2O emissions have been recalculated for the enthire time series due to corrections of technical mistakes.

After the recalculations GHG emissions from Manure management decrease with 26% in 2013 year.

5.5.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

Collection of data for implementation higher ensure TACCC (see above)

Collection of data on AWMS for year 2015.

5.6 RICE CULTIVATION (CRF SECTOR 3.C)

5.6.1 SOURCE CATEGORY DESCRIPTION

Rice cultivation is a traditional Bulgarian agricultural activity. During the structural reforms, rice crop areas decreased from 14 100 ha in 1988 to 1417 ha in 1999. There has been a restoration of rice crop areas after 1999, reaching 11 043 ha in 2014.

99,45 Gg CH_4 CO_2-eq. has been emitted in 2014. Emission increase by 8% compared to the year 2013 which is due to the increase of the areas with rice crops.

In Bulgaria rice is produced under the continuously flooded water regime with season length of 125 days and one harvest per year.

5.6.2 METHODOLOGICAL ISSUES

5.6.2.1 Methods

CH_4 emission calculation is carried out according to the default method from the 2006 IPCC GL for continuously flooded water regime.

$$CH_{4\ Rice} = EF \times t \times A \times 10^{-6}$$

EF – daily emission factor, kg CH4/ha/day (see 5.6.2.2);

t – cultivation period of rice = 125 days[29]*;*

A – annual harvested area of rice, ha/day;

5.6.2.2 Emission factors

Daily emission factor are estimated according equation 5.2 from the 2006 IPCC GL:

$$EF = EF_c \times SF_w \times SF_p \times SF_o$$

Table 213 Emissions factors for Rice calculations

Baseline Emission Factor (EF_c)	1,30	Table 5.11 2006 IPCC GL
Scaling factor to account for the difference in water regime during the cultivation period (SF_w)	0,78	Table 5.12 2006 IPCC GL
Scaling factor to account for the difference in water regime before the cultivation period (SF_p)	1,22	Table 5.13 2006 IPCC GL

[29] According NAAS (National Agricultural Advisory Service)

Scaling factor organic amendments (SF_o)	2,15	Eq. 5.3; Table 5.14 2006 IPCC GL

5.6.2.3 Activity data

Data comes from the Agricultural Statistics Department of the Ministry of Agriculture and Food based on surveys on yields of main crops, and for the years before National Statistics Institutes'' yearbooks and FAO's database.

5.6.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty of methane emissions from this source is 20%

5.6.4 SOURCE-SPECIFIC QA/QC AND VERIFICATION

All activities regarding QC as described in QA/QC System have been undertaken.

5.6.5 SOURCE-SPECIFIC RECALCULATIONS

There are no recalculations for this category.

5.6.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements for this category.

5.7 AGRICULTURAL SOILS (CRF SECTOR 3D)

Microbial processes of nitrification and denitrification in agricultural soils produce nitrous oxide emissions. In 2014 this category generates 54% of N_2O emissions from Agricultural sector.

There is a decrease of 55 % for this category from 1988 to 2014 (Figure 88). The reasons are structural changes in agricultural holdings and decrease in arable land area.

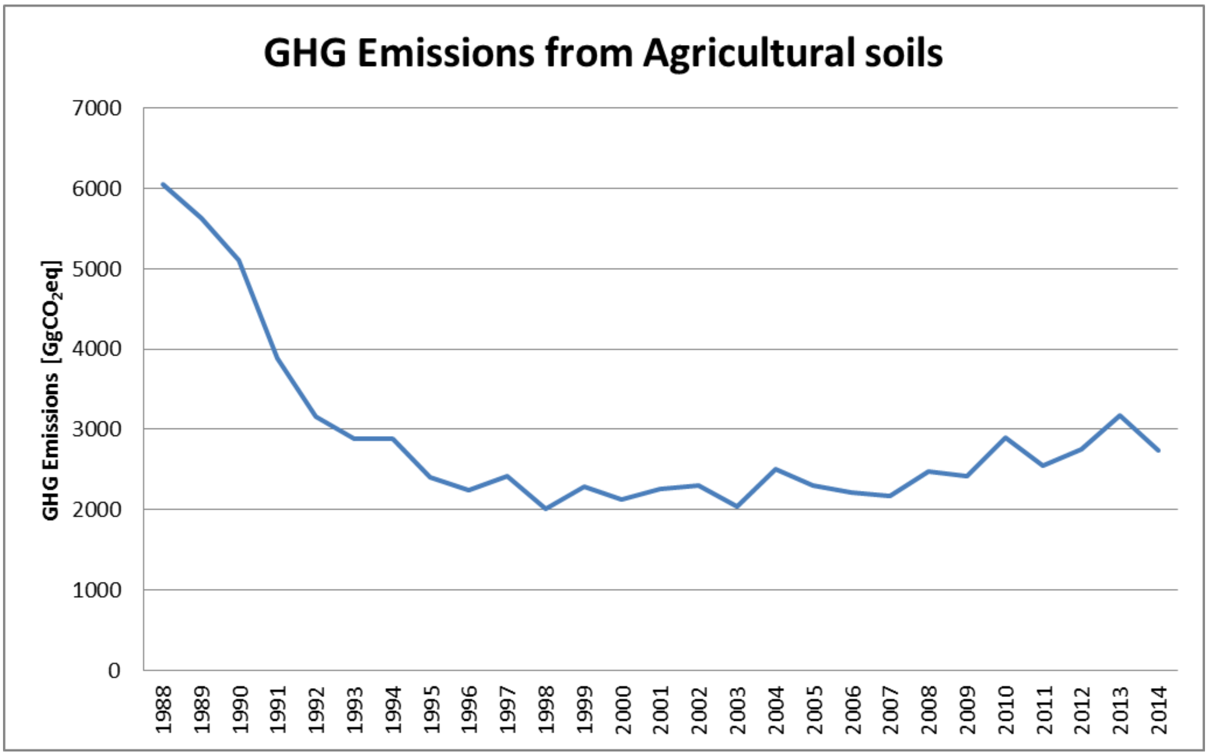


Figure 88 Trend of GHG Emissions from agricultural soils

5.7.1 SOURCE CATEGORY DESCRIPTION

The emissions from this subsector include the two main categories N_2O emissions:

- Direct emissions;
- Indirect emissions.

These two categories above are key sources in the year 2014.

Direct emissions in Bulgaria are results from:

- Soil fertilization with synthetic nitrogenous fertilizers;
- Nitrogen input from manure applied to soils (excluding manure from pasture animals);
- Sewage sludge spreading on agricultural soils;
- Decomposition of vegetable waste from different crops;
- Animal excretion on pasture range and paddock;

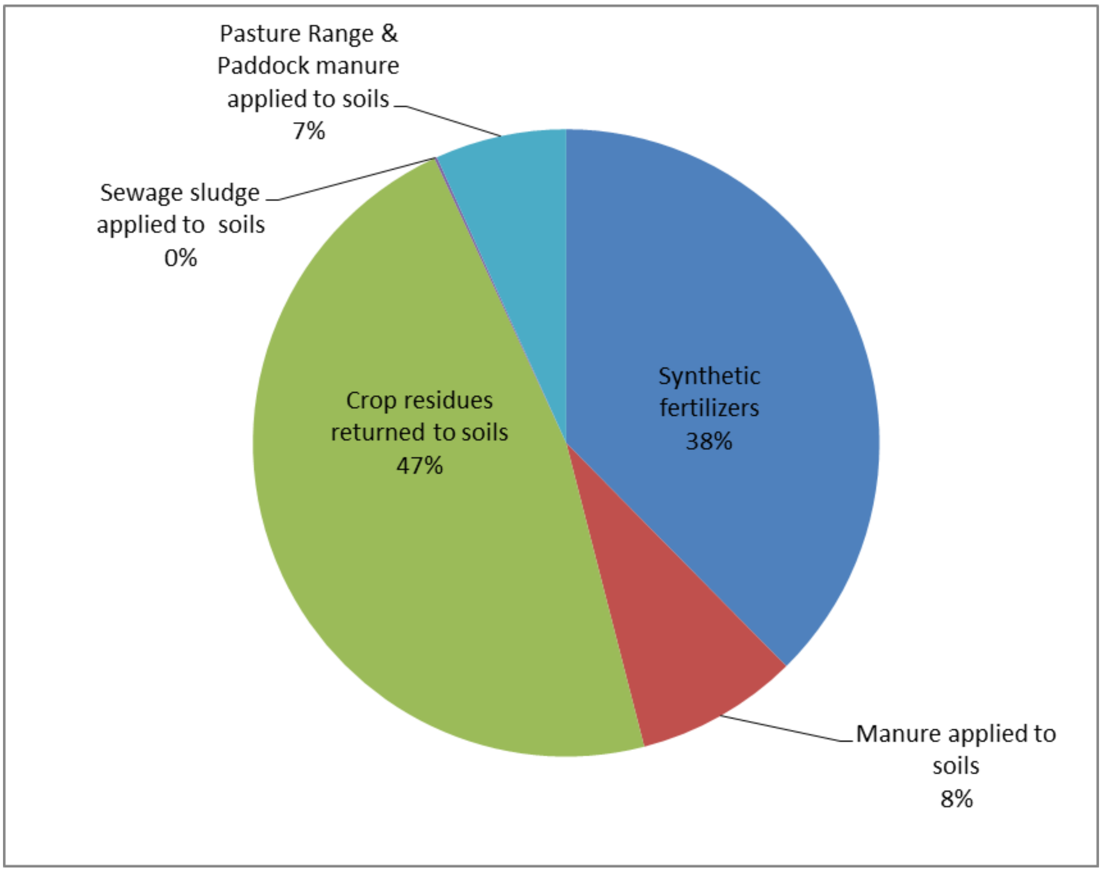


Figure 89 Direct N_2O emissions in 2014(%).

Indirect emissions include:

- ammonia and nitrous oxides release in the ambient air after nitrogen fertilization;
- emissions from drawing of water.

Activities described above are differentiated according to the IPCC classification. One has to take into consideration that the existing emissions of methane from soil are considered natural (non-anthropogenic) and is not subject of the inventory.

Direct N_2O emissions are 2167 Gg CO_2-eq. in 2014. The emission decrease by 14% in 2014 compared to 2013 mostly due to the lower consumption of synthetic fertilizers in 2014 (see Table 217) – in 2014 synthetic fertilizers decrease with 33% compared with 2013 year.

Indirect N_2O emissions are 570 Gg CO_2-eq. in 2014. The emissions decrease by 14% compared to 2013 because of the same reason determinant the decrease of direct emissions.

5.7.2 METHODOLOGICAL ISSUES

5.7.2.1 Methods

The IPCC Tier 1 method was applied and IPCC default emission factors were used.

The following formula has been used to estimate Direct emissions (2006 IPCC GL, eq. 11.1).

$$N_2O_{Direct} – N =[(F_{SN} + F_{ON} + F_{CR}) \times EF_1] + (F_{PRP,CPP} \times EF_{3PRP,CPP}) + (F_{PRP,SO} \times EF_{3PRP,SO})]$$

F_{SN} – annual amount of synthetic fertiliser N applied to soil (kg N/yr)

F_{ON} – annual amount of animal manure and sewage sludge applied to soil (kg N/yr)

F_{CR} – annual amount of N in crop residues, returned to soils (kg N/yr)

F_{PRP} – annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock (kg N/yr); The subscripts CPP and SO refer to Cattle, Poultry and Pigs, and Sheep and Other animals

EF_1, $EF_{3PRP,CPP}$, $EF_{3PRP,SO}$ – default emission factors (kg N_2O-N/kg N), see Table 215

In submission 2016 calculations of F_{CR} and F_{ON} were made with implementation of new estimates for Nitrogen in crop residues returned to soils and Nitrogen input of manure applied to soils according 2006 IPCC GL.

- F_{CR} are calculated with eq. 11.7 A from the 2006 IPCC GL. Default values for all parameters given in 2006 IPCC GL Table 11.2 are used except from dry matter values which are based on national values. Annual harvested area of crops and harvested yield for crops are provided by Ministry of Agriculture and Food, dry matter fractions of crops are provided by University of Agriculture of Plovdiv.
- F_{ON} include annual amount of animal manure and sewage sludge applied to soil (equation 11.3 from the 2006 IPCC GL). Annual manure applied to soils are calculated with equation 10.34 and default values for nitrogen loss from manure management (Frac LossMS) given in table 10.23 from the 2006 IPCC GL. In the estimations the amount of nitrogen from bedding is not included due to that information is not available in Bulgaria.
  The 2006 IPCC GL include in F_{ON} annual amount of total compost N applied to soils. Composting in Bulgaria is preaty new technology (there are three composting instalation working from 2011 year). The compost is not with high quality and it used mainly for recultivation. There is no data in the country for composting in Agriculture.

Conversion of N_2O – N emission to N_2O emission for reporting purposes is performed by using the following equation:

$N_2O = N_2O - N \times 44/28$

Indirect emissions including emissions from atmospheric deposition of N volatilised from managed soils and nitrogen leaching (and run-off). Emissions were estimate by using equation 11.9 and 11.10 according the 2006 IPCC GL and default fractions ($Frac_{GASM}$ and $Frac_{LEACH-(H)}$) shown in Table 11.3 in the 2006 IPCC GL.

According the ERT recommendation made in the previous review reports (FCCC/ARR/2014/BGR), Bulgaria used country - specific parameter for $Frac_{GASF}$ to estimate N_2O emissions from ammonia volatilization.

The synthetic fertilizers quantities are provided by the National Service for Plant Protection at the Ministry of Agriculture and Food. According to the EMEP/EEA Guidebook 2013, the NH_3 emission depends on fertiliser type. There is no such information for the consumption of each fertiliser type in the county, so for the estimation of NH3 - N emissions ($Frac_{GASF}$) the sales data from IFA for 2010 were used (Table A1-2, Chapter 3.D, EMEP 2013). Furthermore, the NH_3 emission factor for each fertiliser is given, based on the values from the EMEP/EEA Guidebook 2013. The major part of the Bulgarian emission is related to the use of ammonium nitrate and anhydrous ammonia fertiliser, where the emission factor is 0.037 and 0.011 kg NH_3-N per kg N, respectively. The Bulgarian $Frac_{GASF}$ is low compared to the IPCC default value. This is due to the small consumption of urea (<6%), which has a high emission factor.

Table 214 Activity data for the estimations of $Frac_{GASF}$.

Fertiliser type	NH3 Emission factor, kg NH3-N per kg N	Percent	Consumption, t N	Average NH3-N emission (FracGASF)
Urea	0,243	6%	15531,36	0,035
Ammonium nitrate (AN)	0,037	40%	103542,40	
Ammonia	0,011	53%	137193,68	
Ammonium sulphate (AS)	0,013	1%	2588,56	

5.7.2.2 Emission factors

Emission factors are the default ones from the 2006 IPCC GL. So far, there are no assessments of these emission factors, which result from measurements in the country. The factors are represented in Table 215.

Table 215 N_2O emissions factors for agricultural soils.

Category	Emission Factor [kg N_2O-N/kg N]	Source
3.D.1 Direct Soil Emissions		
3.D.1.1 - Synthetic fertilizers (mineral fert.)	0.01	Table 11.1 - 2006 IPCC GL
3.D.1.2.a - Animal waste applied to soils		
3.D.1.2.b - Sewage sludge spreading		
3.D.1.4 - Crop residue return to soil		
3.D.1.3 Pasture, range and paddock manure		
- Cattle, poultry and pigs - Sheep and "other animal"	0.02 0.01	Table 11.1 - 2006 IPCC GL
3.D.2 Indirect soil emissions		
3.D.2.1 - Atmospheric deposition	0.01/ kg of volatized nitrogen	Table 11.3 -2006 IPCC GL
3.D.2.2 - Nitrogen leaching (and run-off)	0.0075/ kg N-loss by leaching	Table 11.3 - 2006 IPCC GL

5.7.2.3 Activity data

The manure quantity is calculated using the prototype parameters for different types of animals in the Eastern Europe region, given in the 2006 IPCC GL and using the data provided by the Agricultural University of Plovdiv.

The synthetic fertilizers quantities are provided by the National Service for Plant Protection at the Ministry of Agriculture and Food (see Table 217).

Annual crop production data is provided by the Agrostatistics department at the Ministry of Agriculture and Food and is cross-checked with the FAO database and the National Statistics Institute's yearbooks.

Table 216 Activity data for Agricultural soils

Category	Data Sources
3.D.1 Direct soil emissions	
Synthetic fertilizers (mineral fert.)	National service for Plant Protection (Table 217)
Animal waste applied to soils	Calculations within source category 3.B and eq. 10.34 and default data in table 10.23 from the 2006 IPCC GL.
Crop residue	Harvested amount of agricultural crops - MAF
Sewage sludge spreading	Data from wastewater treatment plants (Table 218)
3.D.1.3 Pasture, range and paddock manure	
Grazing Animals	Calculations within source category 3.B
3.D.2 Indirect soil emissions	
Atmospheric deposition	The amount of manure left for spreading was calculated within source category 3.B. Mineral fertiliser data
Nitrogen leaching (and Run-off)	see above (synthetic fertilizers, animal waste, sewage sludge)

Table 217 Consumption of Synthetic Fertilizers for the period 2008 – 2014:

	2008	2009	2010	2011	2012	2013	2014
Amount of Synthetic fertilizers (t N/year)	173 917	177 553	199 083	192 357	235 386	258 856	174 002

Table 218 Sewage sludge spreading, 2008 – 2014:

	2008	2009	2010	2011	2012	2013	2014
Sewage sludge spreading (t/dm)	52 117	16 644	13 644	17 561	21 241	16 680	16 363,0

5.7.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty from the direct N_2O emissions from this source is 250% and from the indirect emissions - 500%.

Table 219 Uncertainty of sub-sector Agricultural soils for 2014, %

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty

CRF categories	Key Category	GHG	Activity data uncertainty	Emission factor uncertainty	Combined uncertainty
3D1	Direct soil emissions	N_2O	3	250	250
3D1.3	Pasture, Range and Paddock Manure	N_2O	3	250	250
3D2	Indirect Emissions	N_2O	3	500	500

Default values

5.7.4 SOURCE-SPECIFIC QA/QC

All activities regarding QC as described in QA/QC System have been undertaken.

5.7.5 SOURCE-SPECIFIC RECALCULATIONS

There are recalculations in this category for the entire time series due to:

- Productions of feetbeat have been recalculated for the entire time series due to revision of the statistical data – new data was provided from Ministry of Agriculture and Food and from National Statistics Institutes' yearbooks 1990-2014.
- In submissions 2016 productions of alfalfa were included – data was provided from Ministry of Agriculture and Food and from National Statistics Institutes' yearbooks 1990-2014.
- Implementation of new estimates for Nitrogen in crop residues returned to soils and Nitrogen input of manure applied to soils according 2006 IPCC GL (see above);
- Country - specific parameter for $Frac_{GASF}$ (see above);
- In previous submission emissions from N mineralized in mineral soils as a result of loss of soil carbon through change in land use were wrongly reported in Agriculture sector. In this submission the technical mistake was corrected and the emissions are submitted in LULUCF sector (CRF table 4 III).
  In the CRF table 3.D.1.5 is used notation key "NE" due to cropland remaining cropland occurs in Bulgaria, but there are removals no emissions due to area of annual cropland converted in perennials which is bigger than perennial cropland converted to annuals (see LULUCF chapter).

After the recalculations emissions from this category in 2013 increase with 3%.

5.7.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

Collection of data for implementation higher TIER and ensure TACCC (see above).

5.8 FIELD BURNING OF AGRICULTURAL RESIDUES (CRF SECTOR 3F)

5.8.1 SOURCE CATEGORY DESCRIPTION

This sector covers the emissions of non-CO_2 greenhouse gases from the burning (in the field) of crop residue and other agricultural waste on site.

Despite field burning is prohibited by the Bulgarian law, this "tradition" continues and is emission source not only of main GHGs but also of GHGs-precursors.

34,16 Gg CO_2-eq. aggregated GHGs were emitted in 2014 (0,5% of Agriculture emission). This is an increase of 6%, compared to 2013, because of increase in crop production (e.g. 15% more maze in 2014 compared to 2013). The estimations are based on the expert judgement that 3% of the vegetal residues, left on the fields after yielding the crops, are burned.

CH_4 and N_2O emissions from the subcategory are given below.

Table 220 Emissions from GHG from field burning of agricultural residues (1988 – 2014):

Year	GHG emissions [Gg]	
	CH_4	N_2O
1988	1,16	0,03
1989	1,49	0,03
1990	1,19	0,03
1991	1,31	0,03
1992	0,86	0,02
1993	0,67	0,01
1994	0,70	0,01
1995	0,74	0,02
1996	0,42	0,01
1997	0,67	0,01
1998	0,59	0,01
1999	0,57	0,01
2000	0,49	0,01
2001	0,63	0,01
2002	0,73	0,01
2003	0,46	0,01
2004	0,80	0,02
2005	0,64	0,01
2006	0,63	0,01
2007	0,37	0,01
2008	0,78	0,02
2009	0,71	0,02
2010	0,79	0,02
2011	0,81	0,02
2012	0,78	0,02
2013	1,01	0,02
2014	1,07	0.03

5.8.2 METHODOLOGICAL ISSUES

According to the provisions in the IPCC GPG 2000, the calculation methodology took into account the 1996 IPCC GL default emissions ratios (Table 4-16 of Reference Manual). Emission ratios are presented in Table 221.

The rationale for using the 1996 IPCC GL approach, and not the 2006 IPCC GL approach, is as follows:

(1) the 2006 IPCC GL equation was developed to be broadly applicable to all types of biomass burning, and, thus, is not specific to agricultural residues;

and (2) the 2006 IPCC GL default factors are provided only for four crops (corn, rice, sugarcane, and wheat), while this Inventory analyzes emissions from much more crops.

Table 221 Default emission factors for burning of agricultural residues

Gas	Default IPCC 1996 emission ratios
Methane	0.005
Carbon monoxide	0.06
Nitrous oxide	0.007
Nitrous oxides	0.121

Activity data for harvested production by crops is provided by the Statistical Department of the MAF. Specific parameters used for calculations of the emissions are provided from the Agricultural University of Plovdiv (see Table 222).

Table 222 Specific parameters used for calculation of Total carbon released

GREENHOUSE GAS SOURCE AND SINK CATEGORIES						
	Residue/ Crop ratio	Dry matter fraction of residue	Fraction burned in fields	Fraction oxidized	C fraction of residue	N - C radio in biomass residues
1.Cereals						
Wheat	1,3	0.84	0,03	0,9	0,4853	0,006
Barley	1,2	0,85	0,03	0,9	0,4567	0,009
Maize	1	0,78	0,03	0,9	0,4709	0,02
Oats	1,3	0,92	0,03	0,9	0,4466	0,016
Rye	1,6	0,9	0,03	0,9	0,4238	0,01
Rice	1,4	0,85	0,03	0,9	0,4144	0,016
Maize for silage	1	0,78	0,03	0,9	0,4709	0,017
2.Pulses						
Dry beans	2,1	0,85	0,03	0,9	0,4812	0,03
Peas	1,5	0,87	0,03	0,9	0,4466	0,031
Soybeans	2,1	0,86	0,03	0,9	0,4129	0,056
Lentils	0,3	0,18	0,03	0,9	0,4642	0,036
Chick peas	0.3	0,18	0,03	0,9	0,4642	0,036
3.Tubers and Roots						
Potatoes	0,4	0.25	0,03	0,9	0,42	0,026
Sugar beet	2.2	0.72	0,03	0,9	0,53	0,014
4.Other						
Cotton	1.3	0.84	0,03	0,9	0.49	0.03
Sunflower	1,3	0.84	0,03	0,9	0.49	0.03
Peanuts	1	0,86	0,03	0,9	0,46	0,023
Tobacco	1,3	0,84	0,03	0,9	0.49	0.03
Feetbeet	0,3	0,86	0,03	0,9	0,41	0,06
Alfalfa	0,3	0,90	0,03	0,9	0,41	0,06

5.8.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty of methane emissions from this source is 50% and of N_2O emissions – 200%, with very high uncertainty of the activity data.

5.8.4 SOURCE-SPECIFIC QA/QC

All activities regarding QC as described in QA/QC System have been undertaken.

Activity data has been cross-checked with FAO's statistical database.

5.8.5 SOURCE-SPECIFIC RECALCULATIONS

There are recalculations for the entire time series due to including of alfalfa production and revised feetbeat production.

After the improvements, the N_2O emissions in 2013 increase with 3% and CH_4 emissions increase less than 1%.

5.8.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements for this category.

5.9 CO2 EMISSIONS FROM LIMING (CRF SECTOR 3G)

There is no liming in Bulgaria after 1987.

5.10 CO2 EMISSIONS FROM UREA FERTILIZATION (CRF SECTOR 3H)

5.10.1 SOURCE CATEGORY DESCRIPTION

Adding urea ($CO(NH_2)_2$) to soils during fertilization leads to a loss of CO_2 .

Emission of CO_2 from use of urea contributes with less than 1% of the CO_2 emission from the agricultural sector.

5.10.2 METHODOLOGICAL ISSUES

A Tier 1 method as given in the 2006 IPCC GL is used.

Activity data

The amount of urea used on agricultural soils is provided by National service for Plant Protection (see below).

Table 223 Consumption of urea fertilizers (t/year) for the period 2006 – 2014:

	2006	2007	2008	2009	2010	2011	2012	2013	2014

Urea (t/year)	23348	21481	27686	33891	24619	35840	42712	50739	42082

Data were provided by National service for Plant Protection

5.10.2.1 Emission factors

The default emission factor of 0.20 given in the 2006 IPCC GL is used.

5.10.2.2 Methods

CO_2 emissions from urea fertilization were estimated with Equation 11.13 from the 2006 IPCC GL:

$$CO_2 – C\ Emission = M \times EF$$

M – annual amount of urea fertilization, tones urea/year (see above);

EF – emission factor, tone of C/ tone of urea = 0,20 (2006 IPCC GL).

To convert CO_2 – C emissions in CO2, emissions were multiply by 44/12.

Table 224 CO_2 emissions from urea fertilisation:

	2006	2007	2008	2009	2010	2011	2012	2013	2014
CO_2 emissions (Gg)	17,12	15,75	20,30	24,85	18,05	26,28	31,32	37,21	30,86

5.10.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

The uncertainty of emissions from this source is 50%.

5.10.4 SOURCE-SPECIFIC QA/QC

All activities regarding QC as described in QA/QC System have been undertaken.

5.10.5 SOURCE-SPECIFIC RECALCULATIONS

There are no recalculations in this category.

5.10.6 SOURCE-SPECIFIC PLANNED IMPROVEMENTS

There are no planned improvements in this category.

6 LAND-USE, LAND-USE CHANGES AND FORESTRY (CRF SECTOR 4)

6.1 OVERVIEW OF SECTOR LULUCF

Land Use, Land-Use Change and Forestry (LULUCF) sector includes emissions and greenhouse gas removals from different land-use types, changes in the land-use and forestry. The greenhouse gas inventory of LULUCF sector comprises emissions and removals of CO_2 due to overall carbon gains or losses in the relevant carbon pools of the predefined six land-use categories. These pools are above-ground biomass, below-ground biomass, dead organic matter (litter and dead wood) and soils. Sources of the non-CO2 emissions in the LULUCF sector are the biomass burning, lime and urea application, as well as fertilisation.

Since reporting year 2015 the methodology used to calculate emissions and removals in LULUCF follows that of the 2006 IPCC Guidelines. The predefined land-use categories are Forest land (FL), Cropland (CL), Grassland (GL), Wetland (WL), Settlements (S), Other land (OL). In accordance with the 2006 IPCC Guidelines emissions and removals should be reported into two sub-categories – land remaining in the same category and land converted to another land-use category. All the land-use changes were traced down and reported for a transition period of 20 years (as require in IPCC 2006) after which they are reported in the respective categories.

6.1.1 SECTOR COVERAGE

In the 2016 Inventory submission Bulgaria reports carbon stock changes, as well as greenhouse gas emissions and removals from Forest Land (CRF 4.A), Cropland (CRF 4.B) and Grassland (CRF 4.C), Wetlands (CRF 4.D) and Settlements (CRF 4.E) and harvested wood products (HWP). The quantity of CH_4 and N_2O emissions is estimated for these sub-categories, where they occur. The completeness of the estimated emissions from sources and removals by sinks is shown in the table below.

Table 225 Overview of subcategories of CRF Sector 4 – LULUCF: status of emission estimates for CO_2, CH_4 and N_2O

Land-Use Categories	Net CO_2 emissions/removals	CH_4	N_2O
A. Forest Land	**x**	**x**	**x**
1. Forest Land remaining Forest Land	x	x	x
2. Land converted to Forest Land	x	x	x
B. Cropland	**x**	**NO**	**x**
1. Cropland remaining Cropland	x	NO	NO
2. Land converted to Cropland	x	NO	x
C. Grassland	**x**	**NO**	**NO**
1. Grassland remaining Grassland	NO	NO	NO
2. Land converted to Grassland	x	NO	NO
D. Wetlands	**x**	**NO**	**NO**
1. Wetlands remaining Wetlands	NO	NO	NO
2. Land converted to Wetlands	x	NO	NO

Land-Use Categories	Net CO_2 emissions/removals	CH_4	N_2O
E. Settlements	**x**	**NO**	**NO**
1. Settlements remaining Settlements	NO	NO	NO
2. Land converted to Settlements	x	NO	NO
F. Other Land	**NO**	**NO**	**NO**
1. Other Land remaining Other Land	x	NO	NO
2. Land converted to Other Land	x	NO	NO
G Harvested Wood Products (HWP)	x		
1. HWP Produced and Consumed domestically	x		
2.HWP Produced and Exported	x		

6.1.2 KEY CATEGORIES

The key source categories within this sector are presented in the table below.

Table 226 Key sources of LULUCF sector

Land-Use Categories	Gas	Level assessment	Trend assessment
4.A.1 Forest Land Remaining Forest Land	CO_2	x	x
4.A.2 Land Converted to Forest Land	CO_2	x	x
4.B.1 Cropland Remaining Cropland	CO_2	x	
4.C.2 Land Converted to Grassland	CO_2	x	x
4.E.2 Land Converted to Settlements	CO_2	x	x
4.F.2 Land converted to Other Land	CO_2		x
4.G Harvested Wood Products	CO_2	x	

6.1.3 EMISSION TRENDS

The emissions and removals in the different categories are presented in Table 227

Table 227 Net emissions and removals of greenhouse gases from land use, land use changes and forestry by categories in CO_2 eq.

Year	Total CO_2 removals	4 A Total Forestland	4 B Total Cropland	4 C Total Grassland	4 D Total Wetlands	4 E Total Settlements	4 F Total Other land	4 G HWP
1988	-15274.68	-14329.29	-1015.20	16.38	NO	711.64	-1.73	-656.48
1989	-15089.06	-14345.68	-825.03	31.00	NO	709.37	-2.23	-656.48
1990	-14899.34	-14376.83	-606.76	44.97	NO	698.48	-2.73	-656.48
1991	-14535.39	-14393.29	-433.53	59.84	NO	709.22	-3.23	-474.41
1992	-13479.56	-14377.99	-324.41	74.47	NO	720.22	-3.73	431.86
1993	-13377.30	-14306.32	-268.65	86.98	NO	691.48	-4.24	423.45
1994	-13351.63	-14310.72	-215.94	100.80	NO	693.68	-4.75	385.29
1995	-13349.69	-14382.38	-122.91	86.31	13.66	698.38	-5.26	362.50
1996	-11110.94	-12287.89	-8.62	99.60	21.62	696.20	-5.77	373.92
1997	-11007.57	-12240.30	55.16	65.18	43.60	707.40	-6.29	367.68

Year	Total CO_2 removals	4 A Total Forestland	4 B Total Cropland	4 C Total Grassland	4 D Total Wetlands	4 E Total Settlements	4 F Total Other land	4 G HWP
1998	-10959.09	-12174.75	37.29	78.15	59.75	710.87	-6.80	336.39
1999	-10936.66	-12161.76	-10.69	90.91	75.92	714.36	-7.32	361.91
2000	-10131.17	-11962.37	782.52	-1004.58	92.12	720.29	1099.15	141.70
2001	-9045.07	-10582.69	785.61	-996.37	108.28	655.53	970.25	14.32
2002	-9102.41	-10637.81	804.29	-988.05	124.43	668.04	914.64	12.06
2003	-9092.49	-10688.19	890.91	-979.63	140.55	649.75	866.49	27.63
2004	-9438.45	-10685.73	852.07	-971.10	156.65	635.08	823.13	-248.54
2005	-9277.37	-10690.93	898.31	-962.47	172.73	743.64	702.85	-141.50
2006	-9195.45	-10263.60	829.32	-953.73	188.79	773.01	655.10	-424.34
2007	-9403.63	-10129.64	784.37	-943.40	204.83	867.00	586.47	-773.26
2008	-8978.31	-10309.00	769.60	-934.27	220.84	1063.54	510.67	-299.69
2009	-9044.64	-10366.36	714.61	-924.84	236.83	892.13	544.49	-141.49
2010	-9250.27	-10371.94	661.33	-915.12	252.81	1070.74	419.67	-367.77
2011	-9592.94	-10389.51	584.09	-905.04	268.76	1000.38	455.52	-607.14
2012	-9616.64	-10378.06	570.93	-894.62	284.68	994.02	453.75	-647.35
2013	-10108.41	-10429.56	881.53	-1043.20	278.64	1024.64	-275.46	-545.01
2014	-10465.53	-10465.53	916.97	-2062.37	281.98	932.96	-323.73	-544.01

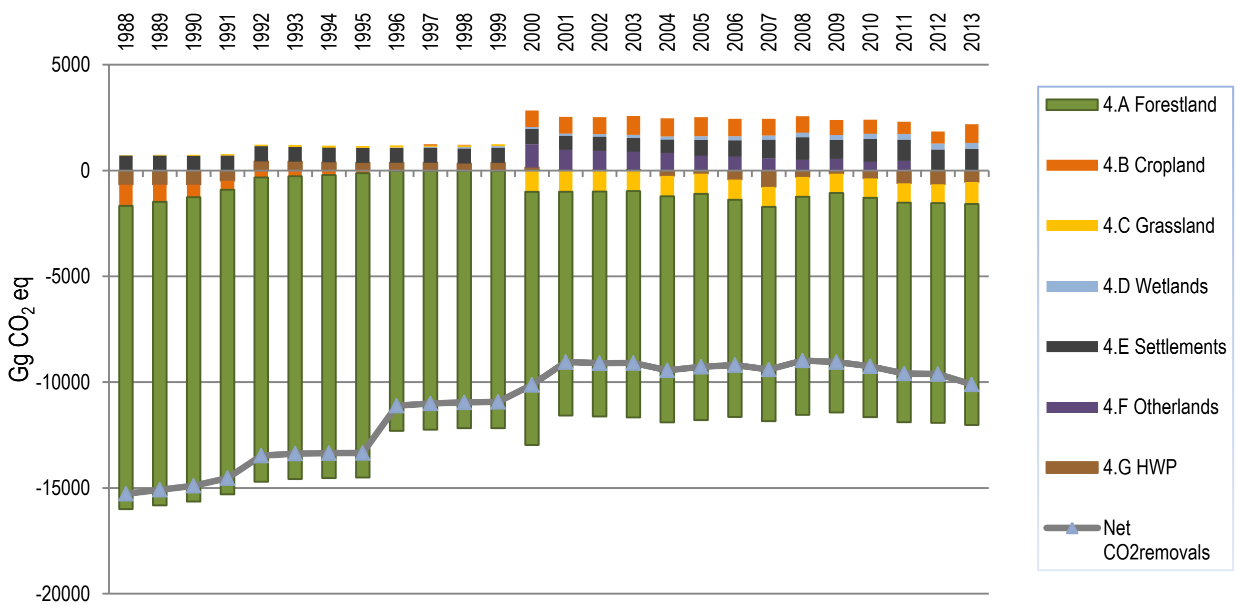


Figure 90 LULUCF emissions and removals 1988 – 2015 CO_2 eq.

The figure shows that the LULUCF sector is serving as a sink of greenhouse gases for Bulgaria. The category "Forest land" is removals of CO_2 during the whole time series. The contribution of the HWP, Cropland, Grassland and Other Land categories to the emissions/removals from LULUCF category is in both directions – as source and as a sink of emissions. All remaining categories (Settlements and Wetlands) are sources of CO_2

emissions. The trend of net CO_2 removals (CO_2 eq) from LULUCF decreases by 36% compared to the base year. The main reason for the overall decrease of the uptakes of CO_2 emissions from LULUCF is due to the fall in removals from category Forest land and the slight increase in emissions from CL, WL and SM categories. The key driver for the trend of emissions in LULUCF is the FL category. The reason for the fall in removals from FL is the observed decline in the rate of forest growth as the average age of the forest stands increases steadily over the reporting period. There is an increase in the middle-aged and mature forests, which affect the growing stock and subsequently the removals estimates. The average age of the forest stands in Bulgaria for 2013 is 53 years. In spite of the decrease observed, the share of the removals from the total GHG emissions (in CO_2eq) is still remarkable. The reason for this is that the emissions in the other sectors have dropped dramatically. The share of the removals in the base year has the figure of – 15% from the total GHG emissions in CO_2eq, while in the inventoried year the share is - 24%.

Comparing with the base year an increase in the emissions in croplands, settlements and wetlands is observed. The total emissions from croplands fluctuate during the whole time series. The emissions from Settlements increase last couple of years due to changes from other land- uses to Settlements according to the risen infrastructural activities since Bulgaria's joined the EU.

In GHGI Submission 2016 a major change in land use pattern has been implemented. The result of the change does not affect the overall trend of emissions/removals from LULUCF but it has affected the trends in CL, GL and OL categories. More information on the changes is presented in chapter 6.2.2.

6.1.4 METHODOLOGY

The inventory follows the methodologies and principles envisaged in the IPCC 2006. All land-use changes have been traced down and reported for a transition period of 20 years after which they are reported in the respective categories.

6.1.5 EMISSION FACTORS

The calculation of the emission factors follows to a great extent the methods, described in the 2006 IPCC Guidelines. In those cases where possible, the emission factors are determined considering the specific conditions of the country. To calculate them data from national statistical sources and studies are used - the official reports of the forestry fund, the national system for environmental monitoring, the scientific research database in Bulgaria and other European countries.

6.2 LAND-USE DEFINITIONS AND THE CLASSIFICATION SYSTEMS USED AND THEIR CORRESPONDENCE TO THE LULUCF CATEGORIES

6.2.1 LAND-USE DEFINITIONS AND CLASSIFICATION SYSTEMS

Forest land

For defining forest, Bulgaria uses the definition in the Bulgarian Forest Act (last amendment

07.08.2012, SG №60):

"***Area over 0.1 ha, covered with forest tree species higher than 5 meters and tree crown cover over 10% or with trees which can reach these parameters in natural environment***".

Areas of natural forest regeneration outside urban areas with a size of more than 0.1 ha also represent "forest". City parks with trees, forest shelter belts, and single row trees do not fall under the category "forests.

According to their functions, forests are divided into: forests for timber production, protective and recreation forests and forests in protected areas.

Forests are also:

- areas which are in a process of recovering and are still under the parameters, but it is expected to reach forest crown cover over 10% and tree height 5 meters;
- areas, which as the result of anthropogenic factors or natural reasons are temporarily deforested, but will be reforested;
- protective forest belts, as well as tree lines with an area over 0.1 ha and width over 10 meters;
- cork oak stands."

All forests in Bulgaria are managed.

Cropland

According to the area data available the category "Cropland" consists of annual crops (cornfields and kitchen gardens) and perennials (vineyards, fruit and berry plantation and nurseries).

Arable land is the land worked regularly, generally under a system of crop rotation - area with annual crops, set - aside area as well as area with seeds and seedlings.

Perennial crops include fruit and berry plantation, vineyards and other permanent crops, nurseries for wine, fruits, ornamental plants, forest trees etc. The orchard is a uniformly kept plantation (by annual pruning and regular treatment for protection from diseases and insects) of fruit trees (pip- trees, stone-trees and nut-trees). The orchard production may be used for direct consumption or processing. The density of plantation is a least 10 trees per decare and therefore the maximum distance between the trees a 10x10m.

Grassland

Part of this category is the permanent grasslands – natural meadows, low productive grasslands, permanent lawns and grassland which are not used for production purposes.

All grasslands are managed.

Wetlands

It is assumed that in the Wetlands category - wetlands surface water areas are included (wetlands) – covered with water or water saturated lands (throughout the year or partially in the year) which does not fall in the other categories. These are natural or artificial water-courses serving as water drainage channels, natural or artificial stretches of water, coastal lagoons, wetlands areas and peatbogs.

Settlements

The Settlements refer to all classes of urban formation. These areas are functionally or administratively associated with public or private land in cities, villages or other settlement types.

Other land

Other land category includes bare soil, rock and all area that do not fall into any of other five land-use categories.

6.2.2 DEVELOPMENT OF LAND USE TRANSITION MATRIX

The land use transition matrices (Table 228) describe the initial and final areas of particular land-use categories and the identified annual land-use conversions among these categories over the reporting period. It should be noticed that the annual totals for the individual years in the matrices do not correspond to the annual totals from CRF tables, where the changes are reported for a transition period of 20 years. Annual figures for area in transition have been derived by national area statistic when it is available and by basic assumption when data on land-use changes is not available (chapter 6.2.1).

Table 228 Annual land use and land-use change matrices

kha	FL	CL	GL	WL	SL	OL	1987
FL	3613.34				0.12		3613.45
CL	0.99	4113.53	7.54	0.00	1.09	1.17	4124.31
GL	5.99	15.29	2100.63		0.56	0.59	2123.07
WL				213.50			213.50
SL					469.87		469.87
OL	0.08	10.28	5.25	0.00	0.14	540.24	555.99
1988	3620.39	4139.10	2113.42	213.50	471.78	542.00	11100.19

kha	FL	CL	GL	WL	SL	OL	1988
FL	3620.27				0.12		3620.39
CL	0.99	4128.23	7.62	0.00	1.10	1.17	4139.10
GL	5.99	15.35	2090.94		0.56	0.59	2113.42
WL				213.50			213.50
SL					471.78		471.78
OL	0.08	10.31	5.22	0.00	0.14	526.25	542.00
1989	3627.33	4153.89	2103.77	213.50	473.69	528.01	11100.19

kha	FL	CL	GL	WL	SL	OL	1989
FL	3627.28				0.05		3627.33
CL	0.98	4142.91	7.69	0.00	1.14	1.17	4153.89
GL	5.94	15.44	2081.24		0.57	0.59	2103.77
WL				213.50			213.50
SL					473.69		473.69
OL	0.08	10.34	5.19	0.00	0.14	512.26	528.01
1990	3634.26	4168.68	2094.13	213.50	475.59	514.02	11100.19

kha	FL	CL	GL	WL	SL	OL	1990
FL	3634.12				0.15		3634.26
CL	0.99	4157.65	7.78	0.00	1.09	1.17	4168.68
GL	6.02	15.45	2071.54		0.54	0.59	2094.13
WL				213.50			213.50
SL					475.59		475.59
OL	0.08	10.37	5.17	0.00	0.13	498.27	514.02
1991	3641.20	4183.47	2084.48	213.50	477.50	500.03	11100.19

kha	FL	CL	GL	WL	SL	OL	1991
FL	3640.95				0.25		3641.20
CL	1.00	4172.40	7.86	0.00	1.03	1.18	4183.47
GL	6.10	15.45	2061.83		0.51	0.58	2084.48
WL				213.50			213.50
SL					477.50		477.50
OL	0.08	10.41	5.14	0.00	0.12	484.29	500.03
1992	3648.14	4198.26	2074.83	213.50	479.41	486.05	11100.19

kha	FL	CL	GL	WL	SL	OL	1992
FL	3648.09				0.05		3648.14
CL	0.98	4187.02	7.93	0.00	1.16	1.18	4198.26
GL	5.94	15.61	2052.14		0.57	0.58	2074.83
WL				213.50			213.50
SL					479.41		479.41
OL	0.08	10.43	5.11	0.00	0.13	470.30	486.05
1993	3655.08	4213.06	2065.19	213.50	481.31	472.06	11100.19

kha	FL	CL	GL	WL	SL	OL	1993
FL	3654.99				0.08		3655.08
CL	0.98	4201.74	8.01	0.00	1.14	1.18	4213.06
GL	5.96	15.65	2042.44		0.56	0.58	2065.19
WL				213.50			213.50
SL					481.31		481.31
OL	0.08	10.46	5.09	0.00	0.12	456.31	472.06
1994	3662.01	4227.85	2055.54	213.50	483.22	458.07	11100.19

kha	FL	CL	GL	WL	SL	OL	1994
FL	3661.90				0.12		3662.01
CL	0.99	4216.15	7.95	0.44	1.13	1.19	4227.85
GL	5.99	15.69	2032.74		0.54	0.57	2055.54
WL				213.50			213.50
SL					483.22		483.22
OL	0.08	10.79	5.21	0.05	0.12	441.83	458.07
1995	3668.95	4242.64	2045.89	214.00	485.13	443.59	11100.19

kha	FL	CL	GL	WL	SL	OL	1995
FL	3668.84				0.12		3668.95
CL	0.99	4230.85	8.03	0.45	1.13	1.19	4242.64
GL	5.99	15.75	2023.04		0.54	0.57	2045.89
WL				214.00			214.00
SL					485.13		485.13
OL	0.08	10.83	5.18	0.05	0.11	427.35	443.59
1996	3675.89	4257.43	2036.25	214.49	487.03	429.11	11100.19

kha	FL	CL	GL	WL	SL	OL	1996
FL	3675.77				0.12		3675.89
CL	0.99	4245.11	7.86	0.91	1.36	1.19	4257.43
GL	5.99	15.71	2013.33		0.65	0.57	2036.25
WL				214.49			214.49
SL					487.03		487.03
OL	0.08	11.39	5.40	0.09	0.13	412.01	429.11
1997	3682.83	4272.22	2026.60	215.49	489.29	413.77	11100.19

kha	FL	CL	GL	WL	SL	OL	1997
FL	3682.71				0.12		3682.83
CL	0.99	4259.81	7.95	0.91	1.37	1.20	4272.22
GL	5.99	15.77	2003.63		0.64	0.56	2026.60
WL				215.49			215.49
SL					489.29		489.29
OL	0.08	11.43	5.38	0.09	0.13	396.67	413.77
1998	3689.76	4287.01	2016.95	216.49	491.55	398.43	11100.19

kha	FL	CL	GL	WL	SL	OL	1998
FL	3689.65				0.12		3689.76
CL	0.99	4274.50	8.03	0.92	1.38	1.20	4287.01
GL	5.99	15.84	1993.92		0.64	0.56	2016.95
WL				216.49			216.49
SL					491.55		491.55
OL	0.08	11.46	5.35	0.09	0.12	381.33	398.43
1999	3696.70	4301.80	2007.30	217.50	493.80	383.09	11100.19

kha	FL	CL	GL	WL	SL	OL	1999
FL	3696.59				0.12		3696.70
CL	0.99	4259.35	15.13	0.91	1.37	24.05	4301.80
GL	5.99	17.32	1965.57		0.64	17.78	2007.30
WL				217.50			217.50
SL					493.80		493.80
OL	0.08	6.60	3.04	0.09	0.13	373.15	383.09
2000	3703.64	4283.28	1983.74	218.50	496.06	414.98	11100.19

kha	FL	CL	GL	WL	SL	OL	2000
FL	3703.62				0.01		3703.64
CL	1.39	4240.81	15.13	0.90	0.51	24.53	4283.28
GL	10.74	17.32	1942.03		0.25	13.40	1983.74
WL				218.50			218.50
SL					497.39		497.39
OL	0.04	6.62	3.02	0.10	0.15	403.71	413.64
2001	3715.80	4264.75	1960.19	219.50	498.31	441.64	11100.19

kha	FL	CL	GL	WL	SL	OL	2001
FL	3715.68				0.12		3715.80
CL	1.40	4222.27	15.13	0.90	0.65	24.39	4264.75
GL	10.83	17.32	1918.49		0.33	13.22	1960.19
WL				219.50			219.50
SL					499.32		499.32
OL	0.04	6.63	3.01	0.10	0.15	430.70	440.63
2002	3727.96	4246.23	1936.63	220.50	500.57	468.30	11100.19

kha	FL	CL	GL	WL	SL	OL	2002
FL	3727.89				0.07		3727.96
CL	1.40	4203.73	15.13	0.89	0.71	24.36	4246.23
GL	10.80	17.32	1894.94		0.36	13.21	1936.63
WL				220.50			220.50
SL					501.52		501.52
OL	0.04	6.65	2.99	0.11	0.16	457.40	467.35
2003	3740.12	4227.70	1913.07	221.50	502.83	494.97	11100.19

kha	FL	CL	GL	WL	SL	OL	2003
FL	3740.04				0.08		3740.12
CL	1.40	4185.19	15.13	0.89	0.63	24.46	4227.70
GL	10.80	17.32	1871.40		0.32	13.23	1913.07
WL				221.50			221.50
SL					503.88		503.88
OL	0.04	6.67	2.97	0.12	0.17	483.94	493.91
2004	3752.28	4209.18	1889.51	222.50	505.08	521.63	11100.19

kha	FL	CL	GL	WL	SL	OL	2004
FL	3752.10				0.19		3752.28
CL	1.41	4166.65	15.13	0.88	2.32	22.79	4209.18
GL	10.90	17.32	1847.86		1.16	12.28	1889.51
WL				222.50			222.50
SL					503.50		503.50
OL	0.04	6.68	2.96	0.12	0.17	513.23	523.21
2005	3764.45	4190.66	1865.95	223.51	507.34	548.29	11100.19

kha	FL	CL	GL	WL	SL	OL	2005
FL	3764.29				0.15		3764.45
CL	1.41	4148.11	15.13	0.87	2.44	22.69	4190.66
GL	10.86	17.32	1824.32		1.22	12.23	1865.95
WL				223.51			223.51
SL					505.60		505.60
OL	0.04	6.70	2.94	0.13	0.18	540.04	550.03
2006	3776.61	4172.13	1842.39	224.51	509.59	574.96	11100.19

kha	FL	CL	GL	WL	SL	OL	2006
FL	3776.31				0.29		3776.61
CL	1.42	4129.57	15.13	0.87	2.96	22.17	4172.13
GL	10.99	17.32	1800.77		1.48	11.83	1842.39
WL				224.51			224.51
SL					506.94		506.94
OL	0.04	6.72	2.92	0.13	0.18	567.62	577.62
2007	3788.77	4153.61	1818.83	225.51	511.85	601.62	11100.19

kha	FL	CL	GL	WL	SL	OL	2007
FL	3787.94				0.83		3788.77
CL	1.49	4111.03	15.13	0.86	3.46	21.64	4153.61
GL	11.46	17.32	1777.23		1.73	11.09	1818.83
WL				225.51			225.51
SL					507.96		507.96
OL	0.04	6.74	2.91	0.14	0.14	595.56	605.52
2008	3800.93	4135.09	1795.27	226.51	514.11	628.29	11100.19

kha	FL	CL	GL	WL	SL	OL	2008
FL	3800.83				0.10		3800.93
CL	1.40	4092.49	15.13	0.86	2.08	23.13	4135.09
GL	10.82	17.32	1753.69		1.04	12.40	1795.27
WL				226.51			226.51
SL					512.93		512.93
OL	0.04	6.75	2.89	0.14	0.22	619.42	629.46
2009	3813.09	4116.56	1771.71	227.51	516.36	654.95	11100.19

kha	FL	CL	GL	WL	SL	OL	2009
FL	3812.79				0.31		3813.09
CL	1.43	4073.95	15.13	0.85	3.88	21.33	4116.56
GL	11.00	17.32	1730.15		1.94	11.31	1771.71
WL				227.51			227.51
SL					512.29		512.29
OL	0.04	6.77	2.87	0.15	0.20	648.98	659.02
2010	3825.25	4098.04	1748.15	228.52	518.62	681.61	11100.19

kha	FL	CL	GL	WL	SL	OL	2010
FL	3825.14				0.11		3825.25
CL	1.40	4055.40	15.13	0.85	2.17	23.08	4098.04
GL	10.83	17.32	1706.61		1.08	12.31	1748.15
WL				228.52			228.52
SL					517.28		517.28
OL	0.04	6.79	2.85	0.16	0.23	672.89	682.96
2011	3837.41	4079.51	1724.59	229.52	520.87	708.28	11100.19

kha	FL	CL	GL	WL	SL	OL	2011
FL	3837.19				0.23		3837.41
CL	1.42	4036.86	15.13	0.84	1.10	24.16	4079.51
GL	10.93	17.32	1683.07		0.55	12.73	1724.59
WL				229.52			229.52
SL					521.03		521.03
OL	0.04	6.81	2.83	0.16	0.23	698.05	708.12
2012	3849.58	4060.99	1701.03	230.52	523.13	734.94	11100.19

kha	FL	CL	GL	WL	SL	OL	2012
FL	3849.11				0.46		3849.58
CL	1.44	4032.60	15.13	0.18	0.64	11.00	4060.99
GL	11.14	17.32	1671.77		0.32	0.49	1701.03
WL				230.52			230.52
SL					523.77		523.77
OL	0.04	6.80	15.83	0.03	0.20	711.40	734.30
2013	3861.74	4056.72	1702.73	230.73	525.39	722.89	11100.19

kha	FL	CL	GL	WL	SL	OL	2013
FL	3861.58				0.16		3861.74
CL	1.41	4029.82	14.74	0.18	0.42	10.15	4056.72
GL	10.87	16.64	1674.50		0.21	0.50	1702.73
WL				230.73			230.73
SL					526.65		526.65
OL	0.04	6.71	93.98	0.03	0.21	620.66	721.62
2014	3873.90	4053.17	1783.22	230.94	527.64	631.32	11100.19

6.2.3 INFORMATION ON APPROACHES USED FOR REPRESENTING LAND AREAS AND ON LAND-USED DATABASES USED FOR THE INVENTORY PREPARATION.

As it was mentioned above, the LULUCF sector consists of the following categories: Forest land, Cropland, Grassland, Wetlands, Settlements and Other land. All land areas within a country should be assigned to one of these categories.

The land area representation is assembled based on data from different statistical sources (Table 229). Therefore, when compiling the data available for land area representation, the following hierarchical treatment of the data sources has been performed, from top to bottom:

- Top priority is given to the most reliable data which comes from systematically measured statistics and ortho photoimages. This data is used to present the total area of each particular land use cateogry for the whole time series
- Concerning estimation of LUCs between categories, priority is given to estimates based on specific information on land-use changes rather than to estimates of LUCs based on expert judgement
- Estimates of LUCs between categories based on expert judgement are with higher priority than estimates of LUCs based on data gaps
- Data gaps

Hence, the area of forestland is obtained from the National Forest Inventory and Forest Management Plans (data provider Executive Forest Agency). Information on CL and GL areas is gathered from National Statistical Yearbooks and orthophotoimages. The National Statistical Yearbooks provide information on CL and GL areas over the period 1988-2000. The balance of the territory of Bulgaria based on orthophotoimages has been available since 2010. To ensure a full time-series interpolation between the years 2000 and 2012 has been applied. The interpolation was made taking into account the data from orthophotoimages for 2012, because It was considered that the 2012 is more reliable than the 2010 data. Concerning the data on WL and SM, information on its area for single years (1994, 1996) has been obtain from the cadastral maps of the agricultural fund of Bulgaria (Balance by Type of Territories as per their Designation, Cadastre Agency) as well as data from the balance of the territory of Bulgaria based on orthophotoimages for the year 2012. In order to cover the time series – interpolation and extrapolation have been applied. Information on rocks, landslides and barren area from the forestry fund reporting forms (NFI, FMP) Executive Forest Agency) as well as information on other lands (sands, small-scale non-arable lands, lands with poor vegetation etc) from orthophotos are referred to category "Other land". The total national area of 11100.19 kha remains constant over time. Thus, in accordance with IPCC 2006, the difference of the area of all land-use categories and the whole area of the country is referred to "Other land" category.

Table 229 Information on data sources and providers

Land use category	Main data source		Data provider	
	1988-1999	2000-2014	1988-2000	2000-2014
5A Forest land	National Forest Inventory, Forestry Management Plans and its Forestry fund reports		Executive Forest Agency (ExFA)	
coniferous				
deciduous				
forests out of yield				

<table>
<tr><th rowspan="2">Land use category</th><th colspan="2">Main data source</th><th colspan="2">Data provider</th></tr>
<tr><th>1988-1999</th><th>2000-2014</th><th>1988-2000</th><th>2000-2014</th></tr>
<tr><td>5B Cropland</td><td rowspan="3">National Statistical Yearbooks</td><td rowspan="3">balance of the territory of Bulgaria based on orthophotoimages for the years 2010-2014; inbetween interpolation</td><td rowspan="3">National Statistic Institute (NSI)</td><td rowspan="3">Ministry of agriculture and food (MAF)</td></tr>
<tr><td>annual cropland</td></tr>
<tr><td>perennial cropland</td></tr>
<tr><td>5C Grassland</td><td>National Statistical Yearbooks</td><td>balance of the territory of Bulgaria based on orthophotoimages for the years 2010-2014; inbetween interpolation</td><td>National Statistic Institute (NSI)</td><td>Ministry of agriculture and food (MAF)</td></tr>
<tr><td>5D Wetlands</td><td colspan="2" rowspan="2">Cadastral maps of the agricultural fund for single years 1994 and 1996; balance of the territory of Bulgaria based on orthophotoimages for 2014 - inbetween interpolation</td><td colspan="2" rowspan="2">Cadastre Agency and MAF</td></tr>
<tr><td>5E Settlement</td></tr>
<tr><td>5D Other land</td><td colspan="2">National Forest Inventory, balance of the territory of Bulgaria based on orthophotoimages for the years 2010-2014</td><td colspan="2">Executive Forest Agency (ExFA) and MAF</td></tr>
</table>

Major problem in presenting the land use pattern is the limited information on the land-use changes between particular categories. The activity data providers identify the total area for each individual land-use category, but they do not provide detailed information on changes of area between each category. Thus, the approach 1 according to the 2006 IPCC Guidelines has been used for representing the area. When data for completing the information is missing, information from available statistics as well as probability assumptions of known pattern on land-use changes have been used. Thereby, the remaining LUC areas to forests have been assumed to stem from cropland, grassland and other lands. The assessment of the former land use on the identified new forest areas is based on expert judgment on basis of likelihoods. The assessment of the former land use has been done by forestry experts from the Executive Forest Agency (ExFA).The time series in the area statistics shows different trends in the years before and after 2000. Therefore, the time series was divided into these two periods and the land-use changes from cropland, grassland and other lands to forest land were fitted to the different trends in these two periods.

As regards reporting of LUCs to cropland and grassland, information from agricultural statistics (BANSIK) has been used. The agrostatics provides information on LUCs between cropland and grassland as well as between annual and perennial crops and in reverse for a period of 14 years (2000-20114). The LUCs to cropland and grassland for the years before 2000 are unknown. Therefore, the LUCs between CL and GL have been estimated in order to fit the trend in the area. More information on the justification of the estimate is given in the category's chapters. Any conversions and re-conversions from wetlands and settlements are considered as unlikely.

Since Submission 2015, the LUCs to wetlands have been assumed to stem from cropland and other land. The determination of these land-use categories, as the possible land-use changes where the increase in wetlands may stem from, is based on the last step from the hierarchical treatment of the data sources – that is data gaps. It has been considered that the shares of these individual land use categories to the observed increase in wetlands behave like the ratios of the total areas of these land use categories in Bulgaria. In its previous submission Bulgaria reported LUCs from forestland to wetlands due to probability reasons. It was assumed that the observed increase in wetlands suggests also deforestation for wetlands. This forest loss to wetlands was estimated as a share of forest land in the totals of forest land, cropland plus grassland (it was supposed that the increase in wetlands comes from such lands). Actually the reported LUC from forestland to wetlands in the previous submissions of Bulgaria represented an overestimation of deforestation activity since all the information for forest loss due to changes in designation of forest was reported under LUCs to settlements (SM). Since the improvements in area representation made for the Submission 2014 LUCs from forestland to wetlands were not calculated. According to experts from the ExFA, the changes of designation of forest in the years 1988-2012 have been associated with conversion only to SM. There is only one new dam lake (Tsankov kamak) which was built up in recent years but the forest loss associated with its construction works has been already reported in the 70's. Therefore, Bulgaria reports all information provided by the ExFA for forest loss across the time series as LUC associated with conversion to SM. The reported estimates of land-use changes from grassland to other land use categories (forestland and cropland), which are based on specific data and expert judgment, fit very well to the observed decrease in the total grassland area since the base year. Therefore, no land-use changes from grassland to wetlands have been assumed and reported.

Concerning the LUCs to settlements there is information for LUC from forest land to settlements, which is available for the period 1990-1994 and for the years 2001 to 2014. The annual forest loss to settlements for the years 1988, 1989 and 1995-2000 is estimated as an average value of forest loss in the period 1990-1994. Information for LUC from arable land (e.g cropland and grassland) to settlements is available for the years 2001 to 2014. The share of annual cropland, perennial cropland and grassland within the available figure for the total area, which is changed to settlement between 2001 and 2014, was assumed to be the same as the share of the totals of these land-use categories. LUCs from arable lands to settlements for the years before 2001 are estimated using the data gaps approach. The reported land-use changes to settlement fit very well to the increases in settlement area.

Concerning the LUCs from and to OL, except these from OL to FL, are estimated using the data gaps approach. The reporting of changes from OL to CL and GL and in reverse has been implemented in the 2016 GHGI Submission.

Additional information in details on the methodologies and assumptions used in the estimation of land use over the reporting period is presented in the chapters for the different types of land-use.

In accordance with the 2006 IPCC Guidelines, Bulgaria reports the LUC areas within the LUC categories for a transition period of 20 years. Therefore, activity data back to 1968 is needed to report the LUC areas adequately. Due to the lack of data it is assumed that the trends of LUCs in the first years after 1988 were the same as in the years before.

Consequently, the averages of the trends of the first years of the reporting period were extrapolated back to 1968 (1988-2000 or 1988-1999 depending on the split of the time series).

Table 230 presents the total area of the respective land uses and land-use changes between categories for the base and the inventoried year as well as the net changes for the period.

Table 230 Area by type of land use and land-use changes for the base year and the last year of inventory

area in kha	1988	2014	2014-1988
5.A Forest Land - Total	3620.39	3873.90	253.51
5A1. Forest land remaining forest land	3479.33	3658.21	178.87
5A1a. Forest land remaining forest land – coniferous	1198.61	1061.68	-136.92
5A1b. Forest land remaining forest land – deciduous	2259.21	2574.00	314.79
5A1c. Forest land remaining forest land - out of yield	21.52	22.52	0.87
5A2. LUC in forest land	141.05	215.69	74.64
5A2.1.a Annual Cropland in forest land	18.53	24.43	5.89
5A2.1.b Perennial Cropland in forest land	1.19	1.33	0.14
5A2.2 Grassland in forest land	119.81	188.91	69.10
5A2.3 Wetland in forest land	0.00	0.00	0.00
5A2.4 Settlement in forest land	0.00	0.00	0.00
5A2.5 Other land in forest land	1.52	1.03	-0.49
5.B Cropland - Total	4139.10	4053.17	-85.93
Cropland annual	3843.30	3848.01	4.70
Cropland perennial	295.80	205.17	-90.63
5B1. Cropland remaining cropland	3613.98	3558.73	-55.25
5B1a annual cropland remaining annual cropland	3292.80	3320.27	27.47
5B1b perennial cropland remaining perennial cropland	198.71	115.99	-82.72
5B1c LUC perennial cropland in annual cropland	57.34	57.34	0.00
5B1d LUC annual cropland in perennial cropland	65.13	65.13	0.00
5B2. LUC in cropland	525.12	494.44	-30.68
5B2.1a Forest land in annual cropland	0.00	0.00	0.00
5B2.1b Forest land in perennial cropland	0.00	0.00	0.00
5B2.2a Grassland in annual cropland	292.39	321.95	29.56
5B2.2b Grassland in perennial cropland	18.98	15.93	-3.04
5B2.3a Wetlands in annual cropland	0.00	0.00	0.00
5B2.3b Wetlands in perennial cropland	0.00	0.00	0.00
5B2.4a Settlements in annual cropland	0.00	0.00	0.00
5B2.4b Settlements in perennial cropland	0.00	0.00	0.00
5B2.5a Other land in annual cropland	200.76	148.43	-52.33
5B2.5b Other land in perennial cropland	12.99	8.12	-4.87
5.C. Grassland	2113.42	1783.22	-330.21
5C1. Grassland remaining grassland	1857.81	1342.27	-515.54
5C2. LUC in grassland	255.61	440.94	185.33
5C2.1 Forest land in grassland	0.00	0.00	0.00
5C2.2.a Annual cropland in grassland	15.11	209.19	194.08
5C2.2.b Perennial cropland in grassland	135.99	57.23	-78.76
5C2.3 Wetlands in grassland	0.00	0.00	0.00
5C2.4 Settlements in grassland	0.00	0.00	0.00
5C2.5 Other land in grassland	104.51	174.52	70.01
5 D Wetlands	213.50	230.94	17.44
5D1. Wetlands remaining wetlands	213.50	213.50	0.00
5D2. LUC in wetlands	0.00	17.44	17.44
5D2.1 Forest land in wetlands	0.00	0.00	0.00
5D2.2.a Annual Cropland in wetlands	0.00	15.36	15.36
5D2.2.b Perennial Cropland in wetlands	0.00	0.00	0.00
5D2.3 Grassland in wetlands	0.00	0.00	0.00

area in kha	1988	2014	2014-1988
5D2.4 Settlement in wetlands	0.00	0.00	0.00
5D2.5 Other land in wetlands	0.00	2.08	2.08
5 E Settlements	**471.78**	**527.64**	**55.86**
5E1. Settlements remaining settlements	***431.60***	***473.17***	***41.57***
5E2. LUC in settlements	***40.18***	***54.47***	***14.29***
5E2.1 Forest land in settlements	2.31	3.81	1.50
5E2.2.a Annual Cropland in settlements	22.32	30.09	7.76
5E2.2.b Perennial Cropland in settlements	1.42	1.61	0.19
5E2.3 Grassland in settlements	11.54	15.63	4.09
5E2.4 Wetlands in settlements	0.00	0.00	0.00
5E2.5 Other land in settlements	2.59	3.34	0.75
5 F Other land	**542.00**	**631.32**	**89.32**
5F1. Other land remaining other land	***506.80***	***130.59***	***-376.21***
5F2. LUC in other land	***35.20***	***500.73***	***465.53***
5F2.1 Forest land in other land	0.00	0.00	0.00
5F2.2.a Annual Cropland in other land	22.19	297.18	274.98
5F2.2.b Perennial Cropland in other land	1.44	32.71	31.27
5F2.3 Grassland in other land	11.57	170.84	159.27
5F2.4 Wetlands in other land	0.00	0.00	0.00
5F2.5 Settlements in other land	0.00	0.00	0.00
Total area Bulgaria	**11100.19**	**11100.19**	**11100.19**

The data shows that over the period 1988-2014 the areas in the categories “Forest land”, “Wetlands”, “Settlements” and “Other land” have increased by 253.51 kha, 17.44 kha, 55.86 kha and 89.32 kha and they have decreased in the categories “Cropland” and “Grassland” by 85.93 kha and 330.21 kha respectively.

In addition to the information presented above, it should be noted that for submission 2016 a change in the pattern of LUCs from and to CL and GL has been implemented. This change has followed the plan for improvement of land area representation. As it was explained above Bulgaria uses different statistical sources when compiling the inventory. Thus, Bulgaria has kept the totals of land-use categories closer as much as possible to the original data. Bulgaria does not have detailed information on LUCs between categories. Anyway, a combination between the available statistics and probability assumptions has been used. In the past two inventories this approach resulted in a rather good fit in the trend of area changes over ten or twenty plus year period between categories, but did not provide a good fit in CL category which area has more than 30% share from the total country territory. This has led to the need of revising the land use pattern. The trend of area change in CL and GL has shown a steady decrease since the year 2000. This is as a result of the abandons of agricultural area. However, there is no such increase in other land-use categories. At the same time, the difference of the area of all land-use categories and the whole area of the country is referred to “Other land” category. It was noted also that this difference in the areas increases in the past several years. So, one of the possible exchanges between CL and GL and other LU category is between CL/GL and OL. Experts from Ministry of Agriculture and Food also confirmed this. In order to avoid double counting of area it was necessary to revise the land area pattern under SM category.

6.3 FOREST LAND (4.A)

6.3.1 DESCRIPTION OF THE CATEGORY

Forests in Bulgaria cover an area of 3 873 899 ha which represents 34.9% of the country's territory. Over the reporting period, a steady increase in forest territory is observed. In 2014 the forests cover is by 7% more compared to the base year.

In accordance with the IPCC Guidelines the evaluation of the emissions/removals from Forest land category includes an assessment of the changes in the carbon stock in 3 pools – living biomass (above- and below-ground biomass), dead organic matter (dead wood and litter) and soil. The available database in Bulgaria allows to estimate the changes in the carbon stocks in the living biomass (above- and belowground biomass, including all leaves and needles), in the litter (fumic and humic layers) and in the soil pool (0-40 cm depth). Considering the calculations of changes in carbon stock of dead organic matter and soil from the subcategory Forest land remaining forest land tier 1 (2006 IPCC Guidelines) approach has been applied assuming there is no change in the stock of these carbon pools.

CO_2 and non-CO_2 emissions from wildfires (Table 232) are allocated between the subcategory 5.A.1 and 5.A.2 according to their area share in total forestland.

There is no fertilization on forest land in Bulgaria; therefore, direct N_2O emissions from fertilization are reported as NO (not occurring). Non-CO_2 emissions associated with drainage of organic soils are reported as NO, since such activity is not occurring in Bulgarian forests.

6.3.1.1 Trends in the emissions/removals from Forest land category

The Forest category is serving as a sink of CO_2 emissions over the entire time series. The amount of CO_2 removals from the category ranges between 14330.54 Gg CO_2 eq. for 1988 and 10466.20 Gg CO_2 eq for 2013. Despite the observed increase in forest area (

Figure 91), there is a drop in the amount of the removals from the category. This is due to a fall (by 30%) in removals from living biomass pool since 2000 in subcategory Forest land remaining forest land. This is caused by a decrease in the rate of forest growth as the average age of the forest stands increases steadily over the reporting period. At the same time the changes in soil carbon pools when converting other land to forests are associated with emissions – 926 Gg CO_2. This is caused by the higher level of the organic carbon stock in soils of grassland and cropland compared to those of forest land.

Over the reporting period 1988-2013 the data for the total annual net emissions and removals of CO_2 (biomass, litter and soils) are presented in Table 231

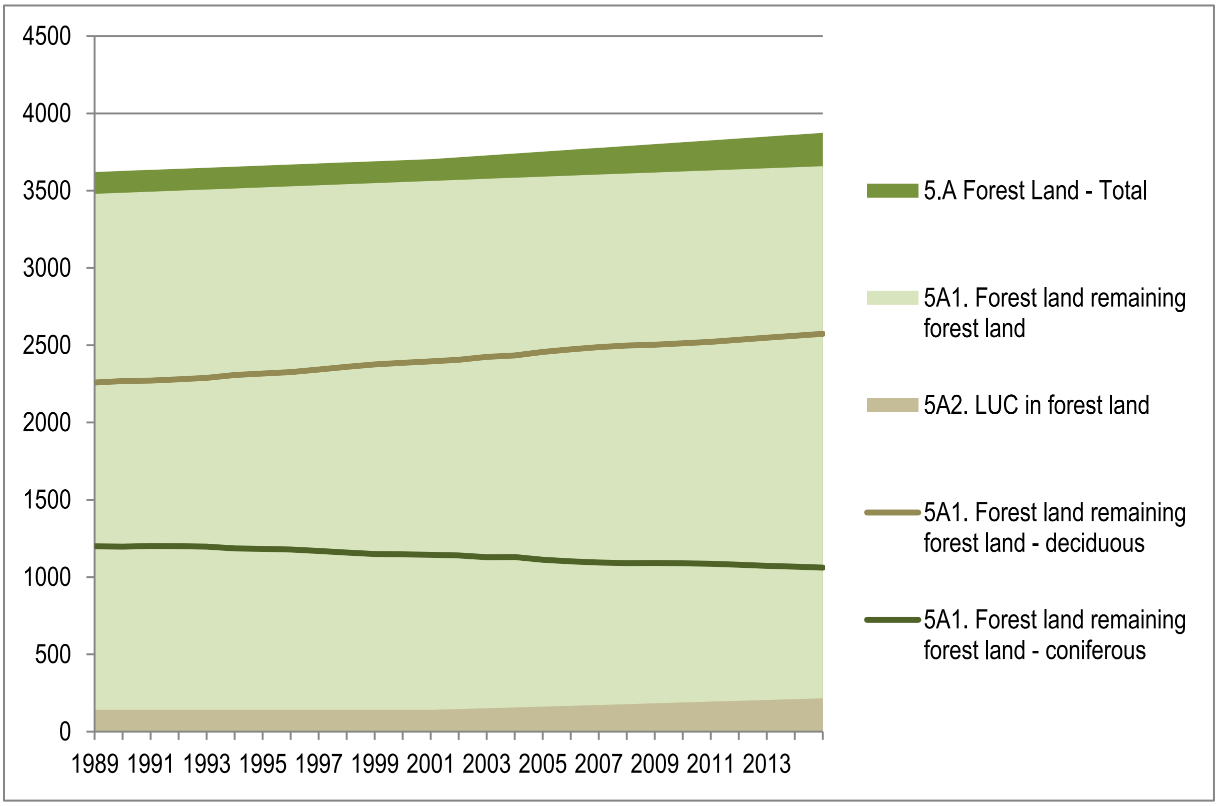


Figure 91 Trends of the changes in area within Forest land category

Table 231 Emissions/removals from Forest land category

year	4.A Total Forest land	4.A.1 FL remaining FL	4.A.2 Land converted to FL	CL to FL	GL to FL	WL to FL	SM to FL	OL to FL
1988	-14331.08	-13787.01	-544.07	-115.88	-412.86	0.00	0.00	-15.32
1989	-14346.54	-13802.05	-544.49	-116.30	-412.86	0.00	0.00	-15.32
1990	-14380.85	-13834.80	-546.06	-116.88	-413.85	0.00	0.00	-15.33
1991	-14395.26	-13850.84	-544.42	-116.97	-412.13	0.00	0.00	-15.31
1992	-14398.22	-13855.01	-543.21	-117.15	-410.75	0.00	0.00	-15.31
1993	-14376.44	-13828.70	-547.74	-118.17	-414.23	0.00	0.00	-15.34
1994	-14380.59	-13833.36	-547.23	-118.41	-413.49	0.00	0.00	-15.33
1995	-14384.50	-13837.63	-546.87	-118.68	-412.86	0.00	0.00	-15.32
1996	-12296.19	-11748.95	-547.24	-119.05	-412.86	0.00	0.00	-15.32
1997	-12243.30	-11695.69	-547.61	-119.42	-412.86	0.00	0.00	-15.32
1998	-12201.65	-11653.67	-547.97	-119.78	-412.86	0.00	0.00	-15.32
1999	-12193.76	-11645.43	-548.33	-120.14	-412.86	0.00	0.00	-15.32
2000	-12185.94	-11637.26	-548.68	-120.49	-412.86	0.00	0.00	-15.32
2001	-10660.56	-10201.95	-458.61	-114.32	-328.78	0.00	0.00	-15.52
2002	-10662.95	-10182.09	-480.86	-116.92	-348.81	0.00	0.00	-15.13
2003	-10707.90	-10201.70	-506.19	-119.87	-371.58	0.00	0.00	-14.75
2004	-10690.13	-10159.72	-530.41	-122.69	-393.36	0.00	0.00	-14.36
2005	-10696.52	-10143.57	-552.95	-125.34	-413.63	0.00	0.00	-13.98
2006	-10277.91	-9699.44	-578.47	-128.33	-436.54	0.00	0.00	-13.60
2007	-10297.31	-9696.52	-600.78	-130.98	-456.59	0.00	0.00	-13.21
2008	-10330.00	-9713.14	-616.86	-133.01	-471.02	0.00	0.00	-12.83
2009	-10375.13	-9717.61	-657.52	-137.73	-507.31	0.00	0.00	-12.48
2010	-10397.15	-9718.43	-678.72	-140.26	-526.35	0.00	0.00	-12.10

year	4.A Total Forest land	4.A.1 FL remaining FL	4.A.2 Land converted to FL	CL to FL	GL to FL	WL to FL	SM to FL	OL to FL
2011	-10417.16	-9709.80	-707.36	-143.58	-552.06	0.00	0.00	-11.73
2012	-10428.42	-9699.20	-729.22	-146.08	-571.81	0.00	0.00	-11.33
2013	-10442.37	-9691.72	-750.65	-148.77	-590.92	0.00	0.00	-10.95
2014	-10469.09	-9685.85	-783.24	-153.32	-619.33	0.00	0.00	-10.59

Table 232 Total emissions from forest wildfires 1988-2014 in CO_2 eq

year	area burnt (ha)	CO_2 emission CO_2 equivalent Gg	CH_4 emission CO2 equivalent Gg	N2O emission CO_2 equivalent Gg
1988	462.00	IE	1.07	0.71
1989	223.00	IE	0.52	0.34
1990	1041.00	IE	2.42	1.60
1991	511.00	IE	1.19	0.78
1992	5243.00	IE	12.20	8.04
1993	18164.00	IE	42.25	27.86
1994	18100.00	IE	42.11	27.76
1995	549.00	IE	1.28	0.84
1996	2150.00	IE	5.00	3.30
1997	777.00	IE	1.81	1.19
1998	6967.00	IE	16.21	10.69
1999	8291.00	IE	19.29	12.72
2000	57915.40	IE	134.73	88.84
2001	20173.04	IE	46.93	30.94
2002	6513.00	IE	15.15	9.99
2003	5105.55	IE	11.88	7.83
2004	1139.90	IE	2.65	1.75
2005	1446.20	IE	3.36	2.22
2006	3706.54	IE	8.62	5.69
2007	43434.60	IE	101.04	66.63
2008	5439.10	IE	12.65	8.34
2009	2270.80	IE	5.28	3.48
2010	6529.35	IE	15.19	10.02
2011	7164.30	IE	16.67	10.99
2012	13045.70	IE	30.35	20.01
2013	3317.51	IE	7.72	5.09
2014	924.30	IE	2.15	1.42

6.3.1.2 Activity data and information used

The National Forest Inventory (NFI) and the information from the Forest Management Plans (FMP) are the main sources of information for the area of forest land and its land-use changes. The NFI in Bulgaria covers assessments for the entire country territory in 10 years' cycles. Therefore, all forest stands are surveyed once in every 10 years. The stand-wise inventory in Bulgaria measures the main data as tree composition, origin, age, management purpose, tree height and diameter; annual increment, bonitat, density of stand, tree growing stock etc. Forest inventory presents collection of qualitative and quantitative data about the investigated area. On the other side, the management planning gives recommendations about the silvicultural operations and activities for the next 10 years period. The plans contain data for forests' territorial division and management, basic characteristics of the forest stands; complex of activities for protection, regeneration and optimal utilization of the forest resources; economic justification, considering ecological and social effects from the implementation of the planned activities. These plans are prepared in accordance with *Regulation № 6 on the structure of the forests and land included in the forest fund and the hunting reserves of Republic of Bulgaria.* The plans contain reporting forms for the forestry fund (FF) including information on: forest area (1FF), afforestated area (2FF), tree biomass stock (3TR), stock by groups of forests and forest cover (4FF), wood harvest (5FF), age and density (6FF) and types of forest stands (7FF). The reporting forms 1FF and 5FF are updated annually and the remaining forms every other 5th year and are submitted to the Regional Forestry Offices and in the Executive Forest Agency (ExFA). The process of forest inventory and planning is stable and consistent over time.

When compiling the data on forest areas, data from the forestry fund reports has been used. Although the high reliability of the gathered data, some adjustments of the original data have been made. In the Submission 2011 it was identified that the net increase in forest land was not only due to afforestation/reforestation (AR) activities but also due to inclusion of area, which were forested before 1990. In order to distinguish those new forest areas which were forested before 1.1.1990 from the total increase in forest area, Bulgaria submitted a plan for improvement of the estimation of AR units of land. In its submission 2014 Bulgaria continues to follow this plan as accepted by the ERT team as answer to the related Saturday paper issue of the 2011 review. The plan has been implemented in stages starting in Submission 2012 and completed for the Submission 2014. According to this plan the following improvement steps have been implemented:

Bulgaria examined the Forest Management Plans (FMPs – see below) for all State Forest Enterprises (SFE), which were inventoried for the period 1991-2012. Like this all changes since 1992 in forest area for each and every SFE has been traced and identified. For those SFE, where there is an increase in the forest area since 1990, the increase is derived into:

a. New forest areas which are included in the forest total, but which were forested before 1990, so new forests with stands of older age classes.

b. And the new forested areas with stands of the youngest age class, which are due to afforestation and reforestation activities (planting and seeding) on arable lands and barren areas or afforestation and reforestation activities (planting, manual and natural seeding) on grassland or on croplands.

These improvement steps have been performed by the experts from Executive Forest Agency, by using the following sources of information:

- Forest Inventory and FMPs[30];

[30] Forest Inventory and FMPs are carried out for each State Forest Enterprise. The inventory aims measurement and processing of the following main data:

1) Forest area and its changes
2) Tree composition, origin, age, management purpose
3) Tree height and diameter,

- Forestry Fund Reporting Form 1FF[31] (forest area) for the 1990;
- Forest maps

The observed increase in forest area due to AR activities for every single SFEs is given for two periods - 1992-2000 and since 2000. The amount of the "new" forest areas since 1.1.1990 which were forested before 1990 (point a) was added to the total forest area in 1991 and the years after according to Forestry Fund Reporting Form 1FF (forest area). Like that the total forest area (particularly those of forest land remaining forest land) in 1991 and in the years after has been adjusted by using interpolation. The new forest areas between 2012 and 1992 according to point b represent the **net increase** in forest due to planting or seeding (manually or naturally) activities. Changes in forest area for the years 1988 – 1991 are based on extrapolation using the same forest change as in the year 1992.

In order to get information for the former land uses that became forests, an expert judgement has been used. Land use (cropland, grassland, other land) typically follows ecological site condition. The experts going through the FMPs know the dominating land uses in the SFE region, so they made an expert judgement of former land use on basis of likelihoods. For example, there are regions where grassland (GL) dominates, because growth/site conditions are not good enough for cropland (CL) plants or CL management or, site conditions are so good that CL dominates. Similarly, other land (OL) can be found in extreme site conditions where FL, CL, GL cannot grow.

6.3.2 METHODOLOGY

6.3.2.1 Forest Land remaining Forest Land (4.A.1.)

6.3.2.1.1 Changes in the carbon stock in the living biomass

Bulgaria follows IPCC GPG 2003 and applies the stock change method when defining carbon stock changes in living biomass. Conversion coefficients used are specific for Bulgaria and the ones given in the IPCC GPG 2003 tables. The main database includes: forest area by type (coniferous and deciduous), and the volume stock (stem wood and branches) by forest type obtained from the forestry fund reports (1 FF and 4 FF). To calculate the changes in the carbon stock of the living biomass Method 2 of IPCC GPG 2003 is used.

$$C_B = (C_{t2} - C_{t1})/(t_2 - t_1)$$

The carbon stock in the biomass is calculated using the equation:

4) Annual increment, bonitat, density of the stands
5) Tree growing stock
6) Data about main rock, soil type and soil bonitat and other important habitat characteristics.

The measurements of the Forest Inventory are carried out for each and every SFE once in every 10 years.

[31] The reporting forms 1FF to 7 FF represent the forest fund reporting forms. The data gathered during the forest inventories is used as data base for preparation of the reporting forms of the forest fund

$$C = A \cdot V \cdot D \cdot BCEF_S \cdot (1 + R) \cdot CF$$

where:

A – area of land remaining in the same land-use category

V – tree stock (stemwood and branches) m3 .ha-1

$BCEF_S$ – biomass conversion and expansion factor for expansion of merchantable growing stock volume to above-ground biomass, tonnes above-ground biomass (m^3 growing stock volume)$^{-1}$

$$BECF_S = BEF_2 \cdot D$$

Where:

BEF_2 - expansion factor for conversion of the stem wood plus branches into a total aboveground tree biomass (stem, branches, leaves),D - basic wood density, tonnes m^{-3}

R – root to shoot ratio

CF – carbon fraction in the dry matter in tonnes C (tonnes d.m.)$^{-1}$

To determine the total quantity of carbon in tree biomass, data for the stemwood plus branches volume (V) is used. The Bulgarian national forest inventory assesses not only the stemwood volume but also the volume of the branches of the trees. Such data have been published on a regular basis in the reports of the forestry fund over a five year period since 1965. For this inventory, data on the wood volume are used separately for coniferous and deciduous forests for the years 1985, 1990, 1995, 2000, 2005 and 2010. The stock changes of the wood volumes were obtained by estimating the difference between the periods divided by 5.

Concerning basic wood density (D) national data is used. The calculations are based on values determined for Bulgaria for shrinkage and the density of the absolutely dry wood (Bluskova, G., 1994; Enchev, E., 1984). Density and shrinkage of the main Bulgarian tree species are available (Norway spruce, Scots pine, Silver fir, Oaks, Common beech, Ash, Willow, White birch, Common hornbeam, Elm).

The values for basic wood density are determined as weighed mean depending on the relative share of the stocks of the coniferous and the deciduous species in the Bulgarian forests. The calculations are made for the periods of which data on the wood stock is available for and an average out of these values is estimated. The variation of the values for the separate periods is from 0.7% for the coniferous to 1.1% for the deciduous.

Table 233 Wood density (D)

D- weighed mean wood density –tonnes m-3	1995	2000	2005	2010
Coniferous	0.427	0.430	0.431	0.430
Weighed mean value	0.430			
Deciduous	0.605	0.605	0.606	0.597
Weighed mean value	0.603			
Weighed mean value for all forests	0.528			

There are no specific values for the biomass expansion factor (BEF_2) for converting the stemwood+branches stock into a total aboveground biomass. Since the Bulgarian NFI assesses also the stock of branches the biomass expansion factor used does not need to account for this tree compartment, so BEF_2 has only to add the leaf biomass. To estimate this specific BEF_2 data from literary sources on results from ecosystem studies for Spruce, Scots pine, Beech and Oaks were used (compiled in Korner, C., Schilcher B. und Pelaez-Riedl S. 1993: Vegetation und Treibhausproblematik: Eine Beurteilung der Situation in Österreich unter besonderer Berücksichtigung der Kohlenstoff- Bilanz. In: ÖAW (Hrsg.): Anthropogene Klimaänderungen: Mögliche Auswirkungen auf Österreich – mögliche Maßnahmen in Österreich. Dokumentation, Österreichische Akademie der Wissenschaften, Wien, 6.1-6.46). The coefficients were recalculated as weighed mean according to the relative share of the forests of Spruce, Scots pine, Beech and Oak in the Bulgarian forests

Table 234 Biomass expansion factor for converting stemwood+branches into total aboveground biomass (BEF2)

Types of forests	Coniferous	Deciduous
BEF2	1.08	1.03
Mean	1.05	

Due to the lack of specific data for the ratio root to shoot (R) for Bulgaria coefficients presented in the IPCC Good Practice Guidance for LULUCF adapted to the conditions in the country (Table 235) are used. A weighed mean value according to the wood stock is determined for the deciduous forests based on the values for R in IPCC GPG (0.35 for oak forests and 0.26 for other deciduous). Concerning the coniferous the value of IPCC GPG is used.

Table 235 Root-to-shoot ratio (R)

Types of forests	Coniferous	Deciduous
R	0.29	0.24

The carbon fraction in the dry matter (CF) is adopted by default form the 2006 IPCC Guidelines. It is 0.51 tonnes C for coniferous and 0.48 for deciduous.

A permanent trend in increasing the volume stock in Bulgarian forest is observed. However, the carbon stock change of living biomass has decreased significantly since 2000 (approx. with 20%). The key driver for the observed decline is the decrease in the rate of forest growth because the average age of the forest stands increases over the reporting period.

6.3.2.1.2 Changes in the carbon stock in the dead organic matter

6.3.2.1.2.1 Changes in carbon stock in dead wood

For the changes in dead wood, the 2006 IPCC Guidelines Tier 1 approach has been used, assuming that there are no changes in dead wood stocks in all managed forests remaining forests.

6.3.2.1.2.2 Changes in carbon stock in litter

Bulgaria reports CSC in litter under Tier 1 (2006 IPCC Guidelines), where litter inputs and outputs are assumed to balance and the pools therefore taken to be stable.

6.3.2.1.3 Changes in carbon stock in soils

No evaluation of the impact of the different systems of forest management and silviculture practices on the carbon contents of the Bulgarian soils have been carried out. There is no official information on the changes that took place over the last 20 years. Due to this reason it is assumed that the average stock of organic carbon in the soils is stable in terms of the types of forests, the manner of their management and the implemented silviculture practices. Therefore the tier 1 approach (2006 IPCC Guidelines) has been applied, which assume that the carbon stock change in mineral soils for sub-category Forest land remaining Forest land is zero.

Histosols cover 0,06% of the total area of Bulgaria and are in protected areas, where all anthropogenic impacts are forbidden. Therefore, there is no peat extraction, draining of soils or other anthropogenic activities that affect the water regime, the temperature on soil's surface and the species. Due to this reasons Histosols are not subject to evaluation.

6.3.2.1.4 Forest fires

There is no biomass burning as in Bulgarian forests the controlled fires are forbidden by law. Therefore, in the current report only emissions of CO_2, CH_4 and N_2O from wildfires have been calculated. For the estimates Tier 1 has been applied, equation 3.27 of IPCC 2006:

For the mass of fuel, available for combustion (Mb) a value of 19,8 tonnes/ha has been used (2006 IPCC Guidelines). The values of the emission factors (G) have been taken from Table 2.5 from the 2006 IPCC Guidelines (for CO_2- 1569, for CH4 - 4.7 and for N_2O - 0.26).

Annual data for the areas affected by fires (A) has been obtained from the Executive Forest Agency and the National Parks in Bulgaria – Rila, Pirin and Central Balkan. Thus, all forest areas were covered by these data. Since the reporting system for wildfires in forests cannot define whether the wildfire happens in AR units of land or not, Bulgaria has shared these emissions between sub-category Forest lands remaining forest land and LUCs to forest land (Afforestation/reforestation areas). Therefore, the emissions from wildfires between these two sub-categories have been estimated according to their area share in total forestland

The total emissions from wildfires (e.g. 5.A.1 and 5.A.2) are presented in Table 232.

6.3.2.2 Lands converted to forests (4.A.2.)

This subcategory includes activities related to the conversion of lands from other type of land-use to forests. The changes in the carbon stocks and emissions and removals of greenhouse gases of lands converted to forests over the last 20 years have been estimated.

6.3.2.2.1 Changes in the carbon stock in the living biomass

To determine the changes in the carbon stock in the living biomass data for the stemwood and branch stock for the first age class (1-20 years) has been used. An average annual increment of the stock (stemwood and branches) of the first age class was determined to 6.5 m3/ha/y, obtained by dividing the stock of the stands of I^{st} age class by average age of 10 years. This value has been used for all land use changes to forests.

In Inventory 2012, the value for wood density (D) of forest stands of first age class has been recalculated due to new NFI data (2010). The weighed mean value for D was determined for the total first age class of the Bulgarian forests according to the wood stock of the single species – 0,505 tonnes m^{-3}. This value has been used for all land use changes to forests.

There are no specific values for the biomass expansion factor (BEF_2) for converting the stemwood+branches stock into total aboveground biomass of the I^{st} age class. Since the Bulgarian NFI assesses also the stock of branches the biomass expansion factor used does not need to account for this tree compartment, so BEF_2 has only to add the leaf biomass. To estimate this specific BEF_2 data from literary sources on results from ecosystem studies for Spruce, Scots pine, Beech and Oaks for the I^{st} age class stands were used (compiled in Korner et al.1993). The coefficients were recalculated as weighed mean according to the relative share of Spruce, Scots pine, Beech and Oak in the first age class of the Bulgarian forests. Table 236 presents the values for BEF_2 .

Table 236 Biomass expansion factor for converting stemwood+branches into total aboveground biomass (BEF_2) for the first age class

Types of forests	Coniferous	Deciduous
BEF_2	1.10	1.08
Mean	1.09	

For the ratio root-to-shoot of the young trees one coefficient is used (R=0,29). It is being calculated as weighed mean value of the coefficients used in the chapter Forest land Remaining Forest land according to the wood stock of coniferous and deciduous forests of the first age class taking into account also the NFI data from 2010.

The calculated average annual increment of carbon stock in the living biomass in lands converted to forests is 2,25 tonnes C/ha.y for the I^{st} age class. For estimating the biomass changes equation 2.4 from 2006 IPCC Guidelines has been used. The biomass of the previous land use that is lost due to the land-use change to forest is estimated as described in the related land-use chapters.

6.3.2.2.2 Changes in dead organic matter

6.3.2.2.2.1 Changes in the carbon stock in dead wood

Due to the young age of the forests in the area converted to forests it is assumed that there is no dead wood and there is no change in this carbon stock.

6.3.2.2.2.2 Changes in the carbon stock in litter in lands converted to forests

According to IPCC definition litter pool includes all non-living biomass in a various state of decomposition, so this means – litter layer (fresh dead plant material), fumic and humic layers. As it was explained in chapter Forest remaining forest, changes in carbon stock in soil the source of information in order to estimate a country specific value for the carbon stock in litter is EEA-MOEW. The database resulted from the implementation of the ICP "Assessment and Monitoring of Air Pollution Effects on Forests"-UN/ECE Convention on Long Range Transboundary Air Pollution.

When analysing carbon content in litter Bulgaria follows ICP Forests Manual methodological approach http://www.icp-forests.org/pdf/FINAL_soil.pdf (see Annex 7 Soil horizon designation p.195) where litter definition is :

OL-horizon (Litter, Förna): this organic horizon is characterised by an accumulation of mainly leaves/needles, twigs and woody materials (including bark), fruits etc. This sub layer is generally indicated as litter. It must be recognized that, while the litter is essentially unaltered, it is in some stage of decomposition from the moment it hits the floor and therefore it should be considered as part of the humus layer. There may be some fragmentation, but the plant species can still be identified. So, most of the original biomass structures are easily discernible. Leaves and/or needles may be dis coloured and slightly fragmented. Organic fine substance (in which the original organs are not recognisable with a naked eye) amounts to less than 10 % by volume.

According to IPCC-GPG definition this represents the "litter layer" (a horizon consisting of relatively fresh dead plant material). For Bulgaria there are no data gathered for the carbon content in this layer during the soil surveys. However, since the changes in biomass fully account for all leaves and needles (the tree biomass estimates accounts for these pools) that represent the material of the litter layer within one year any further accounting of this material would end in double accounting.

In the Submission 2010 Bulgaria reported carbon stock changes in litter in the figure of the carbon model stock for soils. The estimation of the model carbon stock in soils for Bulgaria was based on the data for the carbon stock in the 30 cm layer and OFH horizons (OH+OF, the fumic and humic layers which are the further parts of the "litter pool" in sense of IPCC GPG definition).

OF-horizon (fragmented and/or altered) is a zone immediately below the litter layer. This organic horizon is characterised by an accumulation of partly decomposed (i.e. fragmented, bleached, spotted) organic matter derived mainly from leaves/needles, twigs and woody materials. The material is sufficiently well preserved to permit identification as being of plant origin (no identification of plant species).The proportion of organic fine substance is 10 % to 70 % by volume. Depending on humus form, decomposition is mainly accomplished by soil fauna (mull, moder) or cellulose-decomposing fungi. Slow decomposition is characterised by a partly decomposed matted layer, permeated by hyphae.

OH-horizon (humus, humification): characterised by an accumulation of well-decomposed, amorphous organic matter. It is partially coprogenic, whereas the F horizon has not yet passed through the bodies of soil fauna. The humified H horizon is often not recognized as such because it can have friable crumb structure and may contain considerable amounts of mineral materials. It is therefore often misinterpreted and designated as the Ah horizon of the mineral soil and not as part of the forest floor as such. To qualify as organic horizon, it should fulfil the FAO requirement, as described above. The original structures and materials are not discernible. Organic fine substance amounts to more than 70 % by volume. The OH is either sharply delineated from the mineral soil where humification is dependent on fungal activity (mor) or partly incorporated into the mineral soil (moder).

According to the ICP Forests Manual samples are taken separately for the different depth. OH and OF layers should be sampled together (see Table 5, p. 15 ICP Forests Manual). The data is available for each depth. The estimation for the model carbon stock in litter pool is based on database for carbon content in OFH layers available for the years 2000 – 2002. According to the data available it was estimated that the carbon stock in litter is 5.38 tC/ha.

6.3.2.2.3 Changes in the carbon stock in soils

The changes in soil organic carbon pool followed the land-use conversion from other land-use to forests have been estimated based on reference stock of the soil organic carbon from the soil under different land-use type using the equation:

$$\Delta C_{mineral\ soil} = \left[(SOC_{ref} - SOC_{non\ forest\ land}) \cdot A_{Aff}\right] / T_{Aff}$$

where:

$\Delta C_{mineral\ soil}$ - annual change in the carbon stock in mineral soils in the year of assessment, tonnes C/ yr

SOC_{ref} – reference carbon stock in forest's, tonnes C/ ha

$SOC_{non\ forest\ land}$ - stable carbon stock in the soil in a previous type of land-use (croplands, grasslands and other lands), tonnes C/ ha

A_{Aff} - total afforestated area after the conversion, ha

T_{Aff} - duration of the transition from non-forest land to forest , yr

The used transition period is 20 years according to 2006 IPCC Giudelines.

Source of information for the contents of organic carbon in forest soil is the database of the ICP "Assessment and Monitoring of Air Pollution Effects on Forests"-UN/ECE Convention on Long Range Trans-boundary Air Pollution (CLRTAP)". The data provider is the Executive Environment Agency, which is the responsible authority for the reporting under CLRTAP. Regular assessments on soils have been carried out since 1986. Taking into account the representativeness of the data and the purpose of the estimate, the reference soil organic carbon stock in forest's soil has been evaluated based on dataset since 1998. The dataset on soil contains information on the soil chemistry and physical parameters. The measurements of the soil's parameters are made for layers (0-5cm, 5-10cm, 0-10cm, 10-

20cm, 20-40cm.). The content of organic matter is presented in percentage. In order to estimate the organic carbon stock (tC/ha), data on bulk density is needed. However, the data on bulk density is not available for all layers. Therefore, the bulk density of the soil from different layers has been estimated using the Alexander B (1980) PTF function[32]:

$$\rho_{\mathrm{b}} = 1.72 - (0.294 - org.C,\%)^{0.5}$$

Thus, the organic carbon stock has been calculated for all samples from the dataset. Then, the samples have been grouped by soil type and an average value for carbon stock in the different soil types has been derived. Data on the area of the particular soil types under forest land-use is available according to Soil map of Bulgaria (1:400 000) and Corine land cover data (1:100 000). Therefore, the reference soil organic carbon stock in forest's soil has been derived as a weighted mean from the averages SOCs of every particular soil types which are presented in Bulgarian forests. The procedure to derive the reference carbon stock in forest soils, which has the value of 78.26 tC/ha (0-40 cm) is presented in the figure below. The statistics and the uncertainty associated with the evaluation of the reference stock are presented in the table below. They are derived by using Monte Carlo analysis.

Table 237 Statistics of the evaluation of the reference carbon stock in forest's soil and its uncertainty assessment

statistics	value
Trials	10000
Min	48.231
Median	76.429
Mean	**78.257**
Max	204.950
Std. Dev.	**12.751**
Variance	162.576
Skewness	1.372
Kurtosis	5.257

probability	value
0.025	58.976
0.05	61.311
0.1	64.219
0.25	69.592
0.5	76.429
0.75	84.898
0.9	93.890
0.95	100.808
0.975	107.922

uncertainty	**-24.6**	**37.9**

[32] G.TAULYA et al., 2005 Validation of pedotrasfer functions for soil bulk density estimation on a Lake Victoria Basin soilscape

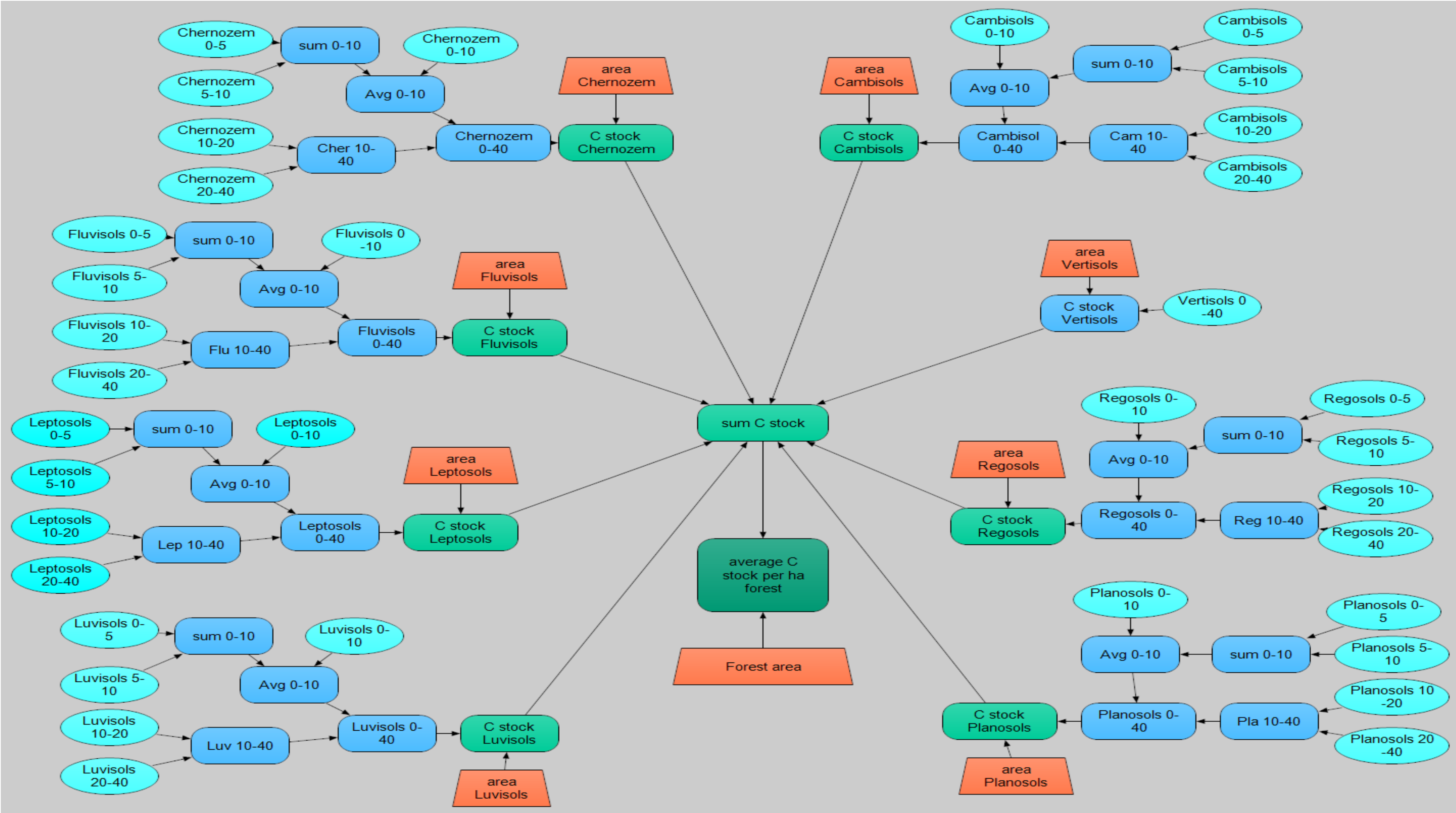


Figure 92 Procedure to derive the organic carbon reference stock in forest's soils

For the stable stock of organic carbon in soils (0-40 cm) of previous types of land-use the following country specific values for annual and perennial cropland, grassland and other land have been used:

- annual crops: 89.9 t C/ha
- perennial crops: 76.5 t C/ha
- grasslands: 103.57 t C/ha
- other land: 69 t C/ha

Following the recommendation from the ERT Bulgaria re-estimated the reference organic carbon stock in soils under other land use. This has been done by using the default SOC reference level as described in table 2.3 in 2006 IPCCC Guidelines. In order to choose the most appropriate default SOC reference level Bulgaria did the following:

According to "Classification scheme for default climate regions" (IPCC, 2006) Bulgaria is in the "warm temperate dry" (appr. 60%), "cool temperate dry" (appr. 20%) and "cool temperate moist" (appr. 20%) regions (please see the map from the link below).

http://forest.jrc.ec.europa.eu/media/cms_page_media/122/BGR_Climate_1.pdf

Concerning the soil type, more than 80% of the territory is under high activity clay soils (please see the map from the link below).

http://forest.jrc.ec.europa.eu/media/cms_page_media/123/BGR_Soil.pdf

Therefore, Bulgaria estimated a weighted mean value for the SOC reference level in soils taking into account the SOC reference levels for HAC soils (table 2.3 from the2006 IPCC Guidelines) for the respective climate regions. The result for the 0-30 cm depth is 51.8 tC/ha. Bulgaria in its inventory estimates the CSC in mineral soils for 0-40 cm depth. Therefore, the value of 51.8 tC/ha had to be corrected for consistency reason. The final result is 69 tC/ha for 0-40 cm.

A description of the methods of deriving these soil C stocks can be found in the respective chapters.

6.3.3 UNCERTAINTY ASSESSMENT

The uncertainties associated with the estimates of CO_2 emissions and removals have been calculated using both Tier1. Tier 1 method combines the uncertainties by means of the error propagation equations. The input uncertainties, associated with the different emission factors and the activity data as well as the sources of information (default values, empirical data or expert judgment) are presented in Table 238 and Table 239. The total uncertainty for Forestland remaining forestland is ± 149% while for Land converted to Forestland is ± 122%. The total uncertainty for CO2, CH4 and N_2O emissions form forest fires is ±102.1% estimated by using Tier 1 method.

Table 238 Uncertainties of emission factors and activity data (Tier 1)

Inputs	Uncertainty (in %)	Source of information
V - Volume stock	10	Executive Forest Agency
D - wood density	30	Default, IPCC GPG 2003

Inputs	Uncertainty (in %)	Source of information
BEF2 - Biomass expansion factor	30	Default, IPCC GPG 2003
R - root to shoot ratio (forestland)	30	Default, IPCC GPG 2003
R - root to shoot ratio (grassland)	95	Default, IPCC GPG 2003
CF - carbon factor	2	Default, IPCC GPG 2003
B cut - yield biomass	10	National Statistical Institute
B peak - biomass of the growth	75	Default, IPCC GPG 2003
Aboveground biomass for perennial	75	Default, IPCC GPG 2003
Annual average growth in annual crops	75	Default, IPCC GPG 2003
Annual accumulation of C in the aboveground biomass of perennials	75	Default, IPCC GPG 2003
Annual Growth in annual cropland	75	Default, IPCC GPG 2003
Losses of carbon in the aboveground biomass of perennials	75	Default, IPCC GPG 2003
C stock in litter pool	141.5	empirical data
Soil C stock in forestland	32.6	empirical data
Soil C stock in annual cropland	25.0	empirical data
Soil C stock in perennial cropland	55.0	empirical data
Soil C stock in grassland	32.9	empirical data
Area	3	for industrial countries, IPCC 2006
Area – LUC	10	expert judgment

Table 239 Uncertainties of emission factors for forest fire (Tier 1)

Inputs	Uncertainty (in %)	Source of information
A - Area destroyed by fire	25%	Average value (20% - 30%), IPCC GPG 2003
B*C - Quantity of wood burnt down*Burning efficiency	75%	Default, IPCC GPG 2003
D - Emission factor for CO_2	75%	Default, IPCC GPG 2003
D - Emission factor for CH_4	75%	Default, IPCC GPG 2003
D- Emission factor for N_2O	75%	Default, IPCC GPG 2003

The update of the uncertainty assessment is planned for the next submission.

6.3.4 DATA VERIFICATION CATEGORY-SPECIFIC QA/QC AND VERIFICATION, IF APPLICABLE

See Chapter 4.11

6.3.5 CATEGORY-SPECIFIC RECALCULATIONS

The following recalculations have been made for Submission 2016:

- Update of some emission coeficeints as C fraction and Root to shoot ratio according to 2006 IPCC.
- non-CO_2 emissions from wildfires have been recalculated according to the updated emission factors from 2006 IPCC Guidelines.
- Changes in area of FL since 2012. A technical error in estimation table has been found.

6.3.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

The following improvements are planned for the next submission:

- Will try to provide a country-specific value for SOC reference level in soil under other land use as reported in its GHG inventory submission

6.4 CROPLAND (4.B)

6.4.1 DESCRIPTION OF THE CATEGORY

Croplands in Bulgaria cover an area of 4 053 173 ha which represents 36.5% of the country's territory. Annual crops have a share of 94.5% from the total cropland's territory and the rest 5% are referred to perennial crops. Since the year 2000 a steady decrease in cropland areas is observed. In 2014 the area of cropland is by 2.0% lower compared to those from the base year.

The evaluation of the emissions/removals from Cropland category is based on estimates of the changes in the carbon stocks in living biomass and soil. The changes in biomass stock are estimated only for perennial crops. For annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year - thus there is no net accumulation of biomass carbon stocks.

Non-CO_2 emissions associated with the management of permanent agricultural lands are estimated as part of Agriculture Chapter from this report. N_2O emissions from land-use conversions to cropland as a result of soil oxidation are reported under LULUCF sector.

There is no agricultural lime application in Bulgaria during the reporting period so CO_2 emissions from liming are reported as NO (not occurring).

Table 240 Categories assessed for emissions/removals

Categories
4 B. Cropland- total
4.B.1 Cropland remaining cropland
- carbon stock change in living biomass of perennial cropland and LUC between annual and perennial cropland
- carbon stock change due to changes in organic matter input (harvest residues) to cropland soils
4 B 2 Land converted to cropland
4 B 2 1 Forest land converted to cropland
4 B 2 2 Grassland converted to cropland
- carbon stock change in living biomass of annual/perennial cropland
- carbon stock change due to changes in organic matter input to cropland soils

The trend in the areas of cropland category is presented in the figure below. The annual cropland's emissions over the reporting period range from -1015.20 Gg CO_2 eq. to 916.97 Gg CO_2 eq. As it can be seen from the table below, emissions from subcategory Cropland remaining cropland have a high level of inter-annual variability. The reason for the variation in the emissions is that Bulgaria reports changes in carbon stock within cropland category (e.g. change from perennial to annual, annual crops toperennial and perennials remaining perennials). Major source of the emissions within subcategory Lands converted to croplands is the carbon stock change in the soil pool when converting grassland to cropland.

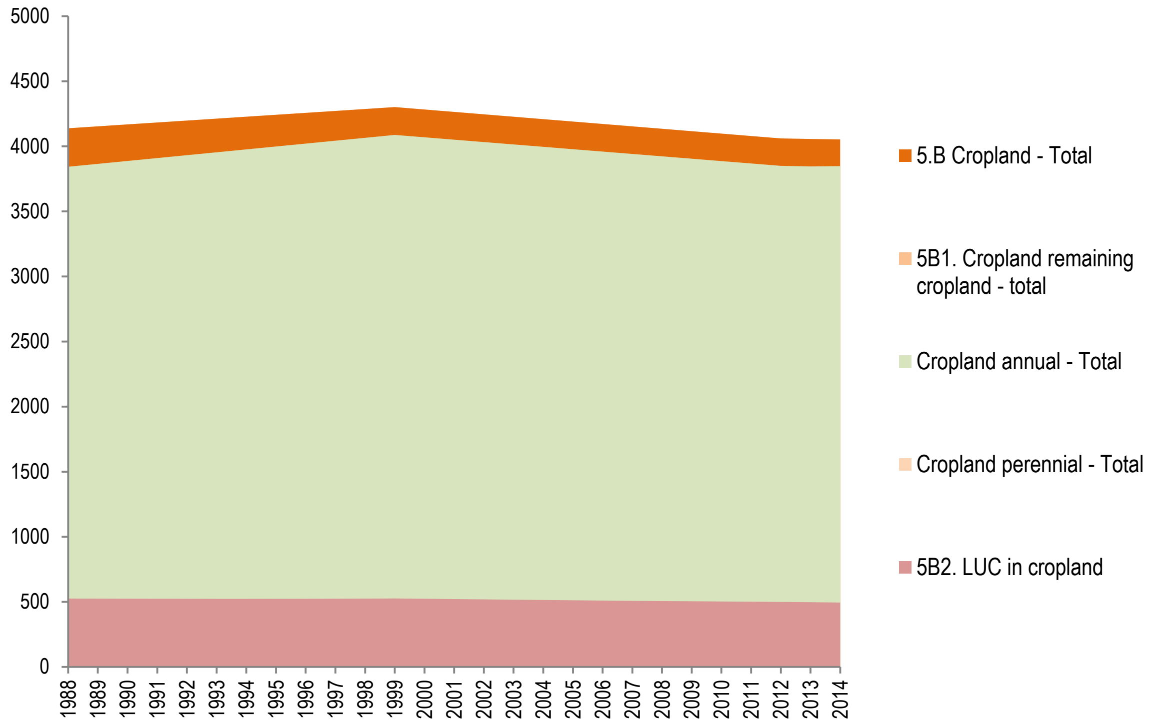


Figure 93 Trend in the areas within Cropland category

Table 241 Eemissions /removals of CO_2 whitin Cropland category (Gg CO_2 equivalent)

Year	4 B Total cropland	4.B.1 Cropland remaining cropland	4.B.2 Land converted to cropland	4.B.2.2 Grassland converted to cropland	4.B.2.5 Other land converted to cropland	4.B.2.2 Grassland converted to cropland (N2O converted into CO2 equivalents)
1988	-1082.32	-1121.39	39.07	863.86	-824.80	67.12
1989	-892.12	-931.40	39.28	862.96	-823.68	67.09
1990	-673.84	-714.04	40.19	862.79	-822.59	67.08
1991	-500.60	-540.96	40.36	861.86	-821.50	67.07
1992	-391.46	-432.11	40.65	861.09	-820.44	67.05
1993	-335.71	-378.82	43.11	862.55	-819.44	67.06
1994	-283.01	-327.53	44.52	862.92	-818.40	67.07
1995	-189.99	-236.71	46.72	863.56	-816.83	67.08
1996	-75.72	-123.31	47.59	864.68	-817.09	67.10
1997	-11.95	-60.33	48.38	864.77	-816.39	67.11
1998	-29.84	-77.24	47.41	866.31	-818.90	67.12
1999	-77.83	-124.53	46.70	868.13	-821.43	67.15
2000	715.05	657.76	57.29	890.00	-832.71	67.47

Year	4 B Total cropland	4.B.1 Cropland remaining cropland	4.B.2 Land converted to cropland	4.B.2.2 Grassland converted to cropland	4.B.2.5 Other land converted to cropland	4.B.2.2 Grassland converted to cropland (N2O converted into CO2 equivalents)
2001	717.82	637.94	79.89	895.16	-815.27	67.79
2002	736.17	633.76	102.41	900.31	-797.90	68.11
2003	822.48	697.61	124.86	905.47	-780.60	68.44
2004	783.31	636.07	147.24	910.62	-763.38	68.76
2005	829.23	659.68	169.55	915.77	-746.22	69.08
2006	759.91	568.13	191.78	920.93	-729.14	69.40
2007	714.64	500.70	213.94	926.08	-712.14	69.73
2008	699.52	463.15	236.37	932.76	-696.39	70.08
2009	644.19	385.73	258.46	939.15	-680.69	70.42
2010	590.57	310.46	280.12	945.19	-665.07	70.76
2011	513.00	211.45	301.55	951.04	-649.49	71.09
2012	499.50	176.74	322.76	956.72	-633.96	71.43
2013	809.78	466.45	343.34	961.90	-618.56	71.75
2014	845.07	491.50	353.57	956.93	-603.36	71.90

6.4.2 INFORMATION ON THE APPROACHES USED FOR PRESENTING THE DATA FOR THE AREAS AND THE DATABASE FROM THE LAND-USE USED OF THE INVENTORY.

Information on total Cropland and Grassland area is available from different data sources during the years. The National Statistical Yearbooks provide information on CL and GL areas over the period 1988-2000. The data shows a steady increase in the CL area and a decrease in GL for the period 1988-1999. However, in order to smooth annual variability in LUCs in CL and GL an interpolation method between 1988-1999 has been used. The balance of the territory of Bulgaria based on orthophotoimages has been available since 2010. To ensure a full time-series interpolation between the years 1999 and 2010 has been applied. Like this, the time series has been divided into two periods which actually represent the land area pattern in these categories.

As regards reporting of LUCs, there is no LUCs from forests to CL or GL. Any conversions and re-conversions from wetlands and settlements to cropland and grassland are considered as unlikely. Thus, it has been considered that the only possible change from other land use to cropland and grassland is between these categories and OL. The agricultural statistics (BANSIK) provides information on LUCs between cropland and grassland as well as between annual and perennial crops and in reverse for a period of 2000-2014.

The LUCs to cropland and grassland for the years before 2000 are unknown. Therefore, the LUCs between CL, GL and OL for this period have been estimated in order to fit the trend in the area.

6.4.3 METHODOLOGY

6.4.3.1 Cropland remaining Cropland (4.B.1.)

6.4.3.1.1 Changes in the carbon stocks in the living biomass

The change in biomass is only estimated for perennial woody crops. For annual crops, increase in biomass stocks in a single year is assumed equal to biomass losses from harvest and mortality in that same year - thus there is no net accumulation of biomass carbon stocks. The estimates of the change in carbon in perennial biomass follow the approach for estimating the annual rates of growth and loss which is recognised as Tier 1 method according to 2006 IPCC Guidelines. There is no national data on the dynamics of the biomass in the perennials influenced by the changes in the land use. According to the 2006 IPCC Guidelines the perennials accumulate biomass through the first 30 years. Emissions from perennials occur in the year of their clearing, assuming that annually 3,33% of the area of perennials are being replanted.

The area of the perennials over the time series ranges from 296 kha to 199 kha. In general there is a trend of decrease in their area. The changes are as a result of the reorganization that took place in the Bulgarian agriculture and especially in land ownership. To determine the annual change in the biomass carbon stock of the perennials the following equation has been used:

$$\begin{aligned}&\text{Annual change in the biomass carbon stock}\\&\quad= (\text{area of the perennials remaining perennials}\\&\quad\cdot \text{coefficient of accumulation of carbon})\\&\quad- \ (\text{area of the perennials 30 year earlier}^{1} \ \cdot 0.033\\&\quad\cdot \text{coefficient of accumulation of biomass});\end{aligned}$$

$$^{1}\ \text{excluding area lost through land} - \text{use change}$$

For the aboveground biomass stock at maturity the value 63 tonnes C.ha-1 has been adopted, and for the annual accumulation - 2,1 tonnes $C.ha^{-1}.y^{-1}$ (2006 IPCC Guidelines).

Table 242 Accumulation and loss of carbon in the aboveground biomass and period of clearing of perennials using the 2006 IPCC Guidelines default method

Climatic zone	Aboveground biomass C stock at maturity (tonnes C/ ha)	Period of clearing (years)	Annual accumulation of C in the aboveground biomass (tonnes C/ha/yr	Loss of carbon in the aboveground biomass (tonnes C/ha/yr)	Uncertainty
Temperate (all humidity regimes)	63	30	2,1	63	±75

6.4.3.1.2 Changes in the carbon stock in the biomass of perennials converted to annual crops

The annual change in biomass C stock is equal to the area of the converted lands ($A_{Conversion}$), multiplied by the carbon stock in the biomass of the perennials ($L_{Conversion}$) plus the changes in the carbon stock in the biomass during the first year after the conversion (ΔC_{Growth}).

$$The\ annual\ change\ \ of\ carbon\ stock\ in\ biomass = A_{conversion}(L_{conversion} + \Delta C_{growth})$$

where,

$L_{conversion} = C_{after} - C_{before}$

$A_{conversion}$ – area of the lands converted to annual crops, ha yr^{-1}

$L_{conversion}$– carbon stock in the biomass of lands which were converted to annual crops, tonnes C ha-1

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha-1

For Bulgaria ΔC_{Growth} has been calculated on the basis of the NSI's yield data for annual crops (cereals, industrial crops, vegetables, fodder crops) for 1995, 2000 and 2005. The absolutely dry weight of these crops was corrected with national coefficients (Krachunov, I, Al. Alexandrov, 2007). To obtain the total biomass of the plants for the expansion from the yield biomass to the total biomass the following coefficients[33] have been used (Table 243). The expansion factors for the rest of the aboveground biomass stem from Austria and the root–to-shoot ratios - from US. Since both countries belong like Bulgaria to the temperate region, they are considered as appropriate for Bulgarian conditions.

Table 243 Coefficients used for calculating the total biomass of the annual crops

Crop	Rest of aboveground biomass (in % of yield biomass)	Aboveground/belowground ratio	Root-to–shoot ratio
wheat	100	-	0,21
rye	140	-	NE
barley	110	-	1,02
oats	150	-	0,4
maize	140	-	0,18
fied peas	100	-	NE
rape	210	-	NE
sunflower	250	-	0,06
sugar beet	80	-	0,43
fodder beet	30	-	NE
potato	30	-	0,07
soya	150	-	0,15
corn silage	20	-	0,18
lucerne	10	-	NE
red clover	10	-	NE
cotton		0.4	0,17
rice		0.4	0,46
peanuts		0.4	0,07
tabacco		0.6	0,8

To estimate the total, the yield biomass is expanded with a coefficient for the rest of the aboveground biomass. After that the aboveground biomass is expanded to the total biomass with the root-to-shoot ratios. An average weighed mean of the cropland biomass was

[33] The expansion factors according to Bodenfruchtbarkeitsbeirat 2001 (pers. comm.)
Root-to-shoot ratios are published by West, T.O., 2008

calculated then on basis of the yields of the individual crops in Bulgaria for single years - ΔC_{Growth} = 3 tonnes C ha-1.

The changes in the carbon stock immediately after the conversion is assumed to be 0 as the biomass is taken away (C_{After}=0).

The value of 63 tonnes C/ha (C_{Before}) (2006 IPCC Guidelines) is used for the carbon stock immediately before the conversion.

6.4.3.1.3 Changes in the carbon stock in the biomass of annual crops converted to perennials

To calculate the annual change of carbon in living biomass in annual crops converted to perennial the same equation as described in chapter 6.4.3.1.2. For the annual increase of the carbon stock in the biomass of the perennials the value 2.1 tonnes C $ha^{-1}y^{-1}$ is used (for each year of the transition period) given in the 2006 IPCC GL.. The value 3 tonnes C ha^{-1} (item 6.4.3.1.2.) is used for the loss of carbon from the biomass of annual crops.

The annual change in the carbon stock of the biomass is equal to the area of the converted lands for a transition period of 20 years ($A_{Conversion}$) multiplied by the annual carbon stock growth of the perennial biomass (ΔC_{Growth} = 2.1 tonnes C ha^{-1}). For the biomass losses the actual annual land use change area annual to perennial is multiplied by the biomass carbon stock of annual crops.

$$Annual\ change\ in\ carbon\ stock\ in\ biomass = \left(area\ of\ the\ converted\ lands\ for\ 20\ yeats \cdot \Delta C_{growth}\right) + \left(actual\ annual\ area\ of\ conversion \cdot L_{conversion}\right)$$

where,

$$L_{conversion} = C_{after} - C_{before}$$

$L_{conversion}$– carbon stock in the biomass of lands which were converted to annual crops, tonnes C ha^{-1}

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha^{-1}

Change of the carbon stock immediately after the conversion is considered to be 0 as the biomass is taken away (C_{After} =0).

For the carbon stock immediately before the conversion the value calculated for Bulgaria is used: 3 tonnes C $ha^{-1}y$ (item 6.4.3.1.2).

6.4.3.1.4 Changes in the carbon stock in soils of croplands remaining croplands

The assessment of the carbon stock in soil is performed at 0-40 cm. The carbon stock of the plant residues on the surface (dead organic matter) and the changes in the non-organic carbon (in the carbonate minerals) are not estimated. The estimates of carbon stock changes in soils are carried out only for mineral soils. The emissions of organic soils are not assessed, because there is no peat extraction or other type of impact on Histosols under annual crops and perennials.

In the period after 1990 Bulgaria is witnessing substantial changes in the land ownership and worsening of the agricultural practices. We could assume that this has affected the emissions/removals of carbon in the soils. There are no representative, official data concerning the impact of the changes that happened in the management of the lands on the stock of organic carbon in the soils. There is no information also for the exact size of the areas which have been affected by the changes in the soils. Due to that an assessment of emissions/removals of carbon by mineral soils in croplands which remain croplands is not carried out.

Source of information for the contents of organic carbon in cropland and grassland soils is the National System for Environment Monitoring (EAEW-MOEW). Taking into account the representativeness of the data and the purpose of the estimate, the reference soil organic carbon stock in cropland and grassland soils has been evaluated based on dataset from a full soil inventory carried out in 2012. The dataset on soil contains information on the soil chemistry and physical parameters from soils under different land use (e.g cropland and grassland). The measurements of the soil's parameters are made for layers (0-20cm, 20-40cm.). The content of organic matter is presented in percentage. In order to estimate the organic carbon stock (tC/ha), data on bulk density is needed. However, the data on bulk density is available only for the upper layer. Therefore, the bulk density of the soil from the layer 20-40 cm has been estimated using the Alexander B (1980) PTF function[34]:

$$\rho_{\mathrm{b}} = 1.72 - (0.294 - org.C,\%)^{0.5}$$

Thus, the organic carbon stock has been calculated for all samples from the dataset. Then, the samples have been grouped by land use and soil type and an average value for carbon stock in the different soil types has been derived. Data on the area of the particular soil types under cropland or grassland management is available according to Soil map of Bulgaria (1:400 000) and Corine land cover data (1:100 000). Therefore, the reference soil organic carbon stock in soils of cropland and grassland has been derived as a weighted mean from the averages SOCs of every particular soil types under cropland and grassland categories. The reference soil organic carbon stocks in cropland (0-40 cm) are 89.92 tC/ha for annual crops and 76.52 tC/ha (STD – 21.05; CV – 27.51) for perennial crops. The statistics and the uncertainty associated with the evaluation of the reference stock in soils of annual crops are presented in the tables below. They are derived by using Monte Carlo analysis.

Table 244 Statistics of the evaluation of the reference carbon stock in soils of annual crops and its uncertainty assessment

statistics	value
Trials	10000
Min	46.890
Median	89.731
Mean	**89.920**
Max	136.662
Std. Dev.	**11.221**
Variance	125.906
Skewness	0.197

probability	value
0.025	68.954
0.05	72.043
0.1	75.904
0.25	82.111
0.5	89.731
0.75	97.121
0.9	104.325
0.95	109.061

[34] G.TAULYA et al., 2005 Validation of pedotrasfer functions for soil bulk density estimation on a Lake Victoria Basin soilscape

statistics	value
Kurtosis	0.114

probability	value
0.975	113.291

uncertainty	**-23.3**	**26.0**

6.4.3.1.4.1 Changes in the carbon stock in the soils of lands with perennials converted to annual crops

The average annual change in the carbon stock in mineral soils of perennials, converted to annual crops (ΔSOC_{20}) has been calculated using the equation:

$$\Delta SOC_{20} = \frac{[(SOC_0 - SOC_{0-T})]}{20} = 0.67\ tC/ha$$

where,

SOC_0 – carbon stocks in the soils after 20 years of transition = 89.92 t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 76.52 t C/ha.

To find the net change in the carbon stock in the soil, the annual change (ΔSOC_{20}) has been multiplied by the converted area.

6.4.3.2 Changes in the carbon stock in the soils of lands under annual croplands converted to perennials

The average change in the carbon stock in mineral soils of lands under annual crops converted to perennials (ΔSOC_{20}) has been calculated using the equation:

$$\Delta SOC_{20} = \frac{[(SOC_0 - SOC_{0-T})]}{20} = -0.67\ tC/ha$$

where,

SOC_0 – carbon stocks in the soils after 20 years of transition = 76.52 t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 89.92 t C/ha.

To find the net change in the carbon stock in the soil, the annual change (ΔSOC_{20}) has been multiplied by the converted area.

6.4.3.2.1 Liming

There is no liming after 1987.

6.4.3.3 Lands converted to croplands (4.B.2.)

6.4.3.3.1 Changes in the carbon stock in the living biomass in lands converted to annual crops

The calculation of the annual changes of the carbon stock in the living biomass in lands converted to annual crops is calculated using the following equations:

$$The\ annual\ change\ \ of\ carbon\ stock\ in\ biomass = A_{conversion}(L_{conversion} + \Delta C_{growth})$$

where,

$L_{conversion} = C_{after} - C_{before}$

$A_{conversion}$ – area of the lands converted to annual crops, ha yr-1

$L_{conversion}$– carbon stock in the biomass of lands which were converted to annual crops, tonnes C ha-1

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha-1

The the carbon stock in the living biomass after the conversion (C_{After}) is equal to 0. The biomass stock before the conversion is 6.07 t/ha for GL and 4.5 t/ha for OL, which represent the average annual stock in biomass of GL and OL. The average annual biomass stock in GL is calculated on basis of statistical data (National Statistical Yearbook) for the average yield of hay from grasslands for a period of 10 years (1995-2005). The values were recalculated to the absolutely dry matter (Krachunov, I., Alexandrov, A, 2007) and expanded with the remaining aboveground stubble biomass (1.6 t ha-1) (according to 2006 IPCC GL) and with a coefficient for the root-to-shoot ratio 2.8 (according to 2006 IPCC GL). The figure of average biomass carbon stock in OL is derived from results of a case study under the project "Land-use and management impacts on carbon sequestration in mountain ecosystems" under the framework of the Bulgarian-Swiss Research Programme ("BSRP"). The projects is conducted by Forest Institute (Bulgarian Academy of Science).

The annual accumulation of carbon in the annual cropland biomass in the first year after the conversion (ΔC_{Growth}) is = 3,0 tonnes C ha-1. The approach for determining the ΔC_{Growth} is described in section 6.4.3.1.2.

The quantity of carbon in the biomass is adopted by default -0,5 t C/t absolute dry matter (2006 IPCC).

6.4.3.3.1.1 Changes of the carbon stock in the living biomass lands converted to perennials.

For perennials a value for the average annual growth of the biomass has been used according to IPCC GPG (2,1 tC/ha y), for the whole period of conversion – 20 years.

$$Annual\ change\ in\ carbon\ stock\ in\ biomass = \left(area\ of\ the\ converted\ lands\ for\ 20\ yeats \cdot \Delta C_{growth}\right) + (actual\ annual\ area\ of\ conversion \cdot L_{conversion})$$

where,

$L_{conversion} = C_{after} - C_{before}$

$L_{cnversion}$– carbon stock in the biomass of lands which were converted to annual crops, tonnes C ha-1

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha-1

To calculate the changes in the carbon stocks in the biomass the following values were used:

ΔC_{growth} = 2,1 tC/ha y (IPCC GPG)

C_{after}= 0

C_{before} = 6.07 t C/ha, calculated for Bulgaria (for GL) and 4.5 t/ha for OL.

6.4.3.3.1.2 Changes in the carbon stock in soils of lands converted to annual crops

To assess the emissions/removals of carbon specific data for the country has been used. The reference carbon stock in grassland soils (103.57) has been calculated as described in 6.4.3.1.4. The statistics and the uncertainty associated with the evaluation of the reference stock are presented in the table below. They are derived using Monte Carlo analysis.

Table 245 Statistics of the evaluation of the reference carbon stock in grassland's soil and its uncertainty assessment

statistics	value
Trials	10000
Min	37.778
Median	103.366
Mean	**103.566**
Max	172.060
Std. Dev.	**17.058**
Variance	290.976
Skewness	-0.015
Kurtosis	-0.063

probability	value
0.025	70.234
0.05	75.803
0.1	81.742
0.25	92.022
0.5	103.366
0.75	115.104
0.9	125.669
0.95	131.326
0.975	136.872

uncertainty	**-32.2**	**32.2**

The average annual change in the carbon stock in the soils of lands converted to annual crops (ΔCLG_{Soils}), is calculated using the following equation:

$$\Delta C_{LGsoil} = \frac{[(SOC_0 - SOC_{0-T})]}{20}$$

where,

ΔC_{LGsoil} - annual change in carbon stock in soils in land converted to CL

SOC_0 – carbon stocks in the soils after 20 years of transition = 89.92 t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 103.57 t C/ha and 69 t/ha.

T – period assessed, years (equal to 20 years),

The change in the carbon stock in soils of lands converted to annual crops was calculated by multiplying the annual change in carbon stock by the area of the converted territory.

6.4.3.3.1.3 Changes in the carbon stock in soils of lands converted to perennials

To assess the emissions/removals of carbon specific data for the country has been used.

The average annual change in the carbon stock in the soils of grassland (ΔCLG_{Soils}), converted to perennials is calculated using the following equation:

$$\Delta C_{LGsoil} = \frac{[(SOC_0 - SOC_{0-T})]}{20} =$$

where,

ΔC_{LGsoil} - annual change in carbon stock in soils in land converted to CL

SOC_0 – carbon stocks in the soils after 20 years of transition = 53 t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 103.57 t C/ha for grassland and 69 t/ha for other land.

T – period assessed, years (equal to 20 years),

The change in the carbon stock in soils of lands converted to perennials was calculated by multiplying the annual change in carbon stock by the area of the converted territory.

6.4.3.3.1.4 N_2O emissions in grasslands converted to croplands

N_2O emissions from land-use conversions to cropland as a result of soil oxidation has been estimated based on tier 1 approach and equations 11.1, 11.2, 11.8. (2006 IPCC Guidelines).

The ratio C/N in the mineral soils is determined on the basis of data from the National network for environmental monitoring (EAEW-MOEW, 2012), which has been recalculated for Submission 2014.

For annual crops C/N = 10,00
For perennials C/N = 9.90

6.4.4 UNCERTAINTY ASSESSMENT

The uncertainties associated with the estimates of CO_2 emissions and removals have been calculated using both Tier 1. Tier 1 method combines the uncertainties by means of the error propagation equations (IPCC Good Practice Guidance, IPCC, 2003). The input uncertainties, associated with the different emission factors and the activity data as well as the sources of information (default values, empirical data or expert judgment) are presented in Table 238. The total uncertainty for Cropland remaining cropland is ±184% while for Land converted to Cropland is ±415%.

6.4.5 DATA VERIFICATION CATEGORY-SPECIFIC QA/QC AND VERIFICATION, IF APPLICABLE

See Chapter 4.11

6.4.6 CATEGORY-SPECIFIC RECALCULATIONS

The following recalculations have been made for Submission 2015:

- Changes in the total area of cropland across the time series due to missed areas of cropland from forestry fund
- Changes in the total cropland area due to complete new interpretation of the activity data. This change affected also area pattern of GL, SM and OL
- Reporting of LUC from OL to CL

- Recalculation of the LUCs to cropland
- N_2O emissions from land-use conversions to cropland as a result of soil oxidation

6.4.7 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

For Cropland category it is planned to continue working on the land-use classification and representation across the time series.

6.5 GRASSLAND (4.C)

6.5.1 DESCRIPTION OF THE CATEGORY

Grassland in Bulgaria cover an area of 1 783 220 ha which represents 16 % of the country's territory. Over the reporting period there is a trend of gradual decrease in grassland areas. In the 2014 the area of grassland is by 14 % lower compared to the base year. In 2014, there is a sharp increase in the grassland area.

The evaluation of the emissions/removals from Grassland category is based on estimates of the changes in the carbon stocks in living biomass and soil.

Some management practices, like burning of stubble-fields are forbidden in Bulgaria. There is no peat extraction, draining of peat soils or other anthropogenic activity which affects their water regime, the temperature on their surface and the species. Due to these reasons the carbon stock change in Histosols is not subject to evaluation.

The area of Grassland category (e.g Grassland remaining grassland 4.C.1 and Lands converted to grassland 4.C.2) and its associated emissions/removals are presented in the tables below.

Table 246 Categories assessed for emissions/removals

Categories
4.C. Grassland-total
4.C.1. Grassland remaining grassland
4.C.2. Land converted to grassland
4.C.2.1. Forest land converted to grassland
4.C.2.2. carbon stock change in living biomass of grassland
4.C.2.3. carbon stock change due to changes in organic matter input (harvest residues) to grassland soils
4.C.2.4. Settlements converted to grassland
4.C.2.5. Other land converted to grassland

Table 247 Land use and land-use changes in the category Grassland (kha) (other land- use changes are not occurring)

year	4.C Grassland Total	4.C.1 Grassland remaining Grassland	4.C.2 LUC in Grassland	4.C.2.2.a Annual cropland in Grassland	4.C.2.2.b Perennial cropland in Grassland	4.C.2.5 OL converted to GL
1988	2113.42	1857.81	255.61	15.11	135.99	104.51
1989	2103.77	1848.09	255.69	15.12	136.06	104.51
1990	2094.13	1838.32	255.81	15.13	136.20	104.48
1991	2084.48	1828.49	255.99	15.16	136.41	104.42

year	4.C Grassland Total	4.C.1 Grassland remaining Grassland	4.C.2 LUC in Grassland	4.C.2.2.a Annual cropland in Grassland	4.C.2.2.b Perennial cropland in Grassland	4.C.2.5 OL converted to GL
1992	2074.83	1818.61	256.23	15.19	136.70	104.34
1993	2065.19	1808.68	256.51	15.23	137.05	104.23
1994	2055.54	1798.70	256.84	15.27	137.47	104.09
1995	2045.89	1788.67	257.23	15.32	137.84	104.07
1996	2036.25	1778.58	257.67	15.36	138.28	104.02
1997	2026.60	1768.43	258.17	15.40	138.57	104.20
1998	2016.95	1758.22	258.73	15.44	138.94	104.36
1999	2007.30	1747.95	259.35	15.49	139.38	104.48
2000	1983.74	1718.99	264.76	28.44	134.02	102.30
2001	1960.19	1690.03	270.15	41.40	128.65	100.10
2002	1936.63	1661.10	275.53	54.36	123.29	97.88
2003	1913.07	1632.18	280.89	67.31	117.93	95.65
2004	1889.51	1603.27	286.23	80.27	112.57	93.40
2005	1865.95	1574.39	291.56	93.23	107.20	91.13
2006	1842.39	1545.52	296.87	106.19	101.84	88.85
2007	1818.83	1516.98	301.85	119.11	96.19	86.55
2008	1795.27	1488.17	307.10	132.07	90.83	84.20
2009	1771.71	1459.43	312.28	145.02	85.40	81.87
2010	1748.15	1430.75	317.40	157.96	79.90	79.55
2011	1724.59	1402.15	322.44	170.89	74.32	77.23
2012	1701.03	1373.63	327.41	183.82	68.67	74.92
2013	1702.73	1357.40	345.33	196.74	62.96	85.63
2014	1783.22	1342.27	440.94	209.19	57.23	174.52

Table 248 Emissions (+)/removals of CO_2 in Grassland Remaining Grassland and Lands Converted to Grassland (Gg CO_2 equivalent) (other land use changes are not occurring)

year	4 C Grassland Total	4.C.1 Grassland remaining grassland	4.C.2 Land converted to grassland	4.C.2.2 Cropland converted to grassland	4.C.2.5 Other land converted to grassland
1988	16.38	0.00	16.38	709.73	-693.34
1989	31.00	0.00	31.00	724.16	-693.17
1990	44.97	0.00	44.97	737.78	-692.80
1991	59.84	0.00	59.84	752.15	-692.30
1992	74.47	0.00	74.47	766.12	-691.65
1993	86.98	0.00	86.98	777.74	-690.76
1994	100.80	0.00	100.80	790.53	-689.73
1995	86.31	0.00	86.31	776.62	-690.31
1996	99.60	0.00	99.60	789.46	-689.86
1997	65.18	0.00	65.18	757.52	-692.34
1998	78.15	0.00	78.15	771.30	-693.15
1999	90.91	0.00	90.91	784.69	-693.78
2000	-1004.58	0.00	-1004.58	-338.30	-666.29
2001	-996.37	0.00	-996.37	-344.13	-652.24
2002	-988.05	0.00	-988.05	-349.96	-638.09
2003	-979.63	0.00	-979.63	-355.79	-623.84
2004	-971.10	0.00	-971.10	-361.62	-609.49
2005	-962.47	0.00	-962.47	-367.45	-595.02
2006	-953.73	0.00	-953.73	-373.28	-580.45
2007	-943.40	0.00	-943.40	-377.63	-565.77
2008	-934.27	0.00	-934.27	-383.46	-550.82
2009	-924.84	0.00	-924.84	-388.91	-535.93
2010	-915.12	0.00	-915.12	-394.02	-521.10

year	4 C Grassland Total	4.C.1 Grassland remaining grassland	4.C.2 Land converted to grassland	4.C.2.2 Cropland converted to grassland	4.C.2.5 Other land converted to grassland
2011	-905.04	0.00	-905.04	-398.73	-506.31
2012	-894.62	0.00	-894.62	-403.06	-491.57
2013	-1043.20	0.00	-1043.20	-407.05	-636.16
2014	-2062.37	0.00	-2062.37	-401.50	-1660.87

6.5.2 INFORMATION ON THE APPROACHES USED TO PRESENT THE DATA ON THE AREAS AND THE DATABASE ON THE LAND-USE USED FOR THE INVENTORY

The approach used for deriving the area information for sub-categories 4.C.1 and 4.C.2 is described in 6.4.2

6.5.3 METHODOLOGY

6.5.3.1 Grassland Remaining Grassland (4.C.1.)

6.5.3.1.1 Changes of the carbon stock in the living biomass

In line with 2006 IPCC Guidelines (Tier 1) the biomass in the grassland remaining grassland is not a source of emissions.

6.5.3.1.2 Changes of the carbon stock in soils

In accordance with the data available in the country it is assumed that there are no changes in the organic carbon stock in the soils of grassland remaining grassland. There is no liming of grassland in Bulgaria.

6.5.3.2 Lands converted to grasslands (4.C.2)

6.5.3.2.1 Forests converted to grassland

This category is not assessed as during the reporting period forests were not converted to grassland.

6.5.3.2.2 Lands converted to grassland

6.5.3.2.2.1 Changes in the carbon stock in the living biomass of lands converted to grassland

The estimates of the changes in biomass carbon stock are based on country-specific data. The average value of the aboveground and belowground biomass of the annual crops is 3 t C ha (Section 6.4.3.3).

The carbon stock in the living biomass of grassland has been estimated. Source of information for the aboveground biomass in grassland is the National Statistical Yearbook, Agroststistics, where the information for the hay yield is published. To recalculate the absolute dry matter a coefficient of 0.8 was used (Krachunov, I, Al. Alexandrov, 2007). The total biomass was calculated after a correction and adding of the rest of the aboveground stubble biomass and the root-to-shoot ratio.

The equation below has been used to aggregate the annual growth of the total stock of the biomass in grasslands (aboveground and belowground)

$$B_{total} = \left[(B_{cut} \cdot 0.5) + (B_{peak\ aboveground} \cdot 0.5)\right] \cdot (1 + R)$$

where:

B_{total} – total biomass (aboveground and belowground), tonnes d.m.

B_{cut}- yield biomass, tonnes d.m =1.8

$B_{peak\ aboveground}$ – biomass of the growth, tonnes d.m =1.6 (according to 2006 IPCC Guidelines)

R - root-to-shoot ratio = 2.8 (according to 2006 IPCC Gidelines)

To calculate the annual carbon stock changes in the living biomass of lands converted to grassland the following equation has been used:

$$The\ annual\ change\ \ of\ carbon\ stock\ in\ biomass = A_{conversion}(L_{conversion} + \Delta C_{growth})$$

where,

$L_{conversion} = C_{after} - C_{before}$

$A_{conversion}$ – annual area of the lands converted to grassland, ha yr-1

$L_{conversion}$– carbon stock in the biomass of lands which were converted to grassland, tonnes C ha-1

ΔC_{growth} – change of the carbon stock in the biomass in the first year after the conversion, tonnes C ha-1

ΔC_{growth} = 6.4 tC/ha y (2006 IPCC GL)

C_{after}= 0

C_{before} = 3 t C/ha, for annual crops (calculated for Bulgaria)

C_{before} = 63 tC/ha for perennials (2006 IPCC Gudelines)

C_{before} = 4.5 tC/ha for Other lands

6.5.3.2.2.2 Changes in the carbon stock in soils of lands converted to grassland

The reference carbon stock in soils of grassland and cropland has been calculated as described in 6.4.3.1.4. and 6.4.3.3.1.2. The annual change in the carbon stock in soils of lands under annual crops (ΔCLG_{Soils}), converted to grassland is calculated using the following equation:

$$\Delta C_{LGsoil} = \frac{[(SOC_0 - SOC_{0-T})]}{20}$$

where,

ΔC_{LGsoil} - annual change in carbon stock in soils in land converted to GL

SOC_0 – carbon stocks in the soils after 20 years of transition = 103.57 t C/ha,

SOC_{0-T} – carbon stock in the soils before the conversion = 89.92 t C/ha for annual crops, 76.5 t C/ha for perennials and 69 tC/ha for other lands.

T – period assessed, years (equal to 20 years),

The change in the carbon stock in soils of lands under annual crops converted to grassland has been calculated by multiplying annual change in carbon stock in soils by the area of the converted territory.

6.5.4 UNCERTAINTY ASSESSMENT

The uncertainties associated with the estimates of CO_2 emissions and removals have been calculated using both Tier 1. Tier 1 method combines the uncertainties by means of the error propagation equations (IPCC Good Practice Guidance, IPCC, 2003). The input uncertainties, associated with the different emission factors and the activity data as well as the sources of information (default values, empirical data or expert judgment) are presented in Table 238. The total uncertainty for Land converted to Grassland is ±445%.

6.5.5 DATA VERIFICATION CATEGORY-SPECIFIC QA/QC AND VERIFICATION, IF APPLICABLE

See Chapter 4.11

6.5.6 CATEGORY-SPECIFIC RECALCULATIONS

The following recalculations have been made for Submission 2016:

- Changes in the total area of grasslands over the reporting period due to missed areas of grassland from forestry fund and some minor technical errors
- Changes in the total grassland area due to complete new interpretation of the activity data. This change affected also area pattern of CL, SM and OL
- Recalculation of the LUCs to grasslands
- Reporting of LUC from OL to GL
- Update of the estimate for annual carbon stock in biomass under GL according to updated value (2006 IPCC Guidelines) for coefficents used in equation

6.5.7 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

See Chapter 4.12

6.6 WETLANDS (4.D)

Due to the lack of information it is assumed that the carbon stocks in the biomass, the dead organic matter and the soils of the surface waters is equal to 0.

The areas of the wetlands range between 213 to 230 kha over the reporting period. Table 249 presents data on the area of wetlands.

Table 249 Land- use and land- use changes in the category Wetlands (kha) (other land use changes are not occurring)

year	4.D Wetlands - Total	4.D.1 Wetlands remaining wetlands	4.D.2 LUC in wetlands	4.D.2.2.a Annual Cropland in wetlands	4.D.2.5 Other land in wetlands
1988	213.50	213.50	0.00	0.00	0.00
1989	213.50	213.50	0.00	0.00	0.00
1990	213.50	213.50	0.00	0.00	0.00
1991	213.50	213.50	0.00	0.00	0.00
1992	213.50	213.50	0.00	0.00	0.00
1993	213.50	213.50	0.00	0.00	0.00
1994	213.50	213.50	0.00	0.00	0.00
1995	214.00	213.50	0.49	0.44	0.05
1996	214.49	213.50	0.99	0.89	0.10
1997	215.49	213.50	1.99	1.80	0.19
1998	216.49	213.50	2.99	2.71	0.28
1999	217.50	213.50	3.99	3.63	0.37
2000	218.50	213.50	5.00	4.54	0.46
2001	219.50	213.50	6.00	5.44	0.56
2002	220.50	213.50	7.00	6.34	0.66
2003	221.50	213.50	8.00	7.23	0.77
2004	222.50	213.50	9.00	8.12	0.89
2005	223.51	213.50	10.00	9.00	1.01
2006	224.51	213.50	11.01	9.87	1.13
2007	225.51	213.50	12.01	10.74	1.27
2008	226.51	213.50	13.01	11.60	1.41
2009	227.51	213.50	14.01	12.46	1.55
2010	228.52	213.50	15.01	13.31	1.70
2011	229.52	213.50	16.02	14.16	1.85
2012	230.52	213.50	17.02	15.00	2.01
2013	230.73	213.50	17.23	15.18	2.05
2014	230.94	213.50	17.44	15.36	2.08

It was assumed that during the period of inventory the conversion to wetlands comes out from annual crops and other lands. The emissions of carbon dioxide from the wetlands are presented in Table 250.

Table 250 Emissions (+)/removals of CO2 in Wetlands Remaining Wetlands and Lands Converted to Wetlands (Gg CO_2 equivalent)

year	4.D Wetlands Total	4.D.1 Wetlands remaining Wetlands	4.D.2 Land converted to Wetlands	4.D.2.2 Cropland converted to Wetlands	4.D.2.5 Other land converted to Wetlands
1988	0.00	NO	0.00	0.00	0.00
1989	0.00	NO	0.00	0.00	0.00
1990	0.00	NO	0.00	0.00	0.00
1991	0.00	NO	0.00	0.00	0.00
1992	0.00	NO	0.00	0.00	0.00
1993	0.00	NO	0.00	0.00	0.00
1994	0.00	NO	0.00	0.00	0.00
1995	13.66	NO	13.66	12.23	1.43
1996	21.62	NO	21.62	19.61	2.01
1997	43.60	NO	43.60	39.68	3.92

year	4.D Wetlands Total	4.D.1 Wetlands remaining Wetlands	4.D.2 Land converted to Wetlands	4.D.2.2 Cropland converted to Wetlands	4.D.2.5 Other land converted to Wetlands
1998	59.75	NO	59.75	54.76	5.00
1999	75.92	NO	75.92	69.90	6.02
2000	92.12	NO	92.12	84.81	7.31
2001	108.28	NO	108.28	99.63	8.65
2002	124.43	NO	124.43	114.37	10.06
2003	140.55	NO	140.55	129.01	11.55
2004	156.65	NO	156.65	143.55	13.10
2005	172.73	NO	172.73	158.00	14.73
2006	188.79	NO	188.79	172.36	16.43
2007	204.83	NO	204.83	186.63	18.20
2008	220.84	NO	220.84	200.80	20.04
2009	236.83	NO	236.83	214.88	21.95
2010	252.81	NO	252.81	228.87	23.94
2011	268.76	NO	268.76	242.77	25.99
2012	284.68	NO	284.68	256.57	28.11
2013	278.64	NO	278.64	252.19	26.45
2014	281.98	NO	281.98	255.22	26.77

Note: The reporting of the subcategory "wetland remaining wetland" follows Tier 1 – no changes in carbon stocks.

6.6.1 INFORMATION ON THE APPROACHES USED TO PRESENT THAT DATA FOR THE AREAS AND THE DATABASE FOR THE LAND-USE USED FOR THE INVENTORY

The data on total of Wetlands areas for single years (1994, 1996) has been obtain from the cadastral maps of the agricultural fund of Bulgaria (Balance by Type of Territories as per their Designation, Cadastre Agency) as well as data from the balance of the territory of Bulgaria based on orthophotoimages for the year 2012 and 2013. In order to cover the time series – interpolation has been applied. The wetlands area for 1996 according to the cadastral map is much lower than the wetlands area according to the balance of the territory based on orthophotoimages. The difference is about 30 kha. Such a dramatic increase in wetlands area has been considered as unlikely. Probably the observed increase is due to the different data sources used in the aggregation of the area data. However, the data from orthophotoimages has been considered as more reliable. Then, in order to level out the big increase in wetlands area a correction of the 1996 data on wetlands has been made. The correction coefficient of 12.38 kha is the net increase in wetlands from 1996 to 2012 according to Corine Land Cover data (1996-2006 CLC data and extrapolated to 2012) as it was reported in the previous submissions. The value of 12.38 kha has been added to the total wetlands area in 1996 and 1994 according to the cadastral map. Then the interpolation between 2012 and 1996 has been applied. The areas of wetlands for the years before 1994 have been considered to be the same as in 1994.

The LUCs to wetlands have been assumed to stem from cropland and other land. The determination of these land use categories as the possible land-use changes where the increase in wetlands may stem from is based on the last step from the hierarchical treatment of the data sources – that is data gaps. It has been considered that the shares of these individual land use categories to the observed increase in wetlands behave like the ratios of the total areas of these land use categories in Bulgaria. In its previous submission Bulgaria reported LUCs from forest land to wetlands due to probability reasons. It was assumed that the observed increase in wetlands suggests also deforestation for wetlands. This forest loss to wetlands was estimated as a share of forest land in the totals of forest land, cropland plus grassland (it was supposed that the wetlands increase comes from such lands). Actually the reported LUC from forestland to wetlands in the previous submissions of Bulgaria represented an overestimation of deforestation activity since all the information for forest loss due to changes in designation of forest was reported under LUCs to settlements (SM). Since the last improvements in area representation made for the Submission 2014 LUCs from forestland to wetlands were not calculated. According to experts from the ExFA, the changes of designation of forest in the years 1988-2012 have been associated with conversion only to SM. There is only one new dam lake (Tsankov kamak) which was built up in recent years but the forest loss associated with its construction works has been already reported in the 70's. Therefore, Bulgaria reports all information provided by the ExFA for forest loss across the time series as LUC associated with conversion to SM. The reported estimates of land-use changes from grassland to other land use categories (forestland and cropland), which are based on specific data and expert judgment, fit very well to the observed decrease in the total grassland area since the base year. Therefore, no land-use changes from grassland to wetlands have been assumed and reported.

6.6.2 METHODOLOGY

6.6.2.1 Lands converted to wetlands (4.D.2)

6.6.2.1.1 Changes in the carbon stock in living biomass of croplands converted to wetlands

The annual change in the carbon stock in the living biomass of croplands converted to wetlands is calculated using the following equation.

$$The\ annual\ change\ in\ the\ carbon\ stock = anual\ area\ of\ lands\ converted\ to\ wetlands \cdot (B_{after} - B_{before}) \cdot CF$$

where,

B_{before}– living biomass stock in lands before the conversion – 3.0 tC/ha for annual crops and 4.5 tC/ha for othe land.

B_{after} – living biomass immediately after the conversion, t d.m./ha (for TierI 1 = 0),

CF –carbon fraction in the dry matter (d.m.) (under Tier 1 = 0.5 t C/t d.m.).

6.6.2.1.2 Changes in the carbon stock in soils in lands converted to wetlands

Changes in the carbon stock in the soils when converting annual crops to wetland areas are calculated using the equation:

$$\Delta C_{wl} = A \cdot \frac{SOC_{\ after} - SOC_{before}}{20}$$

where:

A – area of the converted lands for a transition period of 20 years, ha.

SOC_{before} – carbon stock in the soil immediately before the conversion, tC/ha; for soils of annual crops 89.92 t C/ha and 69 tC/ha for other lands

SOC_{after} – carbon stock in the soil 20 years after the conversion, t C/ha. The conversion of carbon in the soils 20 years after the conversion is assumed to be 0.

6.6.3 UNCERTAINTY ASSESSMENT

The uncertainties associated with the estimates of CO_2 emissions and removals have been calculated using both Tier 1. Tier 1 method combines the uncertainties by means of the error propagation equations (IPCC Good Practice Guidance, IPCC, 2003). The input uncertainties, associated with the different emission factors and the activity data as well as the sources of information (default values, empirical data or expert judgment) are presented in Table 238. The total uncertainty for Land converted to Wetlands is ±25%.

6.6.4 DATA VERIFICATION CATEGORY-SPECIFIC QA/QC AND VERIFICATION, IF APPLICABLE

See Chapter 4.11

6.6.5 CATEGORY-SPECIFIC RECALCULATIONS

The following recalculations have been made for Submission 2016:

- Chages in the area distribution of the total LUCs to wetlands between annual cropland and other land, which are as a result of area recalculations in these two land-use categories

6.6.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

See Chapter 4.12

6.7 SETTLEMENTS (4.E)

Settlements cover an area of 527.64 kha in 2014, which represent 4.7% of the total territory of the country. The area of settlements has increased gradually over the period. The settlements area in 2014 is by 11% higher compared to the base year. The reporting of the subcategory "settlements remaining settlements" follows Tier 1 – no changes in carbon stocks. It is assumed that dead wood and litter do not exist in the settlements, therefore only emissions/removals from changes in living biomass and in soil have been calculated. The land-use changes to settlements origin from the categories Forests (data provided by the Executive Forest Agency), Cropland, Grassland (data provided by the Ministry of Agriculture and Food) and Other land.

Table 251 Land-use and land-use changes in the category Settlements (kha) (other land use changes are not occurring)

year	4.E SM Total	4.E.1 SM remaining SM	4.E.2 LUC in SM	4.E.2.1 Forest land in SM	4.E.2.2.a Annual Cropland in SM	4.E.2.2.b Perennial Cropland in SM	4.E.2.3 Grassland in SM	4.E.2.5 OL converted to SM
1988	471.78	431.60	40.18	2.31	22.32	1.42	11.54	2.59
1989	473.69	433.62	40.07	2.31	22.22	1.42	11.52	2.60
1990	475.59	435.63	39.96	2.24	22.17	1.43	11.52	2.61
1991	477.50	437.65	39.85	2.27	22.06	1.43	11.48	2.61
1992	479.41	439.66	39.75	2.40	21.90	1.42	11.41	2.60
1993	481.31	441.67	39.64	2.34	21.87	1.42	11.40	2.60
1994	483.22	443.69	39.53	2.31	21.83	1.42	11.38	2.60
1995	485.13	445.70	39.42	2.31	21.77	1.42	11.35	2.59
1996	487.03	447.72	39.32	2.31	21.72	1.41	11.31	2.57
1997	489.29	449.73	39.56	2.31	21.89	1.41	11.38	2.58
1998	491.55	451.74	39.80	2.31	22.06	1.41	11.44	2.58
1999	493.80	453.76	40.04	2.31	22.25	1.41	11.51	2.57
2000	496.06	455.77	40.28	2.31	22.43	1.41	11.57	2.57
2001	498.31	459.12	39.19	2.20	21.79	1.36	11.24	2.59
2002	500.57	462.14	38.42	2.21	21.29	1.33	10.99	2.62
2003	502.83	465.11	37.72	2.17	20.84	1.29	10.77	2.65
2004	505.08	468.18	36.90	2.13	20.32	1.25	10.50	2.69
2005	507.34	468.62	38.72	2.21	21.40	1.30	11.08	2.74
2006	509.59	468.89	40.70	2.24	22.59	1.35	11.72	2.79
2007	511.85	468.25	43.60	2.42	24.29	1.43	12.63	2.84
2008	514.11	466.26	47.84	3.13	26.56	1.52	13.80	2.84
2009	516.36	466.99	49.37	3.12	27.51	1.55	14.28	2.91
2010	518.62	464.83	53.79	3.37	30.13	1.67	15.65	2.97
2011	520.87	465.40	55.48	3.34	31.17	1.70	16.19	3.08
2012	523.13	467.46	55.68	3.32	31.25	1.69	16.23	3.19
2013	525.39	470.00	55.38	3.73	30.76	1.65	15.98	3.26
2014	527.64	473.17	54.47	3.81	30.09	1.61	15.63	3.34

Table 252 Emissions (+)/removals of CO_2 in Settlements remaining settlements and Lands converted to settlements (Gg CO_2 equivalent)

Year	4.E Settlements	4.E.1 Settlements remaining Settlements	4.E.2 Land converted to Settlements	4.E.2.1 Forests converted to Settlements	4.E.2.2 Cropland converted to Settlements	4.E.2.3 Grassland converted to Settlements	4.E.2.5 OL converted to Settlements
1988	711.64	NO	711.64	50.00	403.20	224.87	33.57
1989	709.37	NO	709.37	50.00	401.32	224.41	33.64
1990	698.48	NO	698.48	38.76	401.18	224.73	33.81
1991	709.22	NO	709.22	54.55	397.65	223.37	33.65
1992	720.22	NO	720.22	72.27	393.20	221.38	33.37
1993	691.48	NO	691.48	40.12	395.33	222.48	33.55
1994	693.68	NO	693.68	44.74	393.73	221.82	33.40
1995	698.38	NO	698.38	52.38	391.89	220.93	33.17
1996	696.20	NO	696.20	52.38	390.63	220.24	32.94
1997	707.40	NO	707.40	52.38	397.98	223.77	33.26
1998	710.87	NO	710.87	52.38	400.38	224.94	33.17
1999	714.36	NO	714.36	52.38	402.89	226.07	33.02
2000	720.29	NO	720.29	54.34	405.73	226.98	33.24
2001	655.53	NO	655.53	33.07	376.15	212.58	33.73
2002	668.04	NO	668.04	53.58	370.87	209.57	34.02
2003	649.75	NO	649.75	44.37	364.61	206.13	34.63
2004	635.08	NO	635.08	45.39	354.01	200.40	35.28
2005	743.64	NO	743.64	69.95	408.33	229.56	35.81
2006	773.01	NO	773.01	63.01	430.66	242.69	36.66
2007	867.00	NO	867.00	94.73	469.99	265.06	37.21

Year	4.E Settlements	4.E.1 Settlements remaining Settlements	4.E.2 Land converted to Settlements	4.E.2.1 Forests converted to Settlements	4.E.2.2 Cropland converted to Settlements	4.E.2.3 Grassland converted to Settlements	4.E.2.5 OL converted to Settlements
2008	1063.54	NO	1063.54	216.82	518.19	292.08	36.45
2009	892.13	NO	892.13	63.85	503.79	285.84	38.64
2010	1070.74	NO	1070.74	114.73	586.07	330.73	39.21
2011	1000.38	NO	1000.38	71.38	566.12	321.96	40.92
2012	994.02	NO	994.02	96.93	543.97	310.93	42.19
2013	1024.64	NO	1024.64	155.09	525.73	301.26	42.57
2014	932.96	NO	932.96	87.17	509.64	292.52	43.63

6.7.1 INFORMATION FOR THE APPROACHES USED TO PRESENT THE DATA FOR THE AREAS AND THE DATABASE FOR THE LAND-USE USED FOR THE INVENTORY

Information on the total Settlements area is aggregated using the data on settlements area from the cadastral maps of the agricultural fund of Bulgaria for the years 1994,1996 (Balance by Type of Territories as per their Designation, Cadastre Agency) and data from the balance of the territory of Bulgaria based on orthophotoimages for the year 2012 and 2013. In order to ensure the time series consistency interpolation and extrapolation have been applied. The total settlements area according to the balance from the orthophotoimages is lower than the area from the cadastral map. Since a decrease in settlements area is considered as unlikely, it was assumed that the discrepancy in the extent of the settlements territory is because of using different methodology by the data providers. The settlements area according to cadastral map includes also lands next to villages, which usually are under cropland or grassland management. In the orthophotos these lands are in separate class but are referred to CL. In order to avoid double counting of lands the SM area pattern has been recalculated. The following has been applied:

- Adjustment of the total settlements area for 1996 to match with the known increase in settlements for the period 2001-2014
- Interpolation between the adjusted settlements area for 1996 and 2014
- Extrapolation of settlements area for the period 1988-1996 considering the available data on LUC to settlements

Concerning the LUCs to settlements there is information for LUC from forest land to settlements, which is available for the period 1990-1994 and for the years 2001 to 2014. The annual forest loss to settlements for the years 1988, 1989 and 1995-2000 is estimated as an average value of forest loss in the period 1990-1994. Information for LUC from arable land (e.g cropland and grassland) to settlements is available for the years 2001 to 2014. The share of annual cropland, perennial cropland and grassland within the available figure for the total area, which is changed to settlement between 2001 and 2014, was assumed the same as the share of the totals of these land-use categories. LUCs from arable lands to settlements for the years before 2001 are estimated using the data gaps approach. The reported land-use changes to settlement fit very well to the observed increase in settlements area.

6.7.2 METHODOLOGY

6.7.2.1 Land use change to settlements (4.E.2.)

6.7.2.1.1 Forests converted to settlements

The methodology and the data for the forests are presented in Chapter 6.3.

The estimates include the losses of forest biomass as well as the annual increase of the settlement biomass over the transition period (20 years) and also the changes in the litter (humic and fumic layers) and soil C stock (including the losses in litter). The converted forest area to settlements ranges between 1-2 kha.

6.7.2.1.1.1 Changes in the carbon stock in living biomass of forests converted to settlements

For estimating biomass loss associated with deforestation, data from NFI on volume stock over bark has been used. The data on volume stocks over the five years period since 1990 has been expanded and converted with the related country specific (or default) expansion/conversion factors: wood density (0.43 t/m3 for coniferous, 0.60 t/m3 for deciduous), stemwood plus branches expanded to the whole aboveground tree biomass (1.08 for coniferous, 1.03 for deciduous), root-to-shoot ratios (0.32 for coniferous, 0.28 for deciduous) and C-content (0.50 t C/t d.m.). Then it has been estimated the share of the coniferous and deciduous stocks in the total biomass stock for the respective years. Like this the weighted means for tree biomass stock have been calculated. The means have been used for estimating biomass loss from deforestation for the years across the time series.

Table 253 Living biomass stocks which are used to calculate the emissions associated with forest loss to settlements

		1990	1995	2000	2005	2010
Weighted mean tree biomass stocks	tC/ha	37.71	43.29	47.82	51.66	55.34

For the biomass growth on settlements after deforestation the following values have been taken: 0.09 $tCha^{-1}y^{-1}$ and 0.03 $tCha^{-1}y^{-1}$ for annual and perennial plants respectively. Growth of annual plants is accounted only in the year of conversion, while the growth of the perennial plants at the deforested areas continues. The annual biomass growth for annual and perennial plants has been calculated on the basis of the share of the green areas in the settlements in Bulgaria (2.63% according to study for Sofia (Kovachev, A, 2005)) and the following growth rates: for perennials (trees, bushes) it is 1.2 t C/ha.y, and for the annual plants – 3.3 t C/ha.y. These growth rates have been derived from a detailed biomass study for Vienna (and is also used for the related estimates in Austria).

6.7.2.1.1.2 Changes in carbon stock in dead organic matter of forests converted to settlements

The calculation of the emissions from litter pool (humic and fumic layer) as a result of the conversion of forests to settlements was made by using national data for the carbon stocks in litter (humic and fumic) in forests (5.4 t C/ha). The estimation of changes in litter pool are done based on annual change from FL to WL, cause it is assumed that the litter is oxidised in the year of conversion. Litter does not occur in Settlements, so the carbon stock here is considered as 0 t C/ha.

For estimating changes in DW stock due to deforestation activity it was assumed that the dead wood stocks is equal to 5% of the standing biomass stock of the Bulgarian forests. This is a percentage magnitude for dead wood that is frequently reported for managed forests in Europe. The resulting values are given in the table below.

Table 254 Dead wood stocks used for estimating the changes in DW pool after deforestation

		1990	1995	2000	2005	2010
DW stock	tC/ha	1.89	2.16	2.39	2.58	2.77

6.7.2.1.1.3 Changes in the carbon stock in soils of forests converted to settlements

The calculation of the emissions from soils as a result of the conversion of forests to settlements has been made by using national data for the carbon stocks in the soils in forests (78.26 t C/ha) and the carbon stocks in the soils of the settlements (2.47 t C/ha). The carbon stock in the soils of settlements is determined on the basis of data for the carbon stock in the soils of the green areas in Sofia for 40 cm depth (94 t C/ha), corrected as per the relative share of the green areas in Sofia (2.63%).

6.7.2.1.2 Cropland converted to settlements

6.7.2.1.2.1 Changes in the carbon stock in living biomass of the croplands converted to settlements

When calculating the changes in the carbon stock in the biomass during the conversion of cropland to settlements the values used are the average annual stock of carbon in the biomass of annual crops (3.0 t C/ha) and perennials (63 t C/ha) and the growth rates of the carbon stock in the biomass of the settlements (Section 6.4.3.1)

The annual emissions of carbon dioxide are presented in Table 252.

6.7.2.1.2.2 Changes in the carbon stock in soils for croplands converted to settlements

When calculating the changes in the carbon stock of soils during conversion of croplands to settlements the values used are those of the carbon stock in the soils of annual crops (89.92 t C/ha) and perennials (76.52 t C/ha), and values of the carbon stock in the soil of the settlements – 2.47 t C/ha.

6.7.2.1.3 Grassland converted to settlements

6.7.2.1.3.1 Changes in carbon stock in living biomass of the grasslands converted settlements

When calculating the changes in the carbon stock of the biomass during the conversion of grassland to settlements the values used are the average annual carbon stock in the biomass of grassland determined for Bulgaria (6.4 t C/ha) and the annual growth rates of the carbon stock in the biomass of the settlements.

6.7.2.1.3.2 Changes in the carbon stock in soils from grassland converted to settlements

When calculating the changes in the carbon stocks in the soil during conversion of other land to settlements the values used are those of the carbon stock in the soil of grassland (103.57 t C/ha).

6.7.2.1.4 Other land converted to settlements

6.7.2.1.4.1 Changes in carbon stock in living biomass of other land converted to settlements

When calculating the changes in the carbon stock of the biomass during the conversion of other land to settlements the values used are the average annual carbon stock in the biomass of other land (4.5 t C/ha) and the annual growth rates of the carbon stock in the biomass of the settlements.

6.7.2.1.4.2 Changes in the carbon stock in soils from other land converted to settlements

When calculating the changes in the carbon stocks in the soil during conversion of grassland to settlements the values used are those of the carbon stock in the soil of grassland (69 tC/ha).

6.7.3 UNCERTAINTY ASSESSMENT

The total uncertainty for Land converted to Settlements is ±75 % based on expert judgment.

6.7.4 DATA VERIFICATION CATEGORY-SPECIFIC QA/QC AND VERIFICATION, IF APPLICABLE

See Chapter 4.11

6.7.5 CATEGORY-SPECIFIC RECALCULATIONS

The following recalculations have been made for Submission 2015:

- Changes in the total settlements area due to complete new interpretation of the activity data. This change affected also area pattern of GL, CL and OL
- Chages in the area distribution of the total LUCs to SM between categories
- Reporting of LUC from OL to SM

6.7.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS INCLUDING THOSE IN RESPONSE TO THE REVIEW PROCESS

See Chapter 7.9

6.8 OTHER LAND(5.F)

Activity data on area of other land is gathered from Executive Forest Agency and Ministry of Agriculture and Food. The EFA provides data on rocks and landslides from the forestry fund while the MAF (orthophoto images) provides information on sands, small-scale non-arable lands, lands with poor vegetation. The share of Other land to the total country's territory is 4%. Nevertheless, the difference between the sum of lands from all land-use categories and the total area of Bulgaria ranges between 0.01-3.85%. The total national area of 11100.19 kha remains constant over time. Thus, in accordance with IPCC 2006, the difference of the area of all land-use category and the whole area of the country is referred to "Other land" category in order to avoid double accounting or omission of an area.

The improvements made in the land area representation in Submission 2016 have led to reporting of the LUCs to/from OL. The reported LUCs from/to OL have been estimated based on data gap approach, following the trends in the area of the respective land-uses and considering its shares. These changes have led also to the need of reporting the emissions/removals associated with the conversion of lands from/to OL. The figure of annual carbon stock in biomass (4.5 tC/ha) is derived from results of a case study under the project "Land-use and management impacts on carbon sequestration in mountain ecosystems" under the framework of the Bulgarian-Swiss Research Programme ("BSRP"). Due to lack of data on the annual biomass growth on lands under other land use, Bulgaria used the default factor for biomass growth (1.6 tC/ha, 2006 IPCC Guidelines) in grassland. The average carbon stock in soils is 69 tC/ha. Detailed information on how this has been estimated is given in 1.3.2.2.3.

Further improvements are needed in order to update the data on average carbon stock in biomass and in soils.

6.9 HARVESTED WOOD PRODUCTS

Table 255 Emissions/removals from HWPs (CO2 eq)

CO2 equivalent		HWP Produced and Consumed domestically			HWP Produced and Exported		
year	HWP total	Wood-based panels	Paper and paperboard	Sawnwood	Wood-based panels	Paper and paperboard	Sawnwood
1988	-656.48	-113.05	-94.87	-444.82	-13.84	-0.90	11.01
1989	-656.48	-113.05	-94.87	-444.82	-13.84	-0.90	11.01
1990	-656.48	-113.05	-94.87	-444.82	-13.84	-0.90	11.01
1991	-474.41	-48.70	3.63	-425.64	-4.72	-10.27	11.30
1992	431.86	85.99	76.33	324.90	-5.38	2.01	-51.98
1993	423.45	44.45	45.47	290.74	12.03	10.33	20.44
1994	385.29	41.77	19.38	296.32	13.78	4.71	9.35
1995	362.50	24.15	18.78	313.02	25.90	-6.22	-13.14
1996	373.92	50.28	42.81	349.12	1.35	-14.63	-55.01
1997	367.68	53.55	26.71	380.73	-3.45	2.64	-92.51
1998	336.39	48.99	4.67	270.49	-0.46	0.81	11.89
1999	361.91	169.76	83.43	351.54	-102.21	-17.91	-122.70
2000	141.70	10.12	61.43	368.24	-143.06	-24.52	-130.52

CO2 equivalent		HWP Produced and Consumed domestically			HWP Produced and Exported		
year	HWP total	Wood-based panels	Paper and paperboard	Sawnwood	Wood-based panels	Paper and paperboard	Sawnwood
2001	14.32	-64.34	-14.37	371.98	-111.60	-11.49	-155.85
2002	12.06	26.65	6.75	381.94	-210.09	-15.82	-177.37
2003	27.63	38.69	4.63	374.40	-204.66	-11.25	-174.18
2004	-248.54	182.46	-41.44	155.22	-314.50	-71.99	-158.29
2005	-141.50	213.14	-26.00	302.03	-270.03	-51.46	-309.19
2006	-424.34	211.32	-99.52	33.52	-403.73	-25.59	-140.33
2007	-773.26	90.68	-59.50	75.61	-656.73	-20.92	-202.41
2008	-299.69	-196.39	124.02	26.79	-254.80	63.83	-63.14
2009	-141.49	151.41	106.93	197.90	-558.55	59.63	-98.81
2010	-367.77	-132.84	79.65	138.41	-366.43	39.21	-125.77
2011	-607.14	-155.37	63.28	102.19	-406.25	26.24	-237.23
2012	-647.35	-169.38	24.11	79.63	-403.02	1.67	-180.35
2013	-545.01	-115.27	32.65	121.51	-364.86	1.80	-220.84
2014	-544.01	-115.27	32.65	121.51	-364.86	2.80	-220.84

The estimates have been prepared applying the tier 2 method as suggested by 2014 IPCC KP Supplement using the WoodCarbonMonitor model. Default conversion factors have been applied as listed in Table 2.8.1 in conjunction with data from FAOSTAT (FAO 2015). In order to reduce uncertainties, the initial stock has been estimated using Equation 2.8.6 of KP Supplement with t0=1990.

6.10 QA/QC VERIFICATION

The input data, estimates and results are checked as follows.

- Bottom-up check
- Input data
- Check for the plausibility of the activity data and their trend
- Check for plausibility of the emission factors as well as the related input data and their trends
- Check of input data for completeness
- Estimations
- Check of the correctness of all equations in the estimate files
- Check of the correctness of all interim results
- Check of the plausibility of the results and their trends
- Check of the correctness of all data and results transfer
- Top-down check
- Check of the consistence of the total area for Bulgaria.

Comparison of the activity data used with those from other statistics. Comparison of the used emission factors and underlying input data with those of other data sources (e.g. from literature, results in NIRs of other comparable regions, IPCC default values).

The correctness of the data on the areas and the tree stock is controlled during the preparation, the adoption and the execution of the Forest Management Plans (FMP). The quality control is exercised by the Executive Forest Agency and its subdivisions. Quality control could be exercised by other institutions, e.g. the Ministry of Environment and Waters, municipal authorities as well as by forest landowners. Quality control is exercised at every phase of the preparation of the FMP and the results of the check are documented and the mistakes are corrected.

Concerning the agrostatistical data, from the Agrostatistics and Strategies Directorate of MAF together with the Regional Directorates "Agriculture and forestry" and Municipal Services on agriculture and forestry at MAF organized and conducted the agricultural census in Bulgaria. Around 4000 surveyors participated in the data collection process. Around 400 controllers supervised the work of the surveyors and provided methodological assistance. The controllers delivered the checked questionnaires to the agrostatistics experts from the Regional Directorates "Agriculture and Forestry" according to a previously adopted schedule. The operators did the data entry in the census software spread in the regional offices. The regional data bases are aggregated on national level by Agrostatistics and Strategies Directorate of MAF. The data entry from the filled in questionnaires into computer software was followed by crosschecks and coherence control in order to ensure the data quality.

6.11 PLANNED IMPROVEMENTS

For Submission 2017 it is planned to implement the following improvements:

- To continue the process of improvements in land use classification and representation
- To initiate a study for carbon content on other lands. Other lands are not only rocks and landslides, there is also some areas which can not be assigned to the rest of land-use types but there is vegetation on it.
- To continuously check the coherence of reported data, ensuring consistency and accuracy in the estimation process and in the reporting phase;

6.12 RECALCULATIONS

The recalculations within LULUCF category are as a result of the following improvements which have been implemented in Submission 2015:

- Improvements in land area representation – new transition between categories has been considered which has led to complete change in trend of emissions/removals from CL, GL and OL categories. Nevertheless, the impact of this change on the overall LULUCF emissions/removals is not so big
- Correction of technical errors in estimation tables, which are related to area representation
- Update of the default emission factors to mach those in 2006 IPCC Guidelines
- Implementation of the new GWPs for CH_4 and N_2O gases where they occur

7 WASTE (CRF SECTOR 5)

7.1 OVERVIEW OF SECTOR

This Chapter includes information on the GHG emissions from the Waste sector. The categories and activities for estimation of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) emissions are described in detail.

According to the IPCC nomenclature, the following categories are included in this sector:

- Solid Waste Disposal on Land (5 A)
- Biological treatment of waste (5 B)
- Waste incineration (5 C)
- Wastewater handling (5 D)

The report includes information on methods for estimating greenhouse emissions as well as references of activity data and emissions factors concerning waste management and treatment activities reported under CRF Category 5 Waste.

The most important gas produced in this category is methane.

7.1.1 EMISSION TREND

The major greenhouse gas emissions from Waste sector are CH_4, CO_2 and N_2O. The GHG emissions trends in this sector are presented in Table 254 and following figures.

Table 256 Trend in GHG emissions from Waste by sub-sectors for 1988-2014

GHG gases	CH_4				N_2O			CO_2
Category	5 A	5 B	5 C	5 D	5 B	5 C	5 D	5 C
1988	140.107	NO	7.00539E-05	137.927	NO	0.00486	0.802	21.76
1989	141.401	NO	7.19E-05	129.375	NO	0.00500	0.778	22.33
1990	142.543	NO	7.49E-05	129.266	NO	0.00522	0.666	23.23
1991	143.561	NO	7.62E-05	114.130	NO	0.00531	0.627	23.63
1992	144.428	NO	7.13E-05	107.439	NO	0.00495	0.589	22.16
1993	145.230	NO	7.67E-05	98.099	NO	0.00536	0.596	23.81
1994	145.963	NO	7.8E-05	69.117	NO	0.00545	0.577	24.19
1995	146.620	NO	7.9E-05	86.578	NO	0.00550	0.586	24.54
1996	147.205	NO	7.8E-05	87.804	NO	0.00541	0.557	24.220
1997	149.037	NO	7.86E-05	82.756	NO	0.00546	0.548	24.42
1998	148.367	NO	0.00013	72.169	NO	0.00931	0.594	40.10
1999	147.089	NO	0.000106	65.404	NO	0.00752	0.584	32.82
2000	146.727	NO	0.000231	61.385	NO	0.01685	0.561	70.91
2001	146.152	NO	0.000148	50.917	NO	0.01061	0.534	45.51
2002	144.013	NO	0.000144	48.238	NO	0.01035	0.516	44.48
2003	141.962	NO	0.000163	72.838	NO	0.01166	0.491	50.51
2004	139.932	NO	0.000258	72.020	NO	0.01866	0.499	79.55

2005	138.137	NO	0.000206	48.418	NO	0.01451	0.482	63.79
2006	135.764	NO	0.000195	47.736	NO	0.01357	0.492	60.45
2007	134.046	NO	0.000130	48.105	NO	0.00895	0.467	40.51
2008	132.103	NO	0.000158	44.879	NO	0.01129	0.488	48.86
2009	133.112	NO	0.000125	36.587	NO	0.00883	0.489	38.56
2010	130.725	NO	5.25E-05	36.772	NO	0.00343	0.494	16.52
2011	130.356	0.33	3.88E-05	35.394	0.02	0.00241	0.495	12.31
2012	128.546	0.32	7.68E-05	33.244	0.02	0.00522	0.492	23.97
2013	126.209	0.43	0.000144	39.237	0.03	0.01044	0.489	44.32
2014	124.064	0.23	4.3E-05	39.091	0.01	0.00293	0.486	13.43

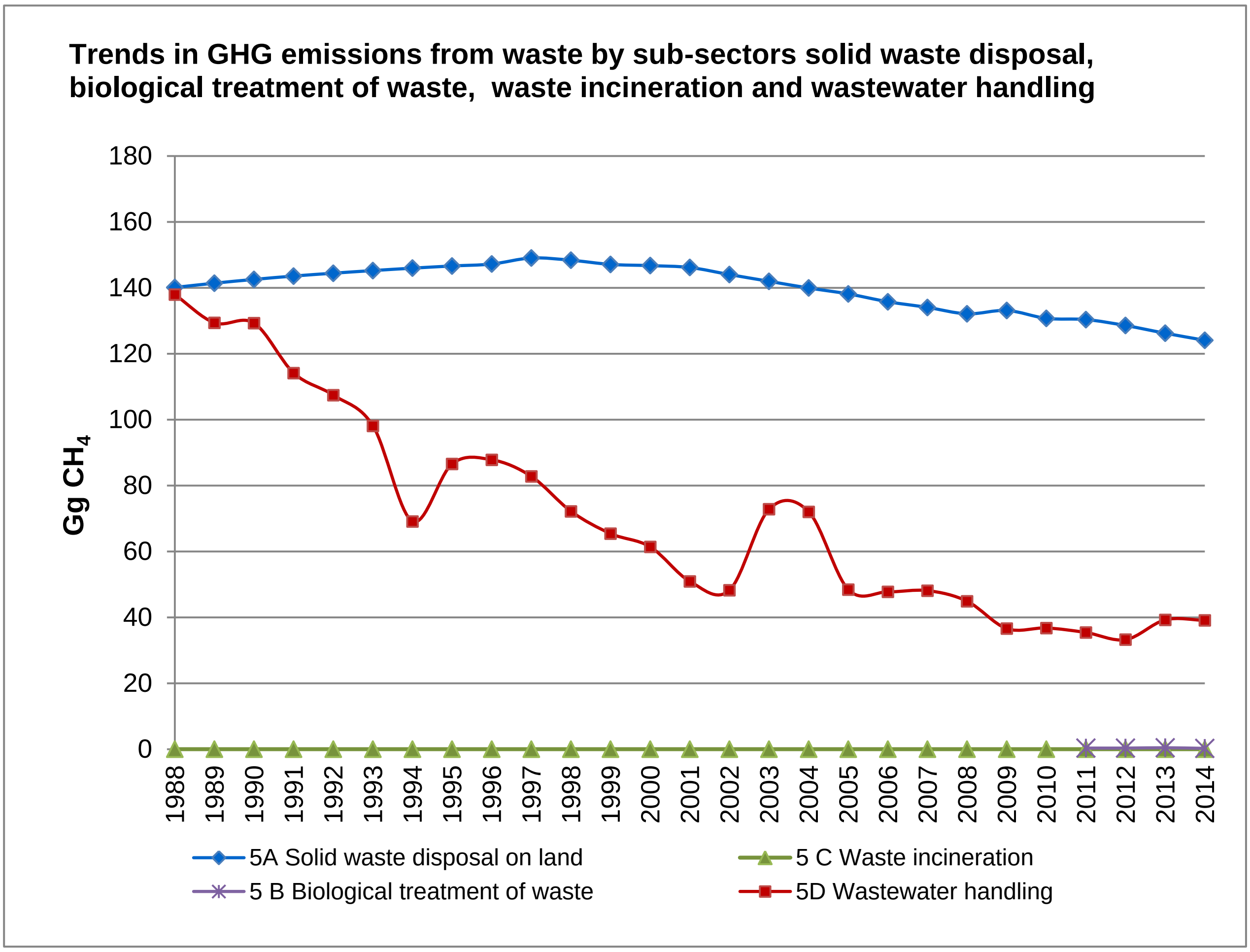


Figure 94 Trend in CH4 emissions

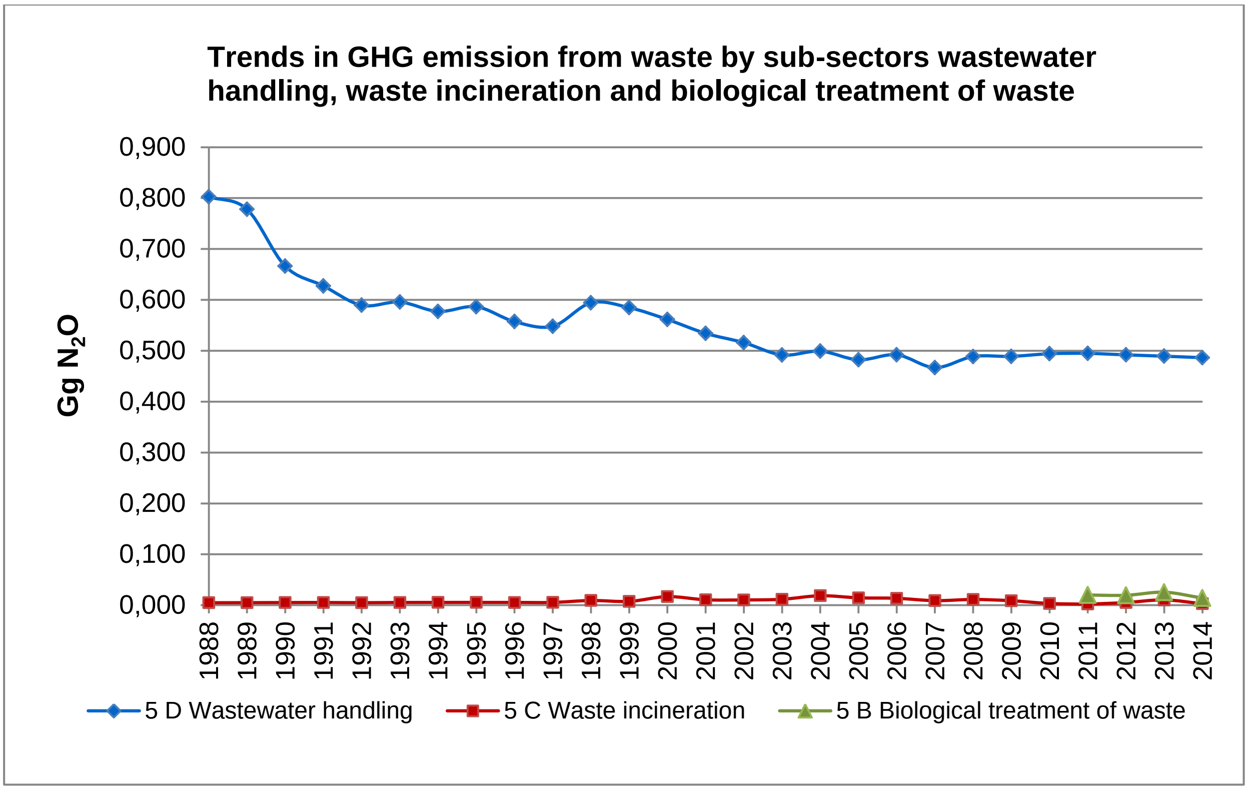


Figure 95 Trend in N2O emissions

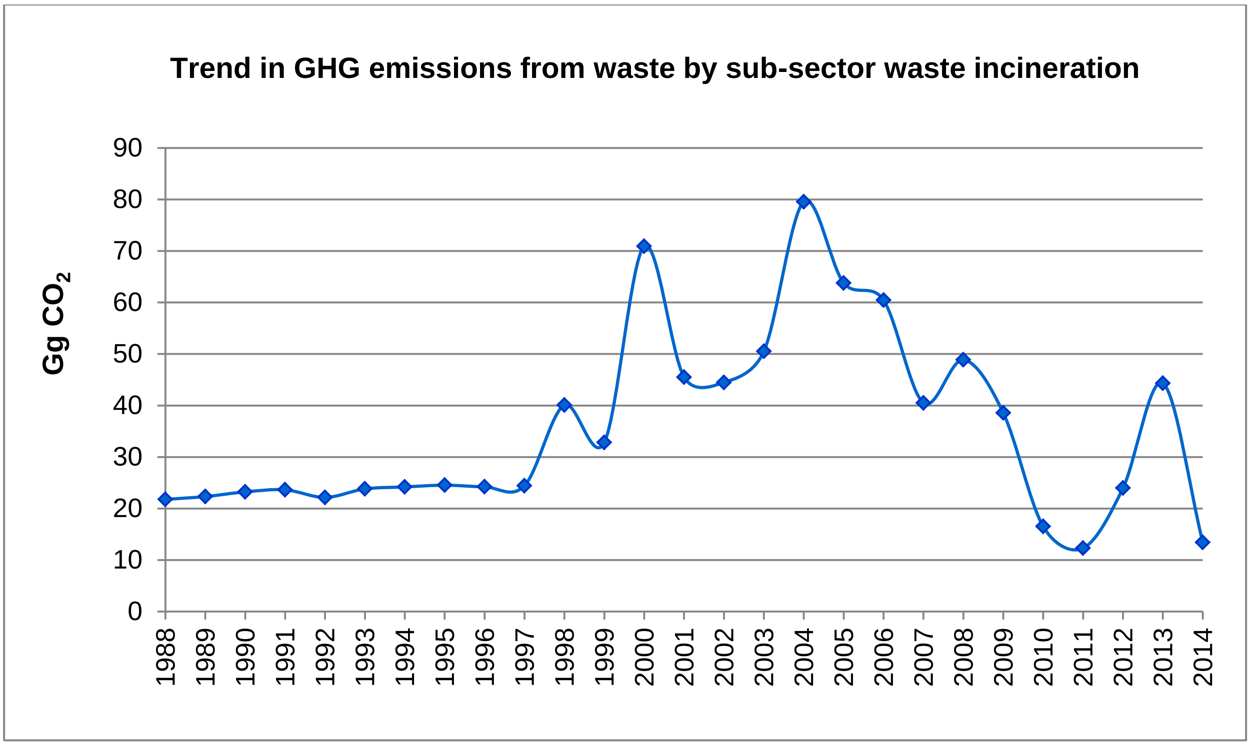


Figure 96 Trend in CO2 emissions

Solid Waste Disposal on Land contributes over 73.05%, Wastewater Handling about 26.43%, Waste Incineration about 0.29% and compost production about 0.23% sector's total emissions.

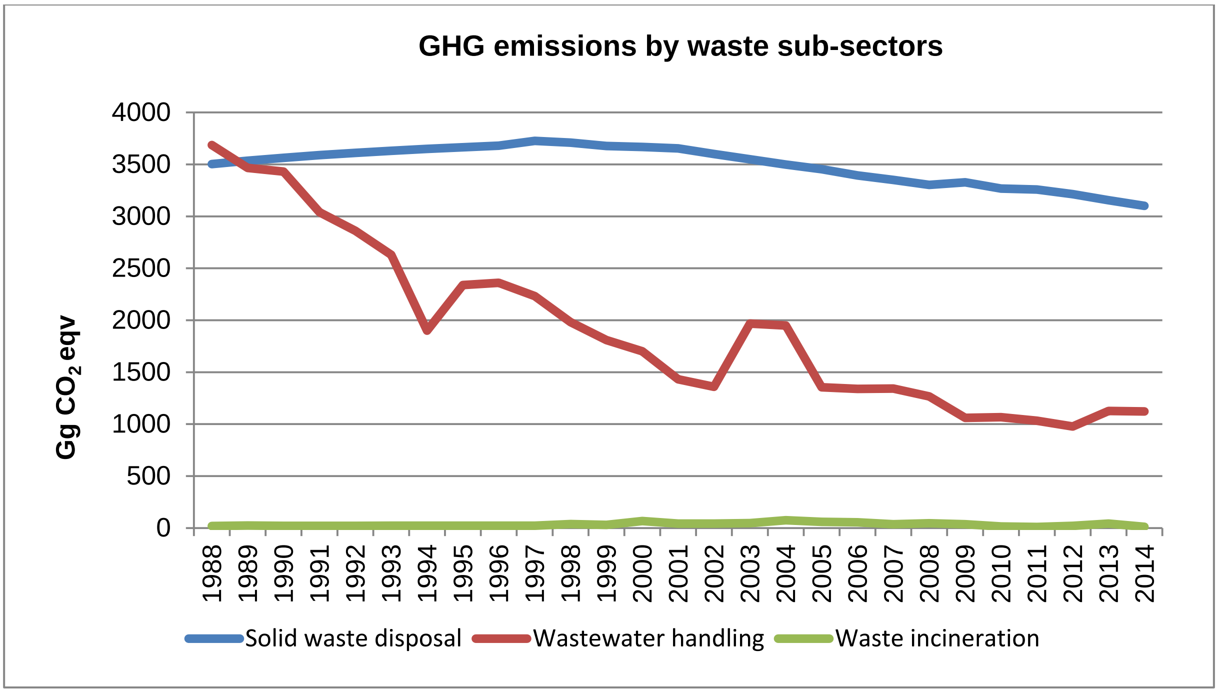


Figure 97 Emissions by waste sub-sectors

Emissions from the waste sector in 2014 decreased by 41 % (4246 Gg CO_2-eq in 2014 compared to 7209.95 Gg CO_2-eq in 1988) compared to the base year.

Figure below presents the total CO_2 eqv from the whole waste sector.

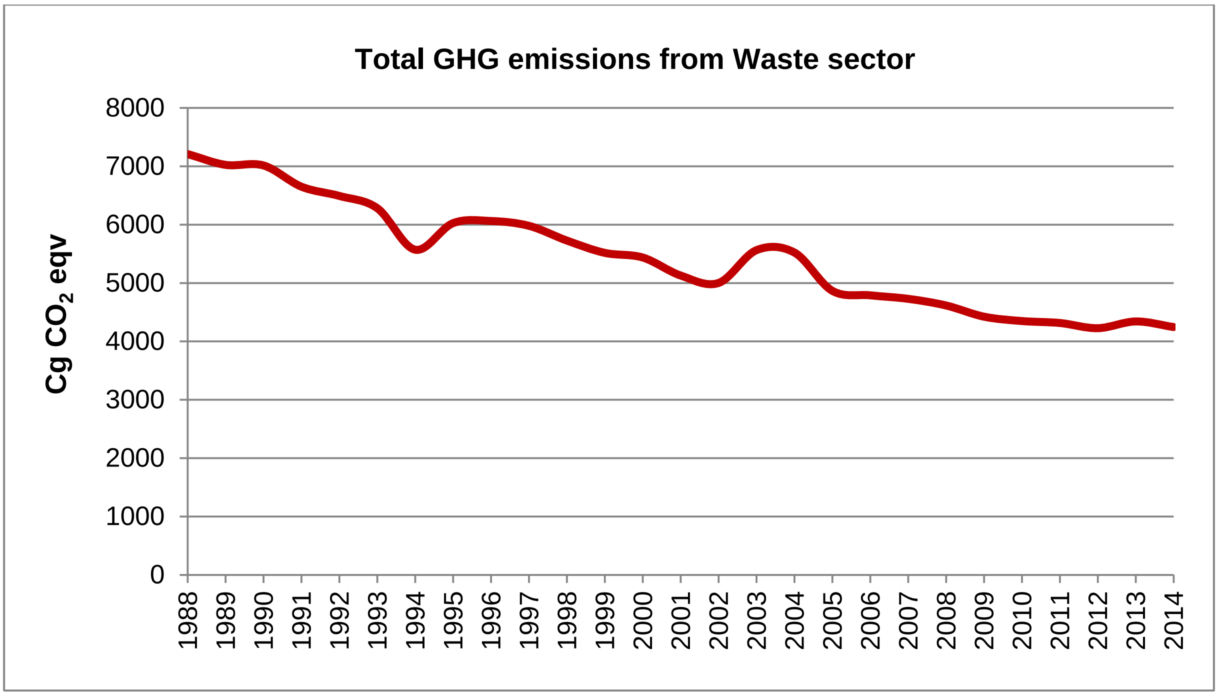


Figure 98 GHG emissions from Waste sector

7.1.2 KEY CATEGORIES

Table 218 described the key categories of the waste sector and type of emitted greenhouse emissions.

Table 257 Key categories, Waste sector (Tier 1)

CRF categories	Category	Key category Y/N	GHG	Assessment of Key Source	Assessment of Key Source
				excluding LULUCF	including LULUCF
5A	Solid Waste Disposal on Land	Yes	CH_4	L,T	L,T
5D	Wastewater handling	Yes	CH_4	L,T	L,T

7.1.3 METHODOLOGY

A more detailed description on the methodology for calculating emissions can be found, described in each subcategory of waste sector.

7.1.4 QUALITY ASSURANCE AND QUALITY CONTROL

Generally described checks and improvements have been taken and are described in sub chapters.

7.1.5 UNCERTAINTY ASSESSMENT

Uncertainty assessments are provided in respective subchapter.

7.1.6 COMPLETENESS

Table 258 Description of the completeness

Waste IPCC Category	Waste IPCC Category	CO_2	CH_4	N_2O
5A Solid waste Disposal on land	5A1 Managed waste disposal	NA	▲	NA
5A Solid waste Disposal on land	5A2 Unmanaged waste disposal	NA	▲	NA
5B Biological treatment of solid waste	5B1Composting Municipal Solid Waste	NA	▲	▲
5C Waste Incineration	5C1 Incineration of municipal waste	NA	NA	NA
5C Waste Incineration	5C1 Incineration of hospital waste	▲	▲	▲
5C Waste Incineration	5C1 Incineration of sewage sludge	NO	NO	NO
5C Waste Incineration	5C1 Incineration of different type of hazardous waste	▲	▲	▲

5D Wastewater handling	5 D1 Domestic wastewater	NA	▲	▲
5D Wastewater handling	5 D2 Industrial wastewater	NA	▲	NA

7.2 SOLID WASTE DISPOSAL ON LAND (CRF SECTOR 5A)

7.2.1 SOURCE CATEGORY DESCRIPTION

Treatment like disposal of municipal, industrial and other solid waste produces significant amounts of methane (CH_4). CH_4 produced at SWDS contributes approximately 3 to 4 percent to the annual global anthropogenic greenhouse gas emissions (IPCC 2001). In this report CH_4 is addressed.

The methodology used to estimate emissions from waste management activities requires country-specific knowledge on waste generation, composition and management practice. The main parameters that influence the estimation of the emissions from landfills, apart from the amount of the disposed waste, are: the waste composition, fraction of methane in landfill gas and amount of landfill gas that is collected and treated. These parameters are strictly dependent on the waste management policies throughout the waste streams which start from waste generation through collection and transportation, separation for resource recovery, recycling and energy recovery and terminate at landfill sites. The improvements of quality and quantity of data are visible in last couple of years. Effort was done in order to evaluate and compile data coming from different sources and adjust them to recommended IPCC methodology which is used for GHGs emissions estimation. At present in our country are used country specific data, where they are available. Default values are used when such data are not available.

Legislation and development planning processes in the field of waste management in Bulgaria:

After the global economic and political change and regime change of government in our country start to lay the groundwork for approval of plans and strategies outlining guidelines on sustainable management.

At the beginning of the nineties years in the country began to develop practices for separate collection of household waste and their subsequent recycling.

During the last couple of years the measures in national legislation aimed at decreasing CH_4 emissions from landfills - limiting the disposal of municipal waste, suspending operations of landfills which do not meet the requirements of the Directive 1999/31/EC; measures for closure and rehabilitation of municipal landfills with terminated operation; coverage of all household waste in a managed system of waste treatment, including all waste to be disposed of in managed landfills and capturing, utilizing or flaring of landfill gas.

New waste management law 2012 - separate bio-waste collection (yards, park and garden wastes, green wastes must be treated via composting or anaerobic digestion); reducing the amount of biodegradable waste, sent to landfills).

National strategic plan for diversion of biodegradable waste going to landfills (2010-2020)

National strategic plan on sewage sludge management (2012-2020)

Ordinance for the treatment of bio-waste (2013)

Ordinance for separate bio-waste collection (2013)

Third National Action Plan on Climate Change (2013-2020)

National Waste Management Plan (2014-2020)

Bulgarian legislation introduce the specific quantitative targets for separate collection, recycling and recovery of municipal bio waste as well as targets for diverting biodegradable municipal waste from landfills. The provisions of the Waste Management Act require that by 31 December 2020 there shall be limiting the amount of biodegradable municipal waste to 35 percent of the total of those wastes in the Republic of Bulgaria in 1995. This is compliant with the requirements of the European directive on the landfill of waste.

The effect of the legislative measures will be visible in the future. Currently, some positive tendencies are observing, concerning SWD on the managed and unmanaged disposal sites.

Since 2000 the share of population, land filling on unmanaged sites decreases and the share of population, which dispose of wastes on managed sites is increasing.

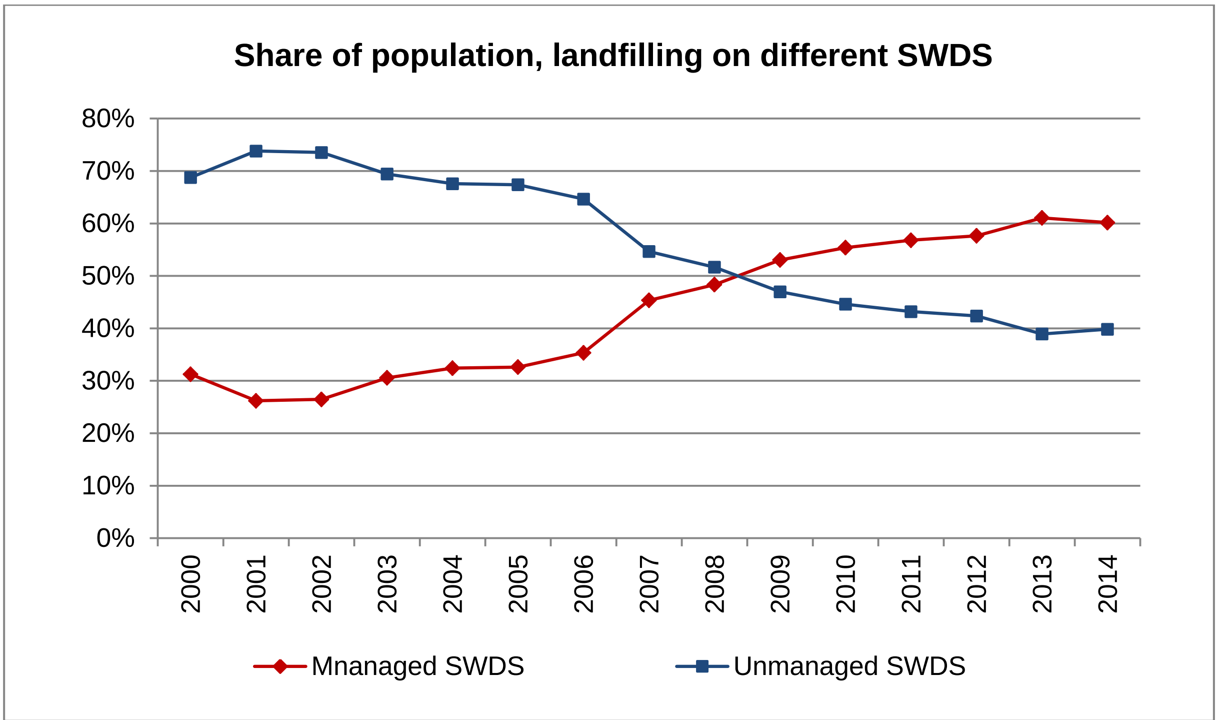


Figure 99 Share of population, land filling on different SWDS

The landfills are classified as managed and unmanaged (see below: Activity data).

As the main criteria for whether landfills are managed and unmanaged, is considered the fact if the landfills meet the requirements laid down in EU Directive 1999/31/EC on the landfill of waste.

7.2.2 EMISSION TREND

Methane emissions are shown in the Table 217 and Table 220, respectively from managed and unmanaged sites.

Landfilling as a method of waste disposal still holds the biggest share in the management of municipal waste, but there is a steady decline in this indicator in recent years (the percentage of waste disposed in landfills drop from 95% in 1990 to 69% in 2014). Recyclable waste collection, which was a scarce practice at the beginning of the nineties, has been increased. In 2013, legislation on bio-waste management was promulgated, which combined with the existing economic instruments as well as the introduced in 2011 landfill tax per ton led to the present positive trends.
The total amount of municipal waste generated in Bulgaria in 2014 is 3 193 kt which is in average 1.21 kg per capita. The total amount of municipal waste generated in the country is following a positive trend towards permanent decrease.
Based on Eurostat data, Bulgaria is under the average level of generation of municipal waste per inhabitant per year in comparison to EU-28 and the trend for this indicator regarding waste prevention is positive. The amounts of separately collected fractions from municipal waste are gradually increasing. Since 2009, collection schemes have been improved for management of six special waste categories - packaging waste, waste oils, end-of-life vehicles, waste electrical and electronic equipment, waste tires, batteries and accumulators. This resulted in increased quantities of collection and recovery of those waste streams and decrease in per capita waste generation. Bulgaria is among the member-states with close to the average level of recycling in recent years.

In the country exist regional systems for waste management where before land filling the waste is subjected to pre-treatment (separation) as recyclable fractions such as paper and cardboard, metals, glass, plastics and wood are sent to recycling facilities. This practice reduces the amount of waste which going to landfills, additionally development of composting activities concerning the decreased land filled degradable fraction of MSW.

The emissions from SWDS are emitted from MSW (including industrial waste as - paper and cardboard, wood waste and vegetable waste), which are land filled. Sludge from wastewater treatment plant has also been considered because it is disposed of at same landfills as MSW, once it meets specific requirements. Emissions from sludge from wastewater treatment plants are included in emissions from SWDS.

Table 259 CH_4 emissions from SWDS

Year	CH_4 emissions		Share of populations land filled on	
	managed	unmanaged	managed	unmanaged
	Gg		%	
1988	0	140,107	0	100
1989	0	141,401	0	100
1990	0	142,543	0	100
1991	0	143,561	0	100
1992	0	144,428	0	100
1993	0	145,230	0	100

Year	CH_4 emissions		Share of populations land filled on	
	managed	unmanaged	managed	unmanaged
	Gg		%	
1994	0	145,963	0	100
1995	0	146,620	0	100
1996	0	147,205	0	100
1997	0	149,037	0	100
1998	0	148,367	0	100
1999	0	147,089	0	100
2000	2.468	144,259	31.25 %	68.75 %
2001	4.370	141,782	26.19 %	73.81 %
2002	5.676	138,337	26.47 %	73.53 %
2003	7.164	134,798	30.57 %	69.43 %
2004	8.636	131,296	32.42 %	67.58 %
2005	10.088	128,049	32.62 %	67.38 %
2006	11.386	124,378	35.35 %	64.65 %
2007	13.315	120,731	45.34 %	54.66 %
2008	15.653	116,450	48.34 %	51.66 %
2009	18.228	114,884	53.03 %	46.97 %
2010	20.235	110,489	55.38 %	44.62 %
2011	21.999	108,357	56.80 %	43.20 %
2012	23.769	104,777	57.64 %	42.36 %
2013	25.182	101,027	61.06 %	38.94 %
2014	26.576	97,488	60.17%	39.83%

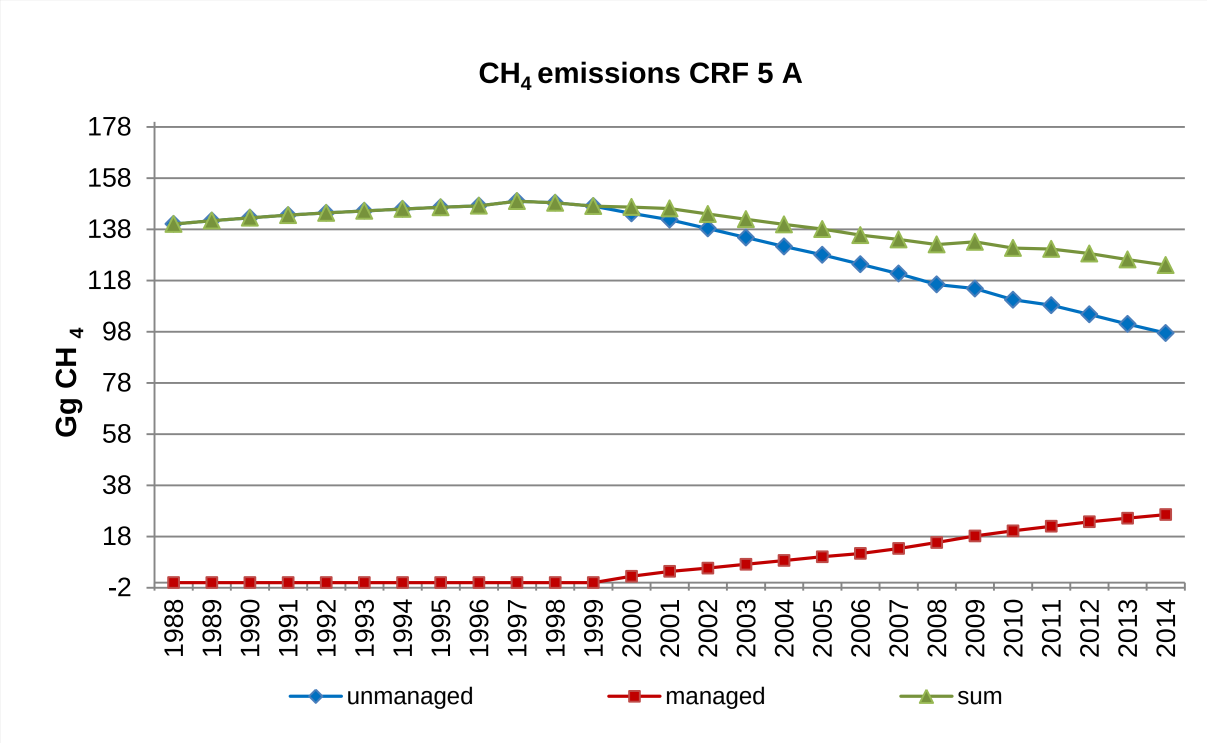


Figure 100 CH4 Emissions from SWDS

7.2.3 METHODOLOGICAL ISSUES

7.2.3.1 Methodology

A. Choice of method:

Emissions from solid waste disposal on land have been calculated using the First Order Decay (FOD) method, the IPCC Tier 2 method given in the 2006 IPCC Guidelines.

The choice of a good practice method will depend on national circumstances.

B. Basics:

- IPCC FOD Tier 2;
- Multi –phase model (based on waste composition);
- Starting year 1950;
- Managed and unmanaged type of site;
- Source AD: NSI, MOEW, ExEA.

C. Influencing factors/ data required:

- Waste amounts deposited / waste generated (starting year 1950)
- Waste treatment (deposition, composting, incineration, recycling)
- Management practices at landfill sites (MCF)
- Conditions at landfill sites + Composition of waste deposited
- Organic carbon in landfill sites (DOC)

- Methane generation rate constant (k)
- Landfill gas recovery, Oxidation
- National waste management policy

7.2.3.2 Activity data and emission factors

The main source of activity data is NSI. Data on Municipal Solid Waste generation rate and on the quantity of MSW disposed to SWDSs and etc. are country specific data. On the basis of generated waste from 1999-2010 and total population of the country are calculated generated waste for the period 1950-1998.

Waste generation rate is based on the evaluation of the collected MSW in the country including recycled waste with origin from population.

Concerning disposed MSW, questionnaires, verified by Eurostat are sending to the municipalities in which they fill the data about the quantities of land filled municipal solid waste.

NSI is currently developing a new methodology for data collection, which will enable the country to report more transparently the amounts and types of industrial waste from industrial sources in the future.

The table below presents the summarized sources of initial activity data.

Table 260 Source of Activity data by year

Year	Parameters										
	generated waste	Source of information	waste generation rate	Source of information	land filling waste	Source of information	waste composition	Source of information	type of landfill		Source of information
									managed	unmanaged	
1950-1998	CS	NSI (proportional to the population)	CS	NSI	CS	NSI	D	IPCC 2006	not defined as such	all unmanaged	IPCC 2006
1998-2000	CS	NSI	CS	NSI	CS	NSI	D	IPCC 2006	not defined as such	all unmanaged	IPCC 2006
2000-2002	CS	NSI	CS	NSI	CS	NSI	D	IPCC 2006	CS	CS	MOEW
2002-2014	CS	NSI	CS	NSI	CS	NSI	CS	MOEW	CS	CS	MOEW

Details about activity data for the whole period (1950-2014), are given in Figure 92

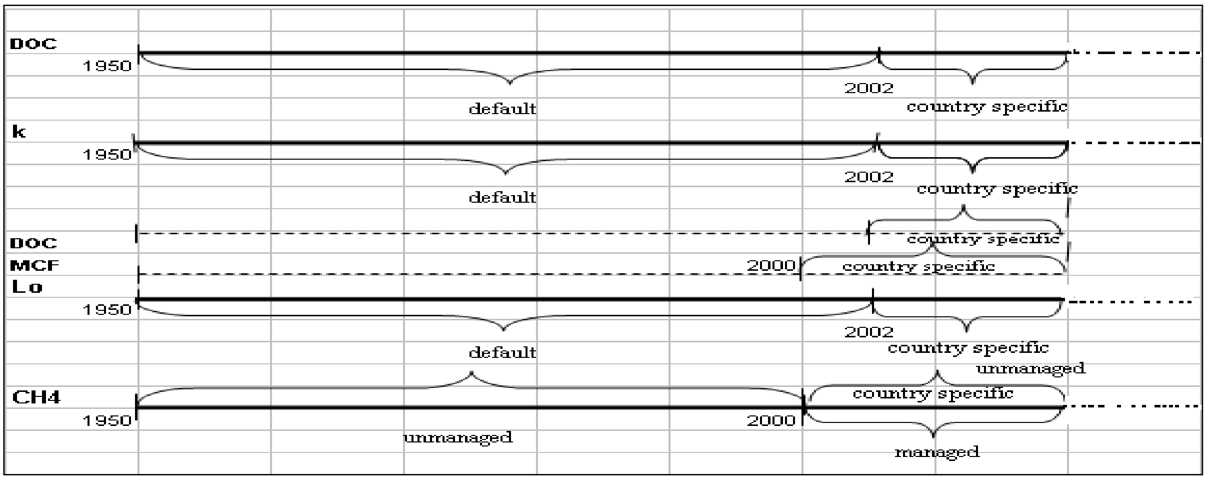


Figure 101 Regarding activity data

The emissions of methane on basis of the activity data are calculated for the entire period 1950-2014, and the plan for calculation depending on the time of reallocated activity data. The quantity of CH_4 emitted during decomposition process is directly proportional to the fraction of degradable organic carbon (DOC), which is defined as the carbon content of different types of organic biodegradable wastes such as paper and textiles, garden and park waste, food waste, wood and straw waste. The main reason for the choice of the period for composition of waste calculation is the fact that in 2002 is done a study at the national level for determine the morphology of the waste. This waste composition is set later in the Implementation Program for Directive 1999/31/EC. A major feature of the study is to determine the rate of accumulation of different types of waste based on distribution and population in different settlements. (Program for the implementation of Directive 1999/31/EC on the landfill of waste, p.21) Table 222 shows the morphological composition of the waste % allocated according to distribution of population.

Table 261 Waste composition

Population	until 3 000	from 3 000 to 25 000	from 25 000 to 50 000	over 50 000
A	Organic waste, %			
Food	4.86	12.56	20.85	28.80
Paper	3.87	6.55	10.45	11.10
Paperboard	1.30	0.70	1.63	9.70
Plastics	5.21	8.98	9.43	12.00
Textiles	3.48	4.70	3.40	3.20
Rubber	1.15	0.45	1.10	0.60
Leather	1.36	1.35	2.10	0.70
Garden waste	14.12	14.00	5.53	6.80
Wood waste	2.14	2.28	1.58	1.30
B	Non-organic waste, %			
Glass	8.85	3.40	8.75	9.90
Metals	2.88	1.30	2.83	1.70

Population	until 3 000	from 3 000 to 25 000	from 25 000 to 50 000	over 50 000
A	Organic waste, %			
C	Other waste, %			
Inert waste	50.78	43.73	32.35	14.20

For country specific biodegradable organic fraction of waste calculations is implemented a model, based on human settlements and distribution of population in them, with the percentage composition of different types of waste and total waste generated for a specific year. Using this model, respectively, the composition of waste is calculated, mainly in four groups:

A – paper, paperboard and textile;
B - garden waste;
C - food (kitchen) waste;
D - wood waste.

DOC is calculated according Equation 3.7 (2006 IPCC, Vol.5: Waste p. 3.13):

$$\boldsymbol{DOC} = \sum_i (\boldsymbol{DOC_i} \bullet \boldsymbol{W_i})$$

Where:

DOC – fraction of degradable organic carbon in bulk waste, Gg C/Gg waste

DOC_i – fraction of degradable organic carbon in waste type i

W_i – fraction of waste type i by waste category

Default values for DOC in different MSW component are used in calculations (2006 IPCC, Vol.5: Waste, Table 2.4, p.2.14). For paper and cardboard – DOC content 40%; for food waste – DOC content 15%; for wood waste – DOC content 43% and for garden and park waste – DOC content 20%.

With the above equation is calculated the value of the decomposed organic structure of the waste for the country at 2014 as a whole:

DOC = 12.28%

DOC was estimated by using country-specific data on waste composition and quantities based on compiled data from 2002 to 2014. From 1950 to 2001 year the default data for DOC (15%) was used in calculation. (Table 6-1, p.6.6, Revised 1996 Guidelines, Reference Manual)

Table 262 Components of waste composition (A, B, C, and D)

Year	waste composition, %		degradable waste, %	DOC
2002	A	16.52%	46.54 %	0.1211
	B	10.22%		
	C	18.05%		
	D	1.76%		
2003	A	16.53%	46.55 %	0.1212
	B	10.22%		
	C	18.05%		

Year	waste composition, %		degradable waste, %	DOC
	D	1.75%		
2004	A	16.55%	46.60 %	0.1213
	B	10.23%		
	C	18.07%		
	D	1.76%		
2005	A	16.58%	46.65 %	0.1214
	B	10.21%		
	C	18.11%		
	D	1.75%		
2006	A	16.62%	46.74 %	0.1217
	B	10.19%		
	C	18.18%		
	D	1.75%		
2007	A	16.63%	46.76 %	0.1217
	B	10.21%		
	C	18.17%		
	D	1.75%		
2008	A	16.63%	46.76 %	0.1217
	B	10.17%		
	C	18.21%		
	D	1.75%		
2009	A	16.62%	46.74 %	0.1216
	B	10.15%		
	C	18.23%		
	D	1.75%		
2010	A	16.66%	46.81 %	0.1218
	B	10.13%		
	C	18.28%		
	D	1.75%		
2011	A	16.84%	47.16 %	0.1227
	B	10.04%		
	C	18.55%		
	D	1.74%		
2012	A	16.87%	47.23 %	0.1229
	B	10.02%		
	C	18.60%		
	D	1.73%		
2013	A	16.90%	47.28 %	0.1230
	B	10.01%		
	C	18.64%		
	D	1.73%		
2014	A	16.87%	47.19%	0.1228
	B	9.99%		
	C	18.61%		
	D	1.73%		

The Methane Correction Factor (MCF) reflects the way in which MSW is managed and the effect of management practices on CH_4 generation.

MCF accounts for the fact that unmanaged SWDS produce less CH_4 from a given amount of waste than anaerobic managed SWDS.

The methodology requires countries to provide data or estimates of the quantity of waste that is disposed of to each of categories of solid waste disposal sites. 2006 IPCC Guidelines gives a default values for MCF (2006 IPCC, Vol.5: Waste Table 3.1, p.6.8), which are presented in Table 224 below:

Table 263 Methane Correction Factor (MCF)

SWDS CLASSIFICATION AND METHANE CORRECTION FACTORS(MCF)	
Type of site	Methane correction factor (MCF)
Managed - anaerobic	1
Managed - semi-aerobic	0.5
Unamanaged - deep (>5 m waste)and/or high water table	0.8
Unmanaged - shallow (<5 m waste)	0.4
Uncategorised SWDS	0.6

To determine the quantity of managed and unmanaged landfills at the national level is applied the method of expert judgment, assessment by leading experts in the field of waste from the structure of MOEW (2006 IPCC Guidelines, Vol.1 General Guidance and Reporting). As the main criteria for whether landfills are managed and unmanaged, is considered the fact if the landfills meet the requirements laid down in the EU Directive 1999/31/EC on the landfill of waste. For managed SWDS country uses MCF=1 and for unmanaged (deep) - MCF=0.8.

The CH_4 generation potential (Lo), (Gg CH_4 generated) depends upon the composition of waste, on waste disposal practices and on the physical characteristics of the SWDS. For calculation of CH_4 generation potential Equations 3.2 and 3.3 (2006 IPCC Vol.5: Waste p. 3.9) are used.

For 2014 inventory year the values are:

$$\mathbf{Lo}_{\text{managed landfills}} = 0.045 \text{ Gg } CH_4$$

$$\mathbf{Lo}_{\text{unmanaged landfills}} = 0.036 \text{ Gg } CH_4$$

Methane generation rate constant (k)

The methane generation rate constant (k) in the FOD method is related to the time necessary for DOC in waste to decay to half of its initial mass (the "half life or t½) and depends on large number of factors associated with the composition of waste and conditions at the site.

Since we have available data on the composition of waste in 2002, we calculate country-specific value of the constant k for the period from 2002 to 2014.

Before 2002 the period from 1950 to 2001 accept the default value of k=0.05 (IPCC Good Practice Guidance, p.5.7)

Country doesn't have the data for specific half-life values and therefore default value for bulk waste (k=0.09) and respectively an half-life ($\mathbf{t}_{1/2}$) = 7 (please see 2006 IPCC, Vol.5: Waste Table 3.3, p.3.17; Table 3.4, p.3.18) is used for calculation of weighted average half-time

The average value for constant k for 2014 inventory year is:

k=0.047 (1/yr)

Besides the following parameters are chosen:

Fraction of DOC dissimilated (DOC_f) is an estimate of the fraction of carbon that is ultimately degraded and released from SWDS, and reflects the fact that some organic carbon does not degrade, or degrades very slowly, when deposited in SWDS. It is also good practice to use a value of 0.5 (including lignin C) as the default (2006 IPCC). For calculations of DOC_f Bulgaria uses a default value of 0.5.

Fraction of CH_4 in landfill gas (F): Landfill gas consists mainly of CH_4 and carbon dioxide (CO_2). The CH_4 fraction F is usually taken to be 0.5 by default according to the 2006 IPCC Guidelines.

Methane recovery (R): The country reports methane recovery from 2010 when the installation was brought to exploitation. Before that is zero (2006 IPCC Guidelines).

The calculation of CH_4 from landfills is based on regulatory basis of obtaining information about waste - Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014).The operators of installations are obliged to report on annual basis. In the reporting formats under the Ordinance there is information about methane, stored in reservoirs, burned in a flare and utilized methane. The amount of gas collected and utilized, measured at SWDS is reported to RIEW (Regional Inspectorate of Environment and Water). Reporting is based on the metering of gas recovered for energy utilization and flaring. These data are country specific. The quantities of recovered methane are given in table 225 below.

Sofia landfill is equipped with gas collection system, system for CH_4 utilization and flaring system. The system for methane utilization is co-generation system (CHP-combined heat and power) for heat and electricity production. The system is operating since 2010. Landfill near Silistra does not collect the landfill gas. It has a flaring system (SIMENS installation).

Oxidation factor (OX). Country uses OX=0.1 for managed and unmanaged landfills.

Table 225 summarizes the parameters used to calculate emissions of methane from Solid Waste Disposal Sites by IPCC Tier 2 method. It contains additional information for some years - 1950, 1960, 1970 and 1980.

Table 225 Parameters in Tier 2 for Solid waste Disposal Sites

Year	Total population	Waste generation rate	Fraction of MSW disposed	Fraction DOC in MSW	CH_4 oxidation factor	CH_4 fraction in landfill gas	CH_4 generation rate constant	Time lag	CH_4 emissions	CH_4 recovery
	1000s	kg/person/day						yr	Gg/yr	Gg/yr
1988	8986.636	1.38	0.950	0.1500	NO	0.5	0.050	38	140.107	NO
1989	8767.308	1.38	0.950	0.1500	NO	0.5	0.050	39	141.401	NO
1990	8669.269	1.38	0.950	0.1500	NO	0.5	0.050	40	142.543	NO
1991	8595.465	1.38	0.950	0.1500	NO	0.5	0.050	41	143.561	NO
1992	8484.863	1.38	0.950	0.1500	NO	0.5	0.050	42	144.428	NO
1993	8459.763	1.38	0.950	0.1500	NO	0.5	0.050	43	145.230	NO
1994	8427.418	1.38	0.950	0.1500	NO	0.5	0.050	44	145.963	NO
1995	8384.715	1.38	0.950	0.1500	NO	0.5	0.050	45	146.620	NO
1996	8340.936	1.38	0.950	0.1500	NO	0.5	0.050	46	147.205	NO
1997	8283.200	1.38	0.950	0.1500	NO	0.5	0.050	47	149.037	NO
1998	8230.371	1.39	0.950	0.1500	NO	0.5	0.050	48	148.367	NO
1999	8190.876	1.64	0.651	0.1500	NO	0.5	0.050	49	147.089	NO
2000	8149.468	1.68	0.654	0.1500	NO	0.5	0.050	50	146.727	NO
2001	7891.095	1.66	0.670	0.1500	NO	0.5	0.050	51	146.152	NO
2002	7845.841	1.65	0.676	0.1211	NO	0.5	0.046	52	144.013	NO
2003	7801.273	1.65	0.681	0.1212	NO	0.5	0.046	53	141.962	NO
2004	7761.049	1.63	0.669	0.1213	NO	0.5	0.046	54	139.932	NO
2005	7718.750	1.60	0.698	0.1214	NO	0.5	0.046	55	138.137	NO
2006	7679.290	1.57	0.627	0.1217	NO	0.5	0.046	56	135.764	NO
2007	7640.238	1.50	0.714	0.1217	NO	0.5	0.046	57	134.046	NO
2008	7606.551	1.62	0.749	0.1217	NO	0.5	0.046	58	132.103	NO
2009	7563.710	1.61	0.770	0.1216	NO	0.5	0.046	59	133.112	NO
2010	7504.868	1.48	0.748	0.1218	NO	0.5	0.046	60	130.725	0.251
2011	7327.224	1.34	0.719	0.1227	NO	0.5	0.047	61	130.356	0.246
2012	7284.552	1.22	0.797	0.1229	NO	0.5	0.047	62	128.546	0.223
2013	7245.677	1.19	0.705	0.1230	NO	0.5	0.047	63	126.209	0.223
2014	7202.198	1.21	0.694	0.1228	NO	0.5	0.047	64	124.064	0.127

7.2.4 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

To ensure consistency over time, it is good practice (2006 IPCC Guidelines) a time series should be developed using the same methods. For entire time series we apply the same FOD methods for emission calculation.

Table 226 Activity data and emission factors Uncertainty Range

Total Municipal Solid Waste (MSWT)	30%
Fraction of MSWT sent to SWDS (MSWF)	±30%
Emission factor uncertainty	80%
Total uncertainty of Waste composition	±30%
Degradable Organic Carbon (DOC) (default)	20%

Degradable Organic Carbon (DOC) (country-specific values)		±10%
Fraction of Degradable Organic Carbon Decomposed (DOCf) (IPCC default value (0.5))		± 20%
Methane Correction Factor (MCF) (IPCC default value)	= 1.0	–10%, +0%
	= 0.8	±20%
Fraction of CH_4 in generated Landfill Gas (F) = 0.5 (default)		±5%
Methane Recovery (R)		±10%
Oxidation Factor (OX)		-
half-life (t1/2) (default)	7	17% /-22%
Combined uncertainty		85%

7.2.5 SOURCE-SPECIFIC QA/QC AND VERIFICATION

During the preparation of the inventory submission activities related to quality control were mainly focused on completeness and consistency of emission estimates and on proper use of notation according to QA/QC (Improvement) plan.

Regarding to Tier 2 activities, emission factors and activity data were checked for key source categories. Solid waste disposal on land represent key source category in Waste sector. CH_4 emissions from solid waste disposal on land were estimated using Tier 2 method which is a good practice.

The next basic QA/QC activities were implemented and national circumstances was taken into account:

- Check activity data, emission factors and other parameters (value, record and archive);
- Check for errors in data input and references;
- Check that emissions and parameters are calculated correctly;
- Check completeness;
- Trends checks and etc.

7.2.6 SOURCE-SPECIFIC RECALCULATION

Recalculations were performed due to application of the 2006 IPCC Guidelines.

After the ESD review in 2015 and the TERT recommendations have been implemented following recalculations:

1) oxidation factor OX=0.1 has been used for both managed and unmanaged landfills;
2) for calculation of weighted half-time is based on k=0.09 and half-life (**t** $_{1/2}$) =7 for bulk waste in estimation of the emissions from SWDS.

7.2.7 SOURCE-SPECIFIC IMPROVEMENT PLAN

It is envisaged commissioning of an integrated information system for reporting the various waste management activities, which will cover all persons who carry out waste activities under national legislation. Information system will allow the implementation of adequate measures and policies regarding waste management in order to reduce the negative impact on the environment and human health. This information will be checked and verified by NSI and reported to Eurostat.

7.3 BIOLOGICAL TREATMENT OF WASTE (CRF CATEGORY 5B)

7.3.1 SOURCE CATEGORY DESCRIPTION

The category includes calculation of CH_4 and N_2O emissions in the atmosphere from biological treatment of solid waste (composting). Calculation of the emissions depends on the quality of collected data, amount and type of solid waste, treated biologically and the choice of emission factors respectively.

Composting is a waste management practice for reducing the volume of land filled organic waste and reducing CH_4 emissions respectively. This activity was not well developed in the country until 2011. With adoption of new Waste management law in 2012 composting is regulated as a practice for reducing the share of biodegradable waste sent to SWDS. In this period three composting facilities have been built.

CH_4 and N_2O emissions from composting are decreasing in 2014 due to decreasing amount of waste composted. The reason for the small amount of composted waste is the quality of incoming raw materials for compost production. After biological treatment of waste, organic fraction gets a very low quality and it has been used in landfills.

7.3.1.1 Methodological issues

Methodology for calculation of CH_4 and N_2O emissions from composting.

The estimation and calculations of the emissions from biological treatment of waste are based on the methodology, proposed in the 2006 IPCC Guidelines, which suggests three methods for emission calculation.

For the emissions estimation from biological treatment of solid waste country uses TIER 1 with default emission factors.

Default emission factors for CH_4 and N_2O emissions from biological treatment of waste

Type of biological treatment	CH_4 Emission Factors (g CH_4/kg waste treated)		N_2O Emission Factors (g N_2O/kg waste treated)	
	on a dry weight basis	on a wet weight basis	on a dry weight basis	on a wet weight basis
Composting	10 (0.08-20)	4 (0.03-8)	0.6 (0.2-1.6)	0.24 (0.06-0.6)

The CH_4 and N_2O emissions from composting can be estimated using default method given in Equations 4.1 and 4.2 shown below:

Equation 4.1

$$CH_4\ Emissions = \sum_i (Mi \bullet EFi) \bullet 10^{-3} - R$$

Where:

CH_4 emissions = total CH_4 emissions in inventory year, Gg CH_4

M_i = mass of organic waste treated by biological treatment type *i*, Gg

EF = emission factor for treatment *i*, g CH_4/kg waste treated

i = composting or anaerobic digestion

R = total amount of CH_4 recovered in inventory year, Gg CH_4

Equation 4.2

$$N_2O\ Emissions = \sum_i (Mi \bullet EFi) \bullet 10^{-3}$$

Where:

N_2O Emissions = total N_2O emissions in inventory years, Gg N_2O

M*i* = mass of organic waste treated by biological treatment type *i*, Gg

EF = emission factor for treatment *i*, g N_2O/kg waste treated

i = composting or anaerobic digestion

7.3.1.2 Activity data

The source of activity data is National Statistical Institute.

The emissions from composting are given in the table 227 below

Year	Total Annual amount treated by biological treatment facilities (Gg)	CH_4 emissions (kt)	N_2O emissions (kt)
2011	83.686	0.335	0.020
2012	81.233	0.325	0.019
2013	106.492	0.426	0.026
2014	58.628	0.235	0.014

Table 227 CH_4 and N_2O emissions from composting

7.3.1.3 Emission factors

Default emission factors (on wet weight basis) are used for emission estimation of CH_4 and N_2O from composting. Country specific emission factors or plant specific emission factors are not available at the moment.

7.3.2 UNCERTAINTY AND TIME – SERIES CONSISTENCY

The uncertainty in CH_4 emissions from compost production is estimated to be about 30% concerning activity data and 100% for N_2O emission factor used and 30% for CH_4 EF used.

7.3.3 SOURCE-SPECIFIC QA/QC AND VERIFICATION

The category is covered by the general QA/QC procedures.

7.3.4 SOURCE-SPECIFIC RECALCULATIONS

Recalculations of N_2O emissions have been made for the whole time series due to updated EF for N_2O from 0.3 to 0.24 g N_2O/kg treated waste in the revised version of.2006 IPCC Guidelines.

7.3.5 SOURCE-SPECIFIC PLANNED IMPROVEMENT

It is envisaged commissioning of an integrated information system for reporting the various waste management activities, which will cover all persons who carry out waste activities under national legislation. Information system will allow the implementation of adequate measures and policies regarding waste management in order to reduce the negative impact on the environment and human health. This information will be checked and verified by NSI and reported to Eurostat.

7.4 WASTE INCINERATION (CRF CATEGORY 5C)

7.4.1 OVERVIEW OF THE SECTOR

Emissions from waste incineration without energy recovery have to be reported in the Waste sector, while emissions from incineration with energy recovery should be reported in the Energy sector. According to the 2006 IPCC Guidelines incineration of waste produces emissions of CO_2, CH_4 and N_2O. Normally, emissions of CO_2 from waste incineration are significantly greater than CH_4 and N_2O emissions. Except this type of emissions in the atmosphere are released non-greenhouse gasses like NOx, NH_3, NMVOCs and etc. Emissions of CH_4 are not likely to be significant and these emissions are much dependent on the continuity of the incineration process, the incineration technology and management practices.

For the purpose of this inventory are calculated emissions of CO_2 from waste incineration (significantly greater than N_2O emissions) N_2O and CH_4 emissions.

Incineration of waste is not a key category in the country. For estimation of CO_2, N_2O and CH_4 emissions TIER 1 method is applied. This report includes emissions from incineration of clinical and hazardous waste that practically are incinerated in the country.

7.4.1.1 Emission trend

Table 228 shows in systematic way the quantity of incinerated type of waste and respectively emissions of CO_2, N_2O and CH_4, according to activity data and type of waste for different years.

Year	Clinical waste				Hazardous waste			
	Clinical waste Gg/yr	CO_2 emissions	CH_4 emissions	N_2O emissions	Hazardous waste Gg/yr	CO_2 emissions	CH_4 emissions	N_2O emissions
1988	0.976	2.146	5.854E-06	4.878E-05	10.70	19.62	0.0000642	0.005
1989	0.981	2.158	5.886E-06	4.905E-05	11.00	20.17	0.000066	0.005

Year	Clinical waste				Hazardous waste			
	Clinical waste Gg/yr	CO_2 emissions	CH_4 emissions	N_2O emissions	Hazardous waste Gg/yr	CO_2 emissions	CH_4 emissions	N_2O emissions
1990	0.977	2.149	5.86E-06	4.884E-05	11.50	21.08	0.000069	0.005
1991	0.993	2.184	5.956E-06	4.963E-05	11.70	21.45	0.0000702	0.005
1992	0.991	2.180	5.944E-06	4.953E-05	10.90	19.98	0.0000654	0.005
1993	0.990	2.178	5.939E-06	4.949E-05	11.80	21.63	0.0000708	0.005
1994	0.996	2.191	5.976E-06	4.98E-05	12.00	22.00	0.000072	0.005
1995	1.070	2.354	6.419E-06	5.349E-05	12.10	22.18	0.0000726	0.005
1996	1.092	2.403	6.554E-06	5.462E-05	11.90	21.82	0.0000714	0.005
1997	1.102	2.424	6.612E-06	5.51E-05	12.00	22.00	0.000072	0.005
1998	1.098	2.416	6.59E-06	5.492E-05	20.56	37.69	0.0001233	0.009
1999	1.105	2.430	6.627E-06	5.523E-05	16.58	30.39	9.947E-05	0.007
2000	1.124	2.472	6.742E-06	5.618E-05	37.33	68.43	0.000224	0.017
2001	1.137	2.502	6.825E-06	5.687E-05	23.46	43.00	0.0001407	0.011
2002	1.168	2.570	7.009E-06	5.841E-05	22.86	41.92	0.0001372	0.010
2003	1.516	3.335	9.096E-06	7.58E-05	25.73	47.18	0.0001544	0.012
2004	1.763	3.879	1.058E-05	8.816E-05	41.28	75.67	0.0002477	0.019
2005	2.353	5.177	1.412E-05	0.0001177	31.97	58.62	0.0001918	0.014
2006	2.579	5.673	1.547E-05	0.0001289	29.88	54.78	0.0001793	0.013
2007	2.035	4.478	1.221E-05	0.0001018	19.66	36.03	0.0001179	0.009
2008	1.440	3.168	8.64E-06	7.2E-05	24.93	45.70	0.0001496	0.011
2009	1.301	2.862	7.805E-06	6.504E-05	19.48	35.70	0.0001169	0.009
2010	1.285	2.827	7.71E-06	6.425E-05	7.47	13.69	4.481E-05	0.003
2011	1.244	2.738	7.466E-06	6.222E-05	5.22	9.57	3.132E-05	0.002
2012	1.355	2.982	8.133E-06	6.777E-05	11.45	21.00	6.871E-05	0.005
2013	0.892	1.963	5.353E-06	4.461E-05	23.10	42.35	0.0001386	0.010
2014	0.744	1.638	4.466E-06	3.722E-05	6.43	11.79	3.858E-05	0.003

Table 228 Quantity of incinerated type of waste and CO_2, CH_4 and N_2O emissions from waste incineration

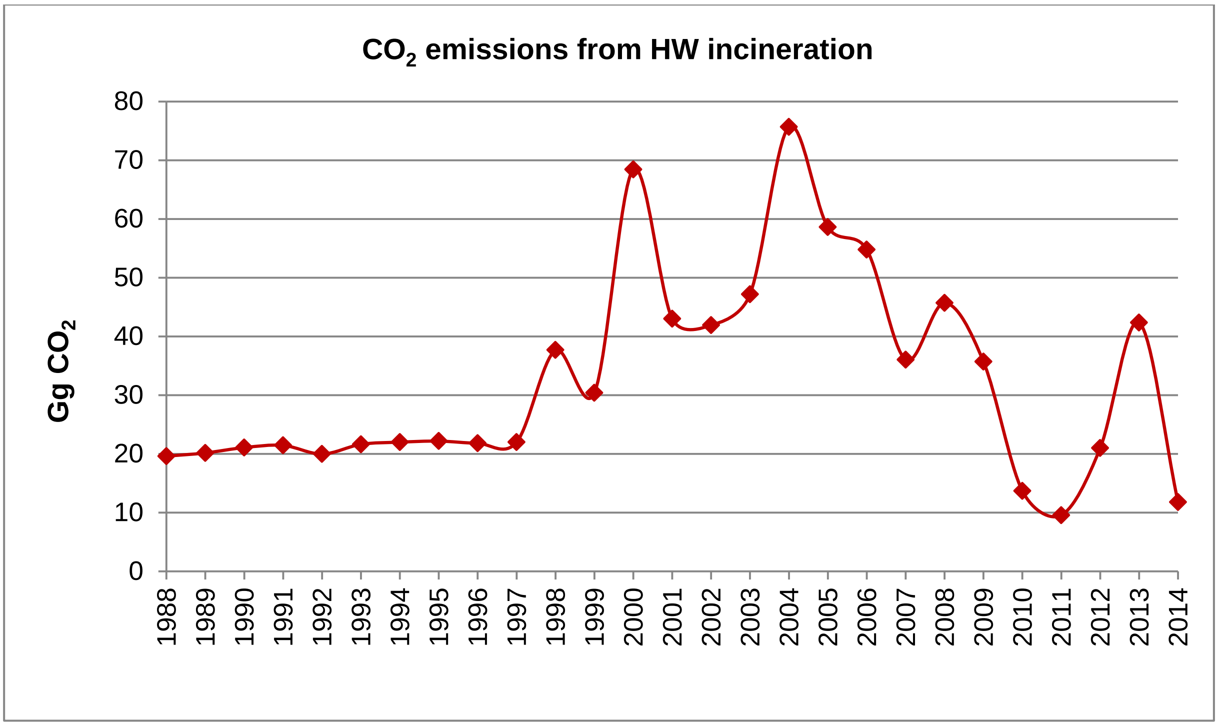


Figure 102 CO2 emissions from hazardous waste incineration

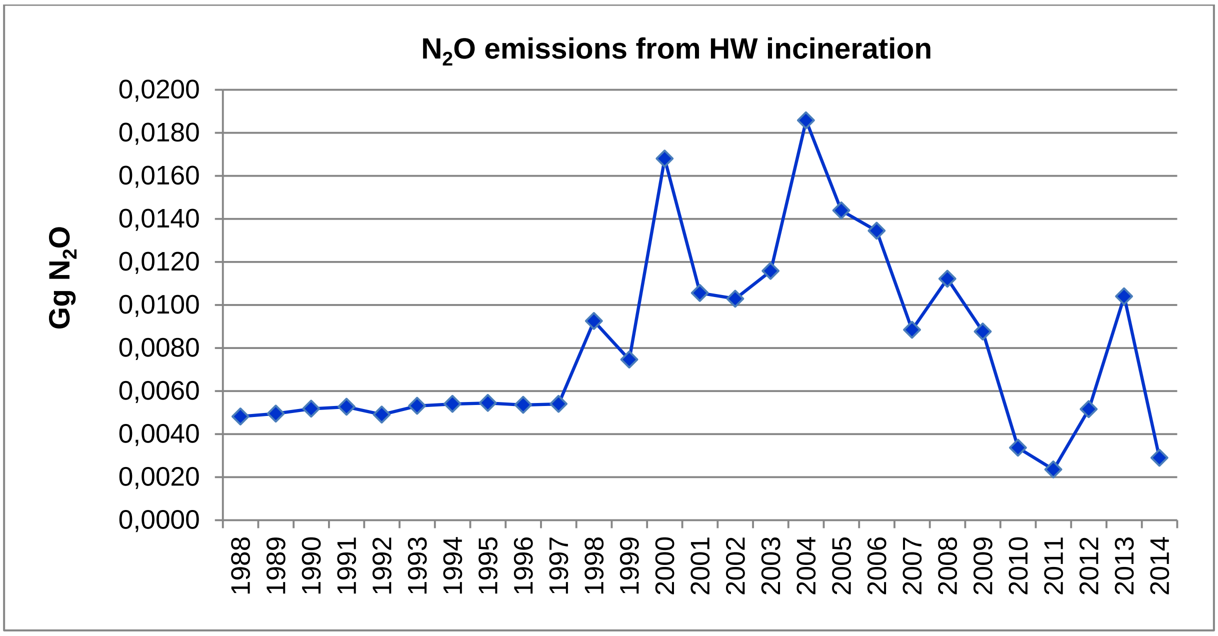


Figure 103 N2O emissions from hazardous waste incineration

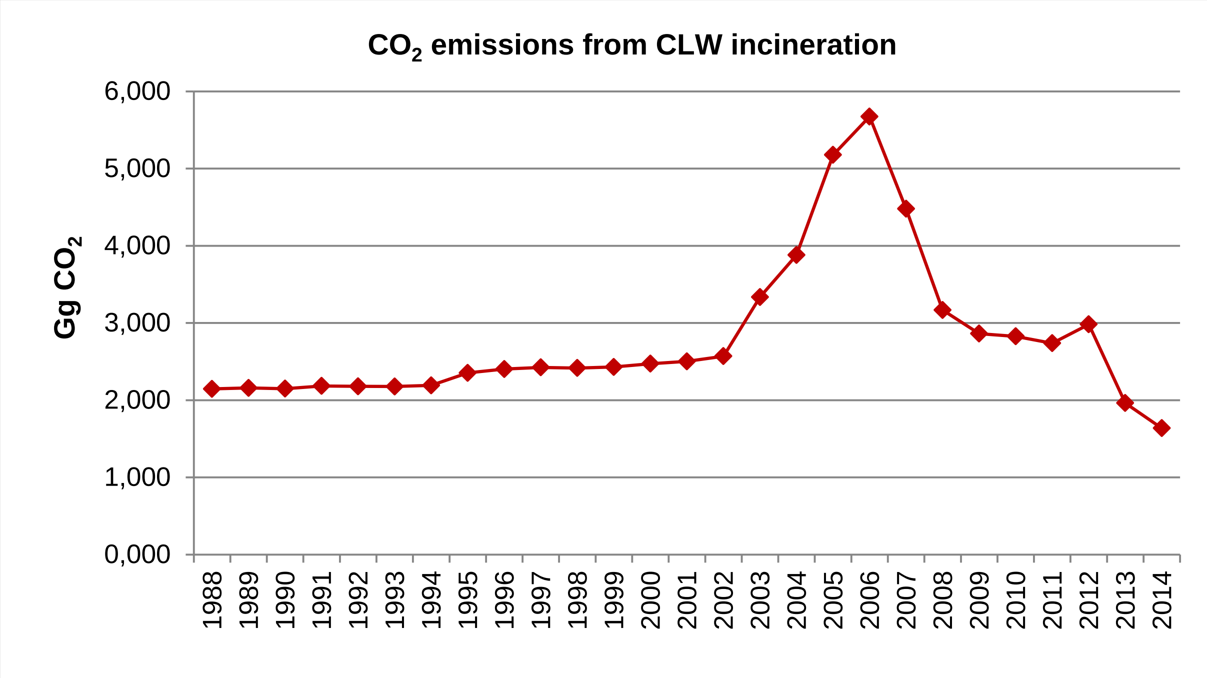


Figure 104 CO2 emissions from clinical waste incineration

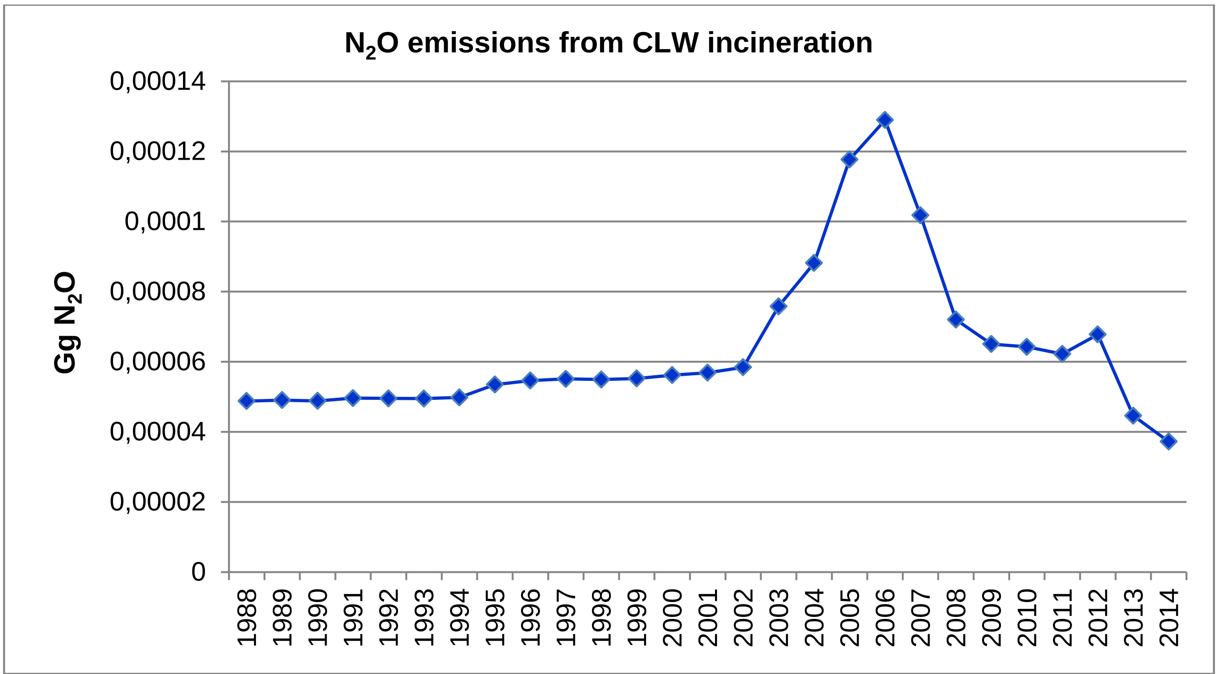


Figure 105 N2O emissions from clinical waste incineration

Reduced incineration of hazardous waste in the installation of Luk Oil Neftochim for 2010 is due to the reduced quantity of processed sludge which is connected with decrease of the quantity of wastewaters in wastewater treatment plant. For 2011 except reduced quantity of processed sludge, a repair of the three-phase centrifuge for oil middling slime processing took place for a long time. For 2012 the quantity of incinerated hazardous waste in the installation increase in comparison with preceding years (doubled quantity of the incinerated waste in comparison with 2011) and that lead to emissions increase respectively.

Reduced incineration of hazardous waste in the installation of Luk Oil Neftochim for 2014 is due to the frequent shutdowns of the furnaces for repair. In 2014 the construction of installations for purifying flue gases from kiln incinerators is completed. Furnaces have a system for continuous measurements of pollutants in flue gases.

Concerning clinical waste, before 2006 in country were working considerable number of furnaces for hospital waste incineration, located on the territory of the hospitals throughout the country. Following the adoptions of more stringent requirements of Directive 2000/76/EC transposed into Regulation No 6/28.04.2004 that has led to the closure of the operation of all this type of furnaces and emissions reduction respectively.

7.4.2 INCINERATION OF CLINICAL WASTE (CRF CATEGORY 5C)

7.4.2.1 Category description

Currently waste incineration is a practice to incinerate clinical waste. There are two incinerators for incineration of clinical waste at the EMEPA and Medicom, located in Sofia. Concerning activity data, we have regulatory basis for obtaining information about waste - Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014). The operators of installations are obliged to report on annual basis. In the reporting formats under the ordinance the quantities of treated waste are included. They contain information about:

- Type of incineration plant
- Capacity of installation
- Year of commissioning the installation
- Reconstruction of the installation (change, year and etc.)
- Quantity of incinerated waste
- Characteristics of incinerated waste

7.4.3 METHODOLOGICAL ISSUES

The choice of a good method for emission calculations depend on national circumstances, including whether incineration of waste is a key category and to what extent country and plant-specific information is available. Concerning waste incineration, most adequate and correct results are going to complete if the information about type of waste and incineration technology are available. The most adequate results will be obtained if the emissions are going to be estimated on the level of incineration plant or divided by type of incinerated waste.

The methods for estimating CO_2, N_2O and CH_4 emissions from incineration differ because of the different factors that influence emission levels. For this reason they are described separately.

7.4.3.1 Choice of method for estimating CO_2 emissions from clinical waste incineration

TIER 1 method is used for estimation of CO_2 emissions from incineration of clinical waste, because it is not a key category. CO_2 emissions have been calculated using the methodology, proposed by the 2006 IPCC Guidelines, by multiplying the incinerated waste with default values for dry matter content in the waste, fraction of carbon in dry matter, fraction of fossil carbon and oxidation factor.

Equation 5.1 (2006 IPCC, Vol.5: Waste p.5.7) is used for estimating CO_2 emissions.

7.4.3.2 Choice of method for estimating N_2O emissions from clinical waste incineration

For N_2O emission calculations equation 5.5 is used (2006 IPCC, Vol.5: Waste p.5.14, TIER 1, non key category)

7.4.3.3 Choice of method for estimating CH_4 emissions from clinical waste incineration

For CH_4 emission calculations equation 5.4 is used (2006 IPCC, Vol.5: Waste p.5.12, TIER 1, non key category)

7.4.4 CHOICE OF EMISSION FACTORS

In the annual reports from operators of incinerators lacks sufficient information for specifying characteristics of waste as carbon content in the waste, fraction of fossil carbon, dry matter content, etc.

For estimation of CO_2 emissions from clinical waste incineration, country used 60 % total carbon content in % of dry weight; 40 % fossil carbon fraction in % of total carbon content and 100 % oxidation factor (2006 IPCC,Vol.5:Waste, p.5.18, Table 5.2)

7.4.4.1 Choice of emission factors for N_2O estimations

If site-specific emissions factors are not available, default factors can be used.

In country incineration plants are type heart or grate. There is no a default EF N_2O for such type of installation. For estimation of N_2O emissions from incineration of clinical waste we choose EF N_2O 50g N_2O/t waste for continuous and semi-continuous incinerators (2006 IPCC, Vol.5: Waste, p.5.22, Table 5.6)

7.4.4.2 Choice of emission factors for CH_4 estimations

For calculation of CH_4 emissions from clinical waste incineration, default EF is used - 6 kg/Gg incinerated waste for semi-continuous incineration (2006 IPCC, Vol.5: Waste, p.5.20, Table 5.3)

7.4.5 INCINERATION OF HAZARDOUS WASTE (CRF CATEGORY 5C)

7.4.5.1 Category description

In the installation of Luk Oil Neftochim are incinerated hazardous waste, mainly sludge and other waste contaminated with oil. As already mentioned, the choice of a good method for emission calculations depend on national circumstances, including whether incineration of waste is a key category in the country and to what extent country and plant-specific information is available.

Concerning activity data, we have regulatory basis for obtaining information about waste- Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014). The operators of installations are obliged to report on annual basis. In the reporting formats under the ordinance the quantities of treated waste are

7.4.5.2 Choice of method for estimating CO_2 emissions from hazardous waste incineration

TIER 1 method is used for estimation of CO_2 emissions from hazardous waste incineration, because it is not a key category.

Equation 5.1 (2006 IPCC, Vol.5: Waste p.5.7) is used for estimating CO_2 emissions

7.4.5.3 Choice of method for estimating N_2O emissions from hazardous waste incineration

TIER 1 method is used for estimation of N_2O emissions from hazardous waste incineration. The calculation of N_2O emissions is based on the waste input to the incinerators and default emission factor.

For N_2O emission calculations equation 5.5 is used (2006 IPCC, Vol.5: Waste p.5.14)

7.4.5.4 Choice of method for estimating CH4 emissions from hazardous waste incineration

The calculation of CH_4 emissions is based on the amount of waste incinerated and on the related emission factor for TIER 1 - Equation 5.4 (2006 IPCC, Vol.5: Waste p.5.12).

7.4.6 CHOICE OF EMISSION FACTORS

For calculation of CO_2 emissions from incineration of hazardous waste default parameters have been used (2006 IPCC, Vol.5: Waste, p.5.18, Table 5.2)

For estimation of CO_2 emissions from hazardous waste incineration, country used 50% total carbon content in % of dry weight; 90% fossil carbon fraction in % of total carbon content and 100 % oxidation factor.

7.4.6.1 Choice of emission factors for N_2O estimations

For calculation of N_2O emissions from hazardous waste incineration we used EF N_2O of 450 g N_2O/t waste (2006 IPCC, Vol.5: Waste, p.5.21, Table 5.5)

7.4.6.2 Choice of emission factors for CH_4 estimations

For calculation of CH_4 emissions from hazardous waste incineration we used EF CH_4 of 6 kg/Gg waste incinerated on a wet weight basis for semi-continuous incineration (2006 IPCC, Vol.5: Waste, p.5.20,Table 5.3).

7.4.7 UNCERTAINTY AND TIME – SERIES CONSISTENCY

Emission factor uncertainty from waste incineration is estimated to be about 100 % - default factors are used, concerning AD uncertainty - 15 % due to higher uncertainty of clinical waste.

Emissions from waste incineration are calculated using the same method and data set consistently for every year in the time series.

7.4.8 SOURCE-SPECIFIC QA/QC AND VERIFICATION

The category is covered by the general QA/QC procedures.

7.4.9 SOURCE-SPECIFIC RECALCULATIONS

Source specific recalculations are not planned.

7.4.10 SOURCE-SPECIFIC PLANNED IMPROVEMENT

It is envisaged commissioning of an integrated information system for reporting the various waste management activities, which will cover all persons who carry out waste activities under national legislation. Information system will allow the implementation of adequate measures and policies regarding waste management in order to reduce the negative impact on the environment and human health. This information will be checked and verified by NSI and reported to Eurostat.

7.5 WASTEWATER HANDLING (CRF SECTOR 5 D)

7.5.1 OVERVIEW OF THE SECTOR

This sector includes CH_4 emissions from wastewater when treated or disposed anaerobically and indirect N_2O emissions for the period 1988-2014. CO_2 emissions from wastewater are not considered in the 2006 IPCC Guidelines.

The calculation of the emissions is separated in two sub categories:

5D1 – Domestic/commercial wastewater treatment;

5D2 – Industrial wastewater treatment

7.5.2 EMISSION TREND

Total CO_2 equivalents from wastewater handling for 2014 are 1122 Gg CO_2 eq. The peak in emissions in 2003 compared to the preceding year is the decision of the Ministry of Environment and Water for the discharge of several big tailing ponds of mining companies in the country. The high level of the emissions of the industrial wastewater kept in 2004 due to the same reason.

Increased CH_4 emissions from Domestic/commercial wastewater treatment in 2013 are due to technical problems with methane tanks in one of the biggest wastewater treatment plants in the country.

TIER 2 is applied in the calculation of the CH_4 emissions from Domestic and Industrial wastewater handling.

Methane emissions from wastewater treatment and CH_4 recovery are shown on the figure below. We divide the emission by domestic and industrial origin.

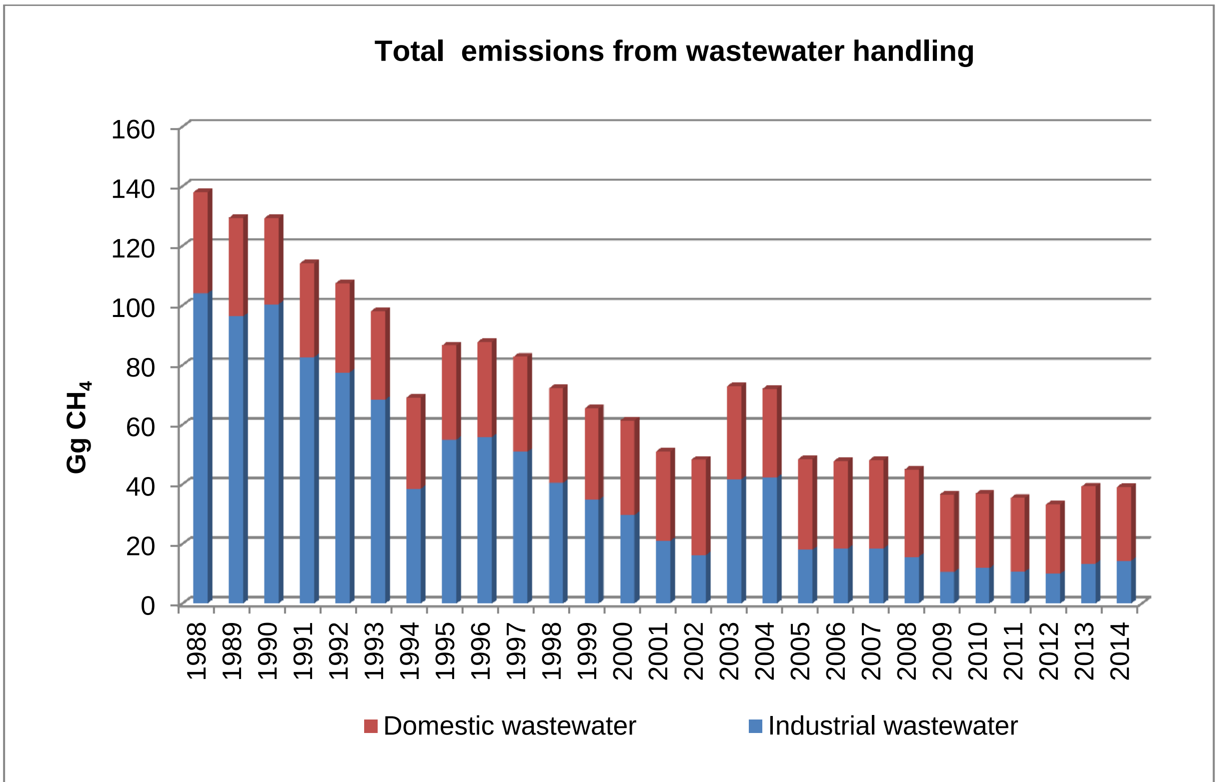


Figure 106 CH4 emissions from wastewater handling

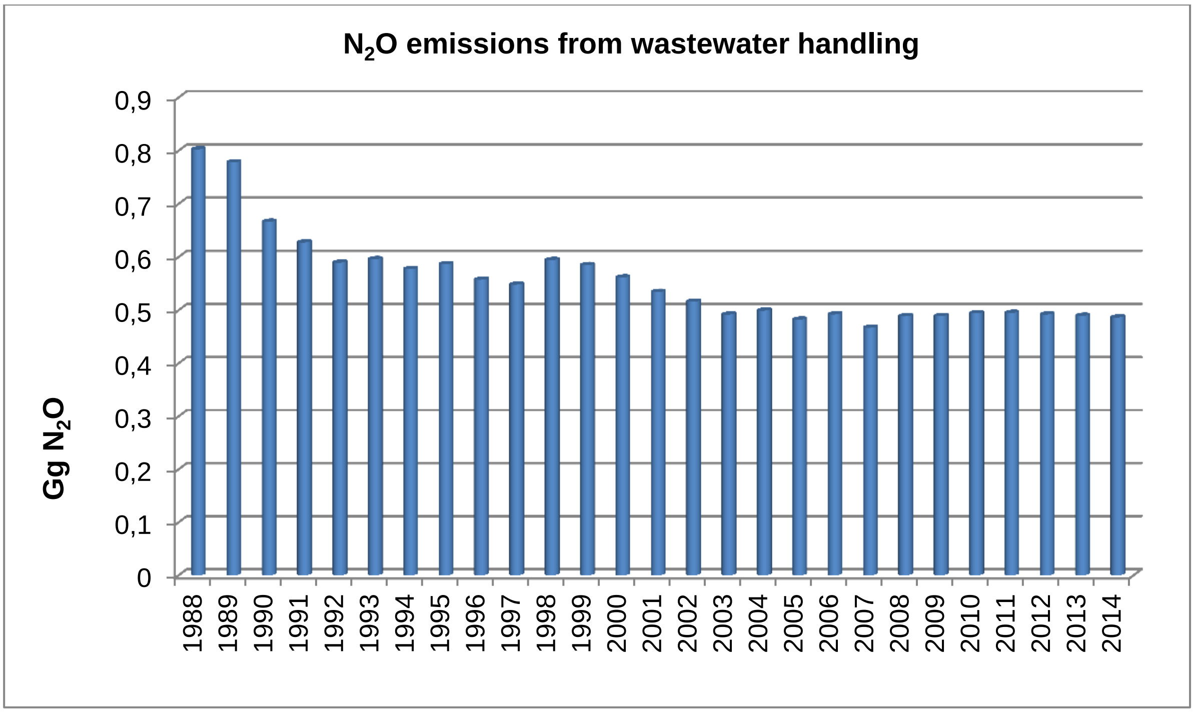


Figure 107 N2O emissions from wastewater handling

7.5.3 DOMESTIC WASTEWATER HANDLING (CRF CATEGORY 5D1)

7.5.3.1 Category description

This category is a key category.

The source of information about treatment and discharge pathways or systems in the country, quantities of wastewater, treated in each treatment system and generated and treated domestic/industrial wastewater is National Statistical Institute.

According to NSI data, domestic wastewater has been treated in centralized aerobic treatment plants, septic systems and discharged into water bodies (sea, river, lakes). In 2014 about 57% of the population is connected to centralized aerobic treatment plants, 18% is connected to the public sewerage, but without treatment (sea, river, lake) and 25% of the country population use septic systems.

In Bulgaria, 73% of the population is classified as urban income group and 27 % - as rural income group (NSI data). Degree of utilization (T) of treatment and discharge pathways for each income group are shown in table 231.

Total methane emissions from domestic wastewater treatment for 2014 are 24.78 Gg. Significant contribution to these emissions have septic systems – 10.05 Gg.

7.5.3.2 Methodological Issues

7.5.3.2.1 Methodology for calculation of the methane emissions from domestic/commercial wastewater handling (5D1)

The 2006 IPCC Guidelines describe methodology for the calculation of the methane emissions in the atmosphere during the processes of domestic wastewater treatment. The decision tree, which describes the steps and the algorithm for calculating methane emissions, is shown on Figure 6.2, page.6.10 / 2006 IPCC.

The methodology for the calculation of the methane emissions from domestic wastewater handling consists of three components: 1) definition of the total organically degradable material in domestic wastewater (TOW); 2) definition of emission factor for each domestic wastewater treatment/discharge pathway or system and 3) emission estimation.

The first step in the calculations is to define the total organically degradable material in domestic wastewater (TOW), which is the AD for this source category. TOW is expressed in the term of biochemical oxygen demand (kg BOD/year). Based on the demographic data acquired by the National Statistical Institute for the respective inventory years, we calculate TOW with the following equation:

$$TOW = P \bullet BOD \bullet 0.001 \bullet I \bullet 365$$

Where:

TOW – total organics in the wastewater in inventory year, kg BOD/yr

P – country population in inventory year

BOD – country specific per capita BOD in inventory year, g/person/day

Default value = 60 g/person/day

0.001 - conversion from grams BOD to kg BOD

I - correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, used in calculations)

Table 229 Total organically degradable material (TOW) in domestic wastewater

Year	Total organic product	Year	Total organic product	Year	Total organic product
	kg BOD/yr		kg BOD/yr		kg BOD/yr
1988	246009161	**1997**	226752600	**2006**	210220564
1989	240005057	**1998**	225306406	**2007**	209151515
1990	237321239	**1999**	224225231	**2008**	208229334
1991	235300854	**2000**	223091687	**2009**	207056561
1992	232273125	**2001**	216018726	**2010**	205445762
1993	231586012	**2002**	214779897	**2011**	200582757
1994	230700568	**2003**	213559848	**2012**	199414611

1995	229531573	**2004**	212458716	**2013**	198350408
1996	228333123	**2005**	211300781	**2014**	197160170

The next step of the calculation is to define the Emission factor.

The emission factor for wastewater treatment and discharge pathway and system is a function of the maximum CH_4 producing potential (Bo) and methane correction factor (MCF) for wastewater treatment and discharge system.

The Equation for calculation of EF is:

$$\boldsymbol{EF_j = B_0 \bullet MCF_j}$$

Where:

EF_j – emission factor, kg CH_4/kg BOD

j – each treatment/discharge pathway or system

Bo – maximum CH_4 producing capacity, kg CH_4/kg BOD

MCF_j– methane correction factor (fraction)

2006 IPCC Guidelines provides the default value for domestic wastewater:

Bo = 0,60 kg CH_4 /kg BOD

The first step for the definition of MCF is to characterize the systems for wastewater treatment in the country. The big picture for the flow of domestic and industrial wastewater and the different possibilities of treatment is shown on Figure 99. In bolded outline are shown the potential methane sources.

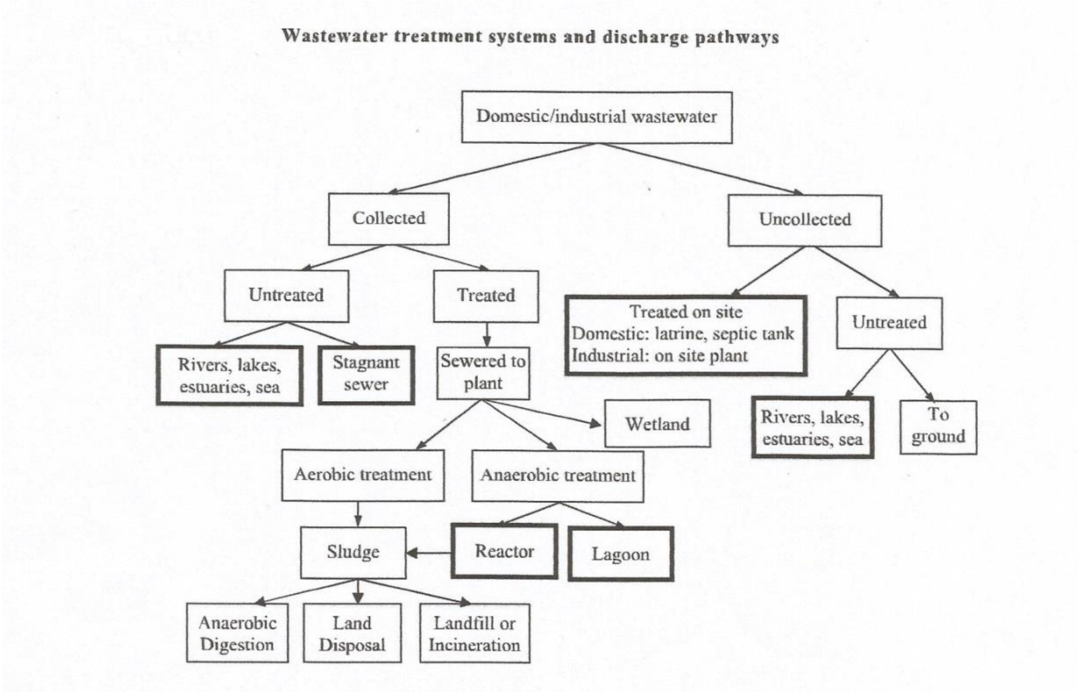


Figure 108 Potential CH4 sources

Following the 2006 IPCC Guidelines, table 6.3, page.6.13, the type of wastewater treatment system and the discharge pathways are defined for the whole country. Based on the data by the National Statistical Institute, we point out three categories of methane emissions sources.

Category 1 - waters without treatment discharged in the water sources (sea, rivers and lakes).

Category 2 - waters discharged trough sewer systems into centralized aerobic wastewater treatment plant. In the general case they are amortized.

Category 3 – waters treated in septic systems.

We use the *methane correction factor* as follows:

Category 1 - waters without treatment discharged in the water sources (sea, rivers and lakes) MCF = 0.1

Category 2 - waters discharged trough sewer system into centralized aerobic wastewater treatment plant – MCF = 0.3

Category 3 – waters treated in septic systems – MCF = 0.5

The same data from National Statistical Institute are used for wastewater distribution among different treatment systems. The data are country specific.

Table 230 Domestic wastewater distribution among different treatment systems

Year	Discharged into sea, river, lake	Centralized, aerobic, not well managed treatment plant	Septic systems
1988	43.07%	32.30%	24.63%
1989	43.07%	32.30%	24.63%
1990	56.14%	17.54%	26.32%
1991	49.36%	18.95%	31.69%
1992	51.23%	21.28%	27.48%
1993	51.02%	22.79%	26.19%
1994	48.08%	25.07%	26.85%
1995	44.25%	28.99%	26.77%
1996	43.30%	28.51%	28.19%
1997	42.54%	29.82%	27.64%
1998	41.54%	32.69%	25.76%
1999	43.72%	32.19%	24.09%
2000	40.61%	32.75%	26.64%
2001	42.28%	33.14%	24.58%
2002	35.52%	37.27%	27.21%
2003	37.23%	37.10%	25.67%
2004	40.16%	37.66%	22.17%
2005	37.38%	40.18%	22.44%
2006	40.27%	38.60%	21.12%
2007	38.36%	40.52%	21.12%
2008	38.96%	41.33%	19.70%
2009	41.41%	40.28%	18.31%
2010	41.20%	41.55%	17.25%
2011	39.26%	42.55%	18.20%
2012	38.08%	45.35%	16.57%
2013	34.82%	43.41%	21.77%
2014	33.50%	45.25%	21.24%

After determination of TOW, wastewater treatment systems and discharge pathways and respective MCF, we can calculate the CH_4 emissions from domestic wastewater as follows:

$$CH_4\ Emissions = \left[\sum_{i,j}\left(U_i \bullet T_{i,j} \bullet EF_j\right)\right](TOW - S) - R$$

Where:

CH_4 emissions – CH_4 emissions in inventory year, kg CH_4/yr

TOW – total organics in wastewater in inventory year, kg BOD/yr

S – organic component removed as sludge in inventory year, kg BOD/yr

R – amount of CH4 recovered in inventory year, kg CH_4/yr

U_i – fraction of population in income group i in inventory year

$T_{i,j}$ – degree of utilization of treatment/discharge pathway or system, j, for each income group fraction i in inventory year

i – income group: rural, urban high income and urban low income

j – each treatment/discharge pathway or system

EF – emission factor, kg CH_4/yr

CH_4 emissions from domestic wastewater treatment and discharge for the period 1988-2014 are shown in figure 100

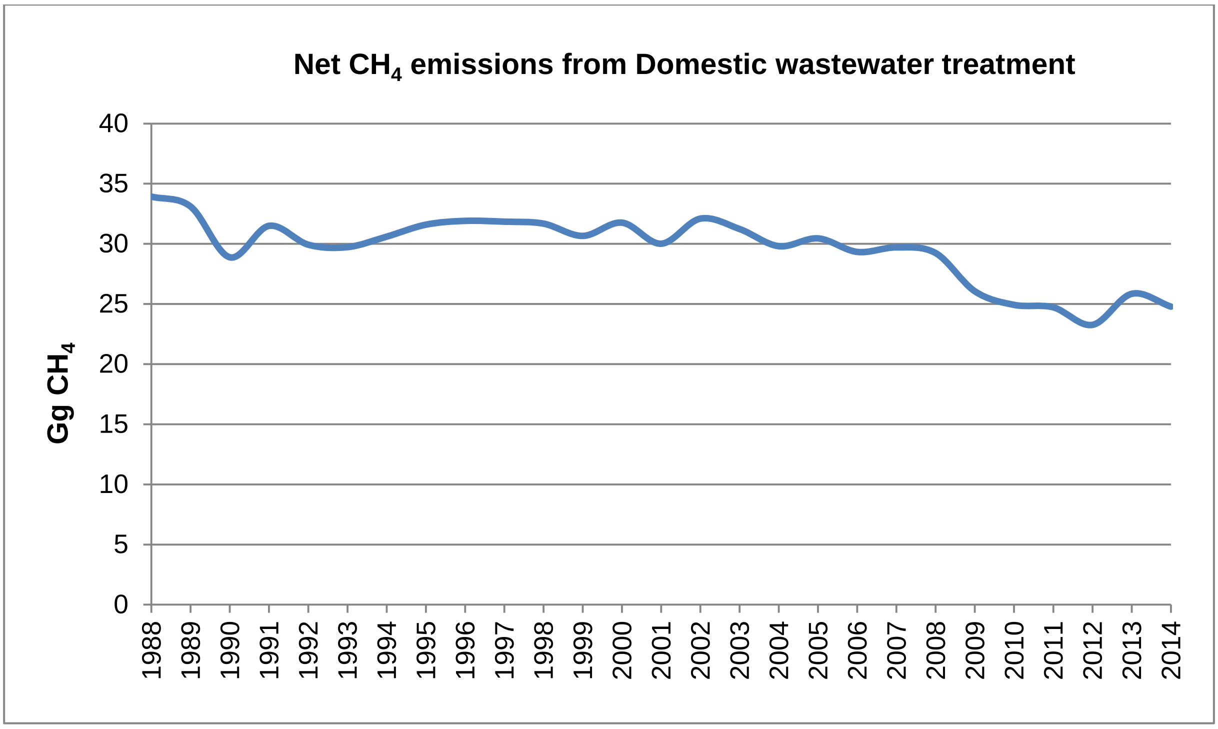


Figure 109 CH4 emissions from domestic wastewater handling

The source of information about degree of urbanization in the country is National Statistical Institute. The population is separated into two main fractions: urban and rural as the dominating is the urban population.

The degree of utilization of each treatment system is calculated for urban and rural population.

The following table summarizes the results

Table 231 Degree of utilization of treatment systems (T) for each income group (U)

Income group	Type of treatment and discharge pathways	Treatment utilization (%)
Urban population	Discharge into the sea,river, lake	25
	To centralized aerobic treatment plant	33
	To septic systems	15
Rural population	Discharge into the sea,river, lake	9
	To centralized aerobic treatment plant	12
	To septic systems	6

7.5.3.3 Choice of emission factors and parameters

For CH_4 emission estimation, default 2006 IPCC Guidelines were used.

Wastewater treatment and discharge pathways

The source of activity data about treatment and discharge pathways or systems in the country, quantities of wastewater, treated in each treatment system and generated and treated domestic/industrial wastewater is National Statistical Institute.

Degradable organic component indicator (BOD)

For domestic wastewater, biochemical oxygen demand (BOD) is the recommended parameter used to measure the degradable organic component in wastewater. The BOD concentration indicates the amount of carbon that is aerobically biodegradable. The IPCC default value of 60 g BOD/person/day or 21900 kg BOD/1000 person/yr was used for emission calculations (2006 IPCC,Vol.5: Waste, p. 6.14).

Correction factor for additional industrial BOD discharged into sewers (I)

The factor expresses the BOD from industries and establishments that is co-discharged with domestic wastewater. The IPCC default value of 1.25 was used for emission calculations (2006 IPCC, Vol.5: Waste, p. 6.14, Table 6.4). The factor I is applied only for the wastewater, treated by WWTP.

Maximum methane producing capacity (B_0)

The IPCC default of 0.6 kg CH_4/kg BOD was used for emission calculations (2006 IPCC, Vol.5: Waste, p. 6.12, Table 6.2).

Methane correction factor (MCF)

Determination of methane correction factor depends on the available systems for wastewater treatment in the country. The defaults MCF, used in calculations are as follows:

a) waters without treatment discharged in the water sources (sea, rivers and lakes) MCF = 0.1
b) waters discharged trough sewer system into centralized aerobic wastewater treatment plant – MCF = 0.3
c) waters treated in septic systems – MCF = 0.5

The source of information about treatment and discharge pathways or systems in the country, quantities of wastewater, treated in each treatment system and generated and treated domestic/industrial wastewater is National Statistical Institute.

Methane recovery (R) The calculation of CH_4 recovery from wastewater handling is based on regulatory basis of obtaining information about waste - Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014).).The operators of installations are obliged to report on annual basis. In the reporting formats under the Ordinance there is information about the type of plant treatment system for CH_4 utilization (e.g. gas holder system, methane tanks and gas burning system); quantity of total captured CH_4, CH_4 stored in reservoirs, utilized and flared methane) and year of commissioning of the installation for CH_4 utilization. Reporting is based on the metering of gas recovered for energy utilization and flaring. These data are country specific.

For 2014 the quantity of recovered methane is 4.50 Gg.

Organic component removed as sludge (S). For sludge removal from the wastewater default IPCC value of zero was used for emission calculations (2006 IPCC, Vol.5: Waste, p.6.9).

For the last couple of years there is an improvement in the sludge management practices – as sludge is stabilized in methane tanks. Information about the quantities of treated sludge and type of treatment is obtained through Ordinance No 1 on the Procedures and forms for providing information about waste management activities and the procedure for keeping public records (published in State Gazette No 51 from 20.06.2014). For 2014 nearly 73% of the sludge in the country is treated anaerobically. All wastewater treatment plants with anaerobic sludge stabilization utilise biogas for generation of heat and/or electricity. Sludge, which will be used in agriculture, need to be treated in a proper way to ensure safety in terms of microbiological and parasitological parameters. According Ordinance on the way of recovery of sludge from wastewater treatment through its use in agriculture for 2014 the quantity of sludge, used in agriculture is 16 363 t; 847.09 t sludge are vermin-composted; 722.370 t are used for reclamation of disturbed areas; 8 828.253 t of sludge are land filled and respective emissions are reported in sector 5 A - Solid waste disposal and 21 985 t of sludge are temporarily stored.

7.5.3.4 Methodology for calculation of the methane emissions of industrial wastewater handling (CRF 5D2)

Industrial wastewater can be treated on site or discharged into centralized sewer. Emissions from industrial wastewater discharged into centralized sewer, are included in emissions from domestic wastewater.

The source of activity data about treatment and discharge pathways or systems in the country, quantities of wastewater, treated in each treatment system and generated and treated domestic/industrial wastewater is National Statistical Institute.

In this sub-category we calculate the methane emissions from industrial wastewater treated on site.

Based on the data acquired by the National Statistical Institute we determine the percentage on industrial wastewater treated on site.

Table 232 Industrial wastewater treated on site

Year	Total industrial wastewater	Treated on site		Non treated on site	
	thou.m^3	thou.m^3	%	thou.m^3	%
1988	1 075 286	610 746	56.80%	464 540	43.20%
1989	1 008 789	572 976	56.80%	435 812	43.20%
1990	1 127 165	610 252	54.14%	516 913	45.86%
1991	900 404	460 803	51.18%	439 601	48.82%
1992	766 131	368 586	48.11%	397 545	51.89%
1993	608 420	304 300	50.01%	304 120	49.99%
1994	526 760	291 347	55.31%	235 413	44.69%
1995	587 085	361 591	61.59%	225 494	38.41%
1996	577 742	352 879	61.08%	224 863	38.92%
1997	489 706	298 698	61.00%	191 008	39.00%
1998	418 679	250 707	59.88%	167 972	40.12%
1999	377 265	206 549	54.75%	170 716	45.25%
2000	328 497	158 273	48.18%	170 224	51.82%
2001	274 475	121 677	44.33%	152 797	55.67%
2002	225 023	136 029	60.45%	88 994	39.55%
2003	666 142	558 201	83.80%	107 941	16.20%
2004	657 812	555 546	84.45%	102 267	15.55%
2005	180 648	102 945	56.99%	77 703	43.01%
2006	227 422	121 008	53.21%	106 414	46.79%
2007	219 057	119 621	54.61%	99 436	45.39%
2008	204 462	109 484	53.55%	94 978	46.45%
2009	172 156	80 950	47.02%	91 206	52.98%
2010	171 890	84 462	49.14%	87 428	50.86%
2011	153 581	69 733	45.40%	83 848	54.60%
2012	146 536	69 526	47.45 %	77 011	52.55%
2013	154 477	74 043	47.93 %	80 433	52.07 %
2014	146 283	74 743	51.09%	71 540	48.91%

2006 IPCC Guidelines describe a method for calculating methane emissions from industrial wastewater in the atmosphere, similar to methodology for calculation of the emissions from domestic/commercial wastewater.

As the first step, it is necessary to determine the total amount of organically degradable material in the wastewater (TOW). It is expressed in terms of chemical oxygen demand (kg/COD/yr). The equation for calculation of TOW for particular industrial sector is:

$$TOW_i = P_i \bullet W_i \bullet COD_i$$

Where:

TOW – total organically degradable material in wastewater for industry i, kg COD/yr

Pi – total industrial product for industrial sector i, t/yr

Wi – wastewater generated, m^3/t product

COD – degradable organic component in wastewater, kg COD/yr

i – industrial sector

Secondly, the emission factors for each industrial wastewater treatment and discharge pathways have to be estimated (2006 IPCC, Vol.5: Waste, p.6.21, eq.6.5). The emission factor is function of the maximum CH_4 producing potential (Bo) and methane correction factor (MCF).

$$\boldsymbol{EF_j = B_0 \bullet\bullet MCF_j}$$

Where:

EF_j – emission factor for each treatment/discharge pathway or system, kg CH_4/kg COD

Bo – maximum CH_4 producing capacity, kg CH_4/kg COD

MCF – methane correction factor

j – each treatment/discharge pathway or system

To determine the methane correction factor, the type of wastewater treatment systems and discharge pathways are defined for the whole country by National Statistical Institute:

a) waters, discharged into sea, river, lake - MCF=0.1;

b) waters, discharged trough sewer system into centralized aerobic treatment plant – MCF=0.3;

c) waters, treated in stagnant sewer – MCF=0.5

These methane correction factors are used in estimation of CH_4 emissions from industrial wastewater treatment.

In the end, the total emission of methane from industrial wastewater is estimated. The equation for calculation of annual CH_4 emissions is as follows:

$$CH_4\ emission = \sum_i [(TOW_i - S_i)EF_i - R_i]$$

Where:

CH_4 emissions – CH_4 emissions in inventory year, kg CH_4/kg COD

TOW – total organically degradable material in wastewater in industry I in inventory year, kgCOD/yr

i – industrial sector

EF – emission factor for industry i, kg CH_4/kg COD for treatment/discharge pathway or system

Ri – amount of CH_4 recovered in inventory year.

CH_4 emissions from industrial wastewater treatment for the period 1988-2014 are shown in figure below.

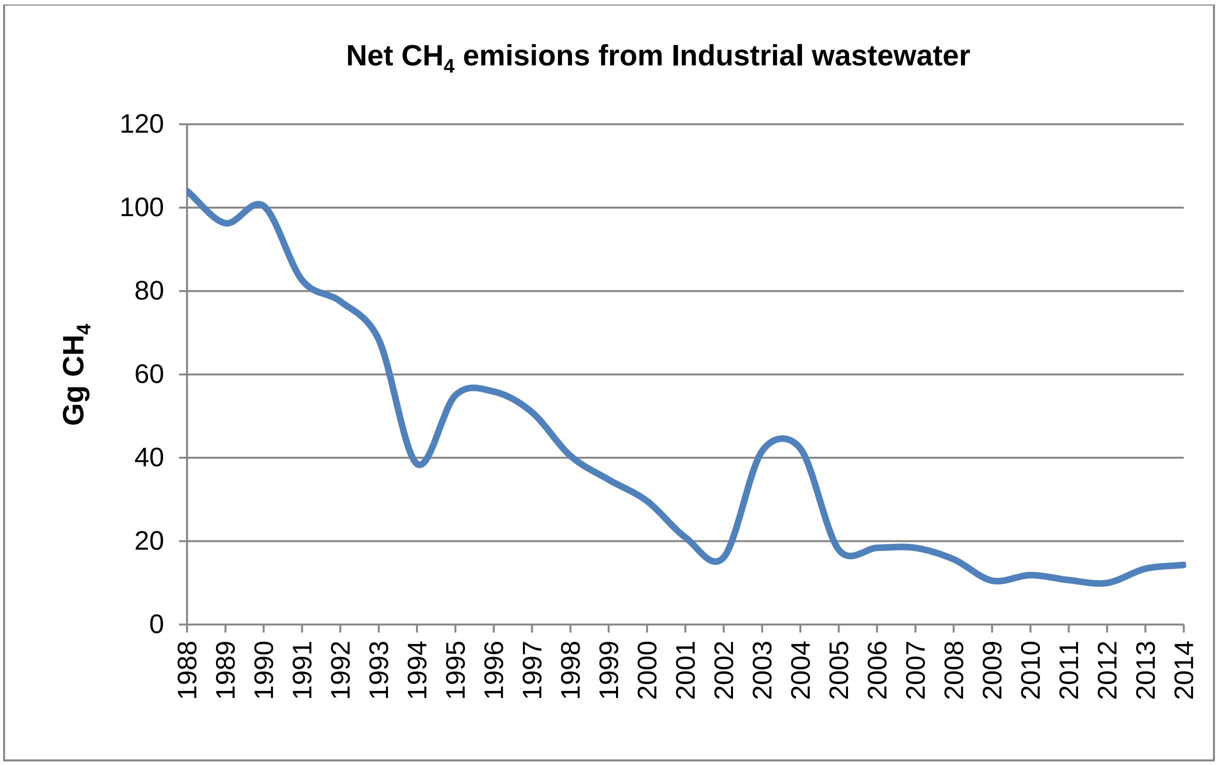


Figure 110 CH4 emissions from industrial wastewater handling

The total organically degradable material in industrial wastewater (total organic product-TOW) is presented in table 233.

Year	Total organic product	Aggregate Emission factor (CS)	Net methane Emissions
	kg COD/yr	kg CH_4/kg COD	GgCH_4
1988	1794670487	0.058	103.99
1989	1683685391	0.057	96.27
1990	1793219664	0.056	100.38
1991	1354065207	0.061	82.63
1992	1083086435	0.072	77.51
1993	894182639	0.076	68.37
1994	856120372	0.045	38.52
1995	1062531694	0.052	54.98
1996	1036931565	0.054	55.89
1997	877721215	0.058	50.91
1998	692248003	0.058	40.48
1999	569190714	0.061	34.74
2000	460720479	0.064	29.62
2001	342558804	0.061	20.91
2002	369241474	0.044	16.14
2003	1399331359	0.030	41.60
2004	1390723614	0.030	42.21
2005	370220819	0.049	17.96
2006	399801476	0.046	18.41
2007	411247113	0.045	18.39
2008	349625886	0.045	15.65
2009	217526034	0.048	10.53
2010	254561533	0.047	11.85
2011	227753235	0.047	10.67
2012	222440980	0.045	9.98

Year	Total organic product	Aggregate Emission factor (CS)	Net methane Emissions
	kg COD/yr	kg CH_4/kg COD	GgCH_4
2013	251003891	0.053	13.39
2014	264661250	0.054	14.31

The quantity of methane from industrial wastewater streams depends on the concentration of the biodegradable organic component in wastewater, the wastewater volume and type of treatment (aerobic or anaerobic).

Using these criteria, we determine the industries with the greatest potential for release of methane emissions, namely:

- Production of food and beverage
- Production of Paper and pulp
- Production of Organic chemicals
- Production of textiles and textile products

These four sectors are generating a large amount of wastewater with high content of degradable organic component.

Quantity of wastewater

Annual amount of the wastewater output for different industrial sectors comes from the National Statistical Institute. Data are collected through statistical questionnaires in electronic and paper format (with instruction for filling, definition and some formulas). Respondents send completed questionnaires to the Regional Statistical Offices for data validation and then to the Central NSI office. Data on the wastewater volume are calculated by combination the survey data and estimations. Statistical questionnaires require detail data on wastewater, generated and discharged by origin of water flows, by place of discharge and by technology of treatment.

Table below shows the wastewater distribution among different treatment systems (Source-NSI).

Table 234 Industrial wastewater distribution among different treatment systems

Year	Discharged into sea, river, lake	Centralized, aerobic, not well managed treatment plant	Stagnant sewer
1988	42.29%	49.53%	8.18%
1989	43.40%	48.85%	7.76%
1990	45.98%	46.08%	7.94%
1991	38.80%	50.34%	10.85%
1992	8.62%	89.63%	1.75%
1993	6.05%	84.98%	8.97%
1994	66.33%	27.37%	6.30%
1995	49.64%	47.24%	3.13%
1996	46.00%	50.20%	3.80%
1997	36.92%	60.16%	2.92%
1998	36.37%	60.29%	3.34%
1999	31.27%	65.38%	3.35%
2000	24.07%	73.28%	2.66%
2001	31.71%	64.52%	3.77%
2002	65.22%	32.14%	2.65%
2003	90.84%	8.85%	0.30%

Year	Discharged into sea, river, lake	Centralized, aerobic, not well managed treatment plant	Stagnant sewer
2004	89.93%	9.42%	0.64%
2005	54.87%	43.21%	1.92%
2006	60.82%	36.28%	2.90%
2007	62.49%	35.55	1.96%
2008	64.55%	31.40%	4.05%
2009	57.15%	38.86%	3.98%
2010	59.94%	37.04%	3.02%
2011	58.31%	39.67%	2.02%
2012	62.28%	35.73%	1.99%
2013	44.82%	53.67%	1.51%
2014	43.98%	53.90%	2.12%

7.5.3.5 Choice of emission factors and parameters

For CH_4 emission estimation, default IPCC 2006 values were used.

Industrial degradable organic component indicator (COD)

The principal factor in determining the CH_4 generation potential of wastewater is the amount of degradable organic material in the wastewater. Common parameter used to measure the organic component of the industrial wastewater is Chemical Oxygen Demand (COD). The COD measures the total material available for chemical oxidation.

In the 2006 IPCC Guidelines are set default values for the degradable organic component of COD (kg/m^3) for the different types of industries (2006 IPCC, Vol.5: Waste, p. 6.22,Table. 6.9).

Based on these data and data provided by the National Statistical Institute about the quantity of wastewater, we define degradable organic components for the different types of industry.

For food and beverage industry, the used value for COD (kg/m^3) is 2.8, which is a default value. For other industries: paper and pulp COD (kg/m^3)=9.0; organic chemicals COD (kg/m^3)=3.0; textile COD (kg/m^3)=0.9

Maximum methane producing capacity (B_0)

It is good practice for the maximum CH_4 producing capacity B_0 to use country specific data from measurements made of various wastewaters. If there is no such specific data, IPCC provides for B_0 to take a default value for industrial wastewater B_0 = 0,25 kg CH_4 / kg COD, used in calculations (2006 IPCC,Vol.5: Waste, p. 6.12,Table 6.2).

Methane correction factor (MCF)

Determination of methane correction factor depends on the available systems for wastewater treatment in the country. The present calculations of CH_4 emissions from industrial wastewater treatment are based on the project, which defines wastewater treatment systems and discharge pathways in the country and respective MCF for each treatment/discharge pathway or system. The MCF, used in calculations is as follows:

a) for waters, discharged into sea, river, lake - MCF=0.1;

b) for waters, discharged trough sewer system into centralized aerobic treatment plant – MCF=0.3;

c) for waters, treated in stagnant sewer - MCF=0.5

Organic component removed as sludge (S)

For sludge removal from the waste water default IPCC value of zero was used for emission calculations (2006 IPCC, p.5.20, pg.6.9).

Methane recovery (R)

For amount of methane recovered default IPCC value of zero was used for emission calculations (2006 IPCC, Vol.5: Waste, p.6.9).

7.5.4 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Table 235 Uncertainty of sub-sector Waste water handling

CRF categories	Key Category	GHG	AD uncertainty	EF uncertainty	Combined uncertainty
5 D1	Domestic Wastewater Handling	CH_4	39	42	57,9
5 D1	Domestic Wastewater Handling	N_2O	20	50	53,9
5 D2	Industrial Wastewater Handling	CH_4	55	30	63,4

7.5.5 SOURCE-SPECIFIC QA/QC AND VERIFICATION

It is recommended to carry out the following basic procedures for checking the quality of data and calculations:

Review and detailed analysis of natural indicators;
Analysis of trends in emissions of greenhouse gases emitted in the treatment of wastewater
Evaluation of the emission factors;
Overview of all archived documents and data necessary for the inventory

7.5.6 SOURSE-SPECIFIC RECALCULATIONS

Recalculations were performed due to application of the 2006 IPCC Guidelines. The main change in the method for estimation of CH_4 emissions from industrial wastewater handling after TERT recommendations is the inclusion of the secondary treated industrial wastewaters into defined water flows from National Statistical Institute. The approach is based on the assumption that the secondary treated industrial wastewaters (discharged into sea, river, lakes) are part of the same industrial wastewaters, treated on-site. That is why we subtract the quantity of secondary treated wastewaters (discharged into sea, river, lakes) from the same waters, treated on-site. The same approach is applied for the secondary treated wastewaters, discharged into a public sewerage, but not treated in wastewater treatment plant (WWTP). Secondary treated industrial wastewaters, discharged into WWTP were not added to the same wastewaters, treated on-site due to double counting. At the end we add the difference, obtained between secondary treated wastewaters and wastewaters treated on-site (for discharged into sea, river, lakes and discharged into public sewerage, but without WWTP flows) to the wastewaters, treated on site, discharged into public sewerage with WWTP, thus increasing the percentage of wastewaters, treated in WWTP. This change led to the change in the quantity of other water flows: wastewater, treated in stagnant sewer and wastewater, discharged into sea, river, lake.

The country found a technical mistake in activity data for 1990 in the quantity of wastewaters, discharged into a public sewerage, but without WWTP and made a correction. The excess water quantity from this category is added to the same category wastewaters without on-site treatment to maintain the balance of the wastewaters.

7.5.7 SOURCE-SPECIFIC IMPROVEMENT PLAN

Improvements in wastewater handling are connected with CH_4 emission estimation from industrial and domestic/commercial wastewater treatment for transparent explanation of methodology used for CH_4 emission estimation.

It is envisaged commissioning of an integrated information system for reporting the various waste management activities, which will cover all persons who carry out waste activities under national legislation. Information system will allow the implementation of adequate measures and policies regarding waste management in order to reduce the negative impact on the environment and human health. This information will be checked and verified by NSI and reported to Eurostat.

N_2O emissions from sludge spreading are calculated only in Sector Agriculture and are excluded from reporting in the waste sector.

7.5.8 NITROUS OXIDE EMISSIONS FROM WASTEWATER

7.5.8.1 Methodological Issues

For estimation of N_2O from domestic wastewater effluent, 2006 IPCC Guidelines suggest a single methodology for calculations with no higher TIERS and decision tree provided.

7.5.8.2 Choice of method

Nitrous oxide emissions can occur as direct emissions from treatment plants or from indirect emissions from wastewater after disposal of effluent into waterways, lakes or the sea. This section addresses indirect N_2O emissions from wastewater treatment effluent that is discharged into aquatic environments. 2006 IPCC Guidelines suggests a methodology for calculation of N_2O emissions.

The calculations of the emissions follow the general equation 6.7 (p.6.25):

Equation 6.7:

$$N_2O \text{ Emissions} = N_{Effuent} \bullet EF_{Effluent} \bullet 44/28,$$

Where:

N_2O emissions - N_2O emissions in inventory year, kg N_2O/yr

$N_{Effluent}$ - nitrogen in the effluent discharged to aquatic environments, kg N/yr

EF $_{Effluent}$ - emission factor for N_2O emissions from discharged to wastewater, kg N_2O-N/kg N

The factor 44/28 is the conversion of kg N_2O-N into kg N_2O.

Table 236 Values of N_2O emissions from wastewater treatment (kt)

Year	N_2O emissions	Year	N_2O emissions	Year	N_2O emissions
1988	0.802	**1997**	0.548	**2006**	0.492
1989	0.778	**1998**	0.594	**2007**	0.467
1990	0.666	**1999**	0.585	**2008**	0.489
1991	0.627	**2000**	0.561	**2009**	0.489
1992	0.589	**2001**	0.534	**2010**	0.494
1993	0.596	**2002**	0.516	**2011**	0.495
1994	0.577	**2003**	0.492	**2012**	0.492
1995	0.586	**2004**	0.499	**2013**	0.489
1996	0.557	**2005**	0.482	**2014**	0.486

7.5.8.3 Choice of emission factors

The default IPCC emission factor for N_2O emissions from domestic wastewater nitrogen effluent is 0.005 (0.0005-0.25) kg N_2O-N/kg N.

7.5.8.4 Choice of Activity data

The activity data that are needed for estimating N_2O emissions are nitrogen content in the wastewater effluent, country population and average annual per capita protein generation (kg/person/yr). Per capita protein generation consists of intake (consumption) of protein, available at FAO statistics, multiplied by factors to account for additional "non-consumed" protein and for industrial protein discharged into the sewer system. The total nitrogen in the effluent is estimated, using equation 6.8 (p. 6.25) :

Equation 6.8:

$$N_{Effluent} = (P \bullet Protein \bullet F_{NPR} \bullet F_{NON\text{-}CON} \bullet F_{IND\text{-}COM}) - N\ sludge,$$

Where:

N $_{Efflent}$ - total annual amount of nitrogen of the wastewater effluent, kg N/yr

P- human population (country specific)

Protein - annual per capita protein consumption, kg/person/yr

F $_{NPR}$ – fraction of nitrogen in protein, default = 0.16 kg N/kg protein

F $_{NON\text{-}CON}$ – factor for none-consumed protein added to the wastewater (1.4)

F $_{IND\text{-}COM}$ – factor for industrial and commercial co-discharged protein into the sewer system (1.26)

N $_{Sludge}$ – nitrogen removed with sludge (default = zero), kg N/yr

Table 6.11 (IPCC 2006, p.6.27) summarizes N_2O methodology default data

7.5.9 UNCERTAINTIES AND TIME SERIES CONSISTENCY

Large uncertainties are associated with IPCC default emission factors for N_2O from effluent. Table 6.11 includes uncertainty ranges based on expert judgement.

Calculations of the N_2O emissions with new emission factors are made for whole time series.

7.5.10 SOURCE-SPECIFIC IMPROVEMENT PLAN

Improvements are not planned.

7.5.11 SOURCE-SPECIFIC RECALCULATIONS

A technical error in N_2O emission estimation from wastewater treatment has been found. Recalculations have been made for the whole time series.

8 OTHER (CRF SECTOR 7)

This sector from the IPCC classification is designated to submit all GHGs emission sources, which for one or another reason have not been categorized at one of the six preceding sectors.

The Bulgarian inventory has no such specific sources to be reported in this sector.

9 INDIRECT CO_2 AND NITROUS OXIDE EMISSIONS

Indirect CO_2 and nitrous oxide emissions have been reported at the relevant chapters of the report.

9.1 DESCRIPTION OF SOURCES OF INDIRECT EMISSIONS IN GHG INVENTORY

Please see the relevant chapters of the report.

9.2 METHODOLOGICAL ISSUES

Please see the relevant chapters of the report.

9.3 UNCERTAINTIES AND TIME-SERIES CONSISTENCY

Please see the relevant chapters of the report.

9.4 CATEGORY-SPECIFIC QA/QC AND VERIFICATION,

Please see the relevant chapters of the report.

9.5 CATEGORY-SPECIFIC RECALCULATIONS

Please see the relevant chapters of the report.

9.6 CATEGORY-SPECIFIC PLANNED IMPROVEMENTS

Please see the relevant chapters of the report.

10 RECALCULATIONS AND IMPROVEMENTS

10.1 EXPLANATIONS AND JUSTIFICATIONS FOR RECALCULATIONS, INCLUDING IN RESPONSE TO THE REVIEW PROCESS

Recalculations of previously submitted inventory data are performed following the 2006 IPCC Guidelines, chapter 7 with the purpose to improve the GHG inventory. Specific sectoral information on recalculations made are given in Chapters 3-7 dedicated to source/sink categories.

10.1.1 GHG INVENTORY

The GHG emission recalculations for the period 1988-2013 (emission data 1988-2013) were made because of update and revision of activity data, EF and other parameters used for all sectors.

The main reason for recalculations is implementation of recommendations of the Expert Review Team as set out in the annual review report.

Table 264 Summary of GHG emission recalculations in submission 2016

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
1. Energy			
A. Fuel combustion (sectoral approach)			.
1. Energy industries	Revised activity data	For the 2016 submission was identified an error in the calculation files - the quantities for liquid fuels for off-road machinery for the construction sector was erroneously linked to off-road machinery in Agriculture. An additional error was identified and corrected regarding the consumption of solid fuels in CRF category 1.A.2.c for 1988 and 1989.	For more information please see Chapter Energy
2. Manufacturing industries and construction			
3. Transport			
1A3a Civil Aviation			
1A3b Road Transportation			
4. Other sectors			
5. Other			
B. Fugitive emissions from fuels			
1. Solid fuels			
2. Oil and natural gas			
C. CO2 transport and storage			
2. Industrial processes and product use			
A. Mineral industry	Cement production	CO2 emissions from usage of feedstocks, used for supplemental purification of waste gases, are added. Emissions are calculated on the base of the quantity of the consumed substance and a stereometrical stoichiometric correlation.	For more information please see relevant chapter

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
	Lime production	Data for the CaO and MgO content in quicklime are changed as average scopes from the 2006 IPCC are taken. Additionally a correlation factor of 1,02 LKD is applied in emissions calculation.	For more information please see relevant chapter
	Ceramics production	Emission factor for the period before 2008 is changed as a mistake has been found during the check of data for 2008	For more information please see relevant chapter
B. Chemical industry	Soda ash prodcution	A mistake in the calculation file is found, wrong EFs - CO2/CaCO3 and CO2/MgCO3 are used. For 2016 submission they are corrected - CO2/CaO and CO2/MgO. The calculated emissions from quicklime production are multiplied by 1,02 LKD.	For more information please see relevant chapter
C. Metal industry			
D. Non-energy products from fuels and solvent use			
E. Electronic Industry			
F. Product uses as ODS substitutes	Commercial and industrial refrigeration (2.F.1.a and 2.F.1.c)	A technical error has occurred in the F-gases quantities in refrigeration and air-conditioning, These quantities are replaced in three of the reports by RIEW.	For more information please see relevant chapter
	Mobile air conditioning (2.F.1.e)	Recalculation due to the inclusion of the production of cars in Bulgaria and change the data source of the cars' statistics.	For more information please see relevant chapter
	Stationary air conditioning (2.F.1.f)	Reclauclation due to the update of the data with the new study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases, Germany 2011	For more information please see relevant chapter
	Fire protection (CRF 2.F.3)	Revision of data as companies, included in a list from National Fire Safety and Protection of Population Service which have fire extinguishing installations were reviewed.	For more information please see relevant chapter
	Aerosols (CRF 2.F.4)	A technical error has been found in the calculations.	For more information please see relevant chapter
G. Other product manufacture and use			
	Electronical equipment (CRF 2.G.1)	Methodology is not changed for this sector, however due to revised activity data, results increase compared to the previous year.	For more information please see relevant chapter
H. Other			
3. Agriculture			
A. Enteric fermentation	Revised EF	Emissions of CH4 from Enteric fermentation have been racalculated for the cattle due to implemntation of new values of digestibility of feed and CH4 conversion factor	For more information please see Chapter Agriculture
B. Manure management	Revised activity data and methodology	• Emissions of CH4 from Manure Management have been recalculated for the entire time series due to revised estimates of Volatile solid excreted for swine; • Direct emissions of N2O from Manure management have been recalculated for the entire time series due to revised estimates of Nitrogen extration rate for Mature non-dairy cattle; • Indirect emissions of N2O from Manure management have been recalculated for the entire time series due to corrections of technical mistakes	For more information please see Chapter Agriculture /Manure Management

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
C. Rice cultivation			
D. Agricultural soils	Revised activity data and methodology	• Productions of feetbeat have been recalculated for the entire time series due to revision of the statistical data – new data was provided from Ministry of Agriculture and Food and from National Statistics Institutes' yearbooks 1990-2014; • In submissions 2016 productions of alfalfa were included – data was provided form Ministry of Agriculture and Food and from National Statistics Institutes' yearbooks 1990-2014; • Direct emissions of N2O fom Agriculture soils have been recalculated for the entire time series due to implementation of new estimates for Nitrogen in crop residues returned to soils and Nitrogen input of manure applied to soils according 2006 IPCC GL; • Indirect emissions of N2O from Agriculture soils have been recalculated for the entire time series due to implementation of new estimates for FracGASF (Volatilisation from synthetic fertiliser), according recommendations of the FCCC/ARR/2014/BGR.	For more information please see Chapter Agriculture /Agricultural soils
F. Field burning of agricultural residues			
G. Liming			
H. Urea application	New category	According 2006 IPCC GL, CO2 emissions from Urea fertilization have been estimated.	
I. Other carbon-containing fertilizers			
J. Other			
4. Land use, land-use change and forestry(1)			
A. Forest land	Revised activity data and methodology	1.Update of some emission coeficeints as C fraction and Root to shoot ratio according to 2006 IPCC. 2.non-CO2 emissions from wildfires have been recalculated according to the updated emission factors from 2006 IPCC Guidelines. 3.Changes in area of FL since 2012. A technical error in estimation table has been found	For more information please see Chapter LULUCF /Forest land
B. Cropland	Revised activity data and methodology	1.Changes in the total area of cropland across the time series due to missed areas of cropland from forestry fund 2.Changes in the total cropland area due to complete new interpretation of the activity data. This change affected also area pattern of GL, SM and OL 3.Reporting of LUC from OL to CL 4.Recalculation of the LUCs to cropland 5.N2O emissions from land-use conversions to cropland as a result of soil oxidation	For more information please see Chapter LULUCF / Cropland
C. Grassland	Revised activity data and methodology	1.Changes in the total area of grasslands over the reporting period due to missed areas of grassland from forestry fund and some minor technical errors 2.Changes in the total grassland area due to complete new interpretation of the activity data. This change affected also area pattern of CL, SM and OL	For more information please see Chapter LULUCF / Grassland

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	DESCRIPTION OF METHODS	RECALCULATIONS	REFERENCE
		3.Recalculation of the LUCs to grasslands 4.Reporting of LUC from OL to GL 5.Update of the estimate for annual carbon stock in biomass under GL according to updated value (2006 IPCC Guidelines) for coefficents used in equation	
D. Wetlands	Revised activity data and methodology	Chages in the area distribution of the total LUCs to wetlands between annual cropland and other land, which are as a result of area recalculations in these two land-use categories.	For more information please see Chapter LULUCF / Wetlands
E. Settlements	Revised activity data	1.Changes in the total settlements area due to complete new interpretation of the activity data. This change affected also area pattern of GL, CL and OL 2.Chages in the area distribution of the total LUCs to SM between categories 3.Reporting of LUC from OL to SM.	For more information please see Chapter LULUCF / Settlements
F. Other land			
G. Harvested wood products			
H. Other			
5. Waste			
A. Solid waste disposal	Revised EF	1) Oxidation factor OX=0.1 has been used for both managed and unmanaged landfills; 2) For calculation of weighted half-time is based on k=0.09 and half-life (t 1/2) =7 for bulk waste in estimation of the emissions from SWDS	
B. Biological treatment of solid waste	Revised EF	Recalculations of N2O emissions have been made for the whole time series due to updated EF for N2O from 0.3 to 0.24 g N2O/kg treated waste in the revised version of.2006 IPCC Guidelines.	
C. Incineration and open burning of waste			
D. Waste water treatment and discharge	Revised activity data and methodology	1. Change in the method for estimation of CH4 emissions from industrial wastewater handling; 2. A technical error in N2O emission estimation from wastewater treatment has been found. Recalculations have been made for the whole time series	For more information please see Chapter Waste
E. Other			
6. Other (as specified in summary 1.A)			

10.2 IMPLICATIONS FOR EMISSION LEVELS

10.2.1 GHG INVENTORY

As a result of the continuous improvement of Bulgaria's GHG inventory, emissions of some sources have been recalculated on the basis of updated data or revised methodologies, thus emission data for 1988 to 2013 which are submitted this year differ slightly from data reported previously.

Table 265 Recalculation Difference of National Total GHG Emissions.

Year	National Total GHG emissions without LULUCF		
	Submission 2015 [Gg CO_2e]	Submission 2016 [Gg CO_2e]	Recalculation Difference [%]
1988*	120742,02	114577,79	-5,38
1990	118273,80	112358,66	-5,26
1991	108365,14	104041,45	-4,16
1992	86340,73	82598,36	-4,53
1993	80534,09	77754,21	-3,58
1994	78709,89	76533,32	-2,84
1995	74611,96	72195,39	-3,35
1996	75222,99	73531,35	-2,30
1997	75201,43	73604,65	-2,17
1998	71630,61	70085,55	-2,20
1999	67395,80	65960,12	-2,18
2000	60678,69	59207,14	-2,49
2001	59646,17	58265,05	-2,37
2002	62713,60	61303,57	-2,30
2003	60136,97	58523,32	-2,76
2004	64997,18	63407,76	-2,51
2005	63858,46	62380,52	-2,37
2006	64087,24	62653,49	-2,29
2007	64754,60	63331,33	-2,25
2008	68559,62	67244,22	-1,96
2009	67016,24	65987,60	-1,56
2010	58103,89	57088,13	-1,78
2011	60573,36	59820,46	-1,26
2012	66207,98	65095,85	-1,71
2013	61192,18	60030,46	-1,94

**Base year is 1988 for all gases*

10.3 IMPLICATIONS FOR EMISSION TRENDS, INCLUDING TIME SERIES' CONSISTENCY

10.3.1 GHG INVENTORY

As can be seen in Table 241 and Figure 111 Bulgaria's greenhouse gas emissions as reported in the UNFCCC submission 2016 are different compared to the values reported last year due to recalculations.

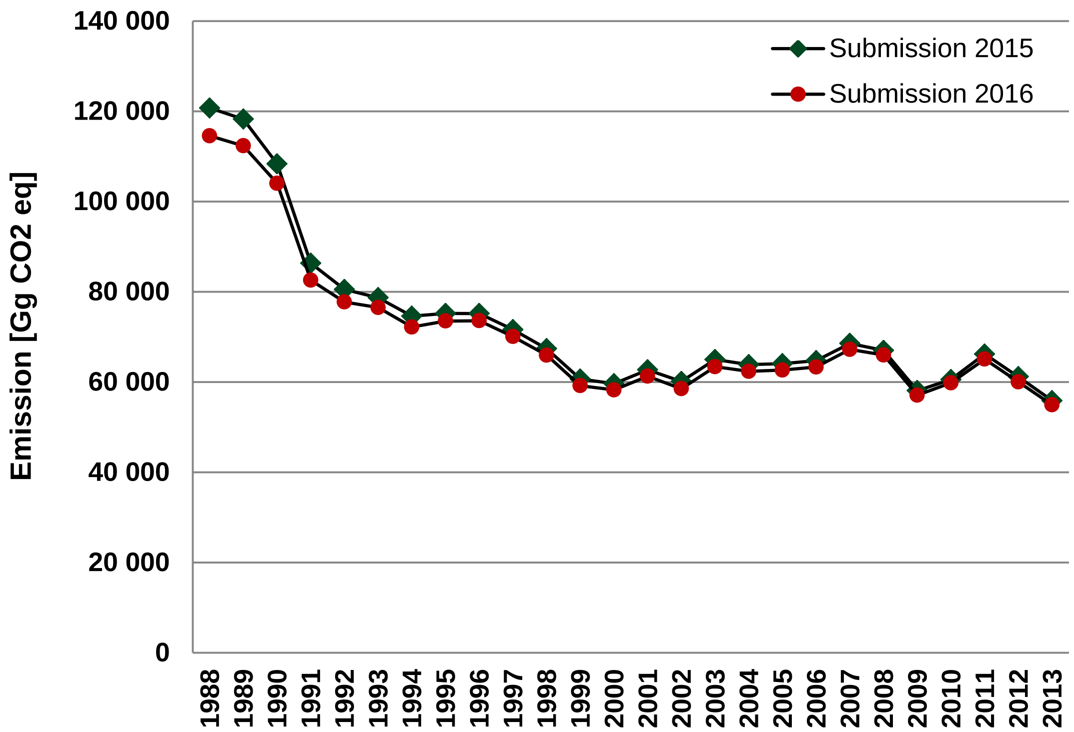


Figure 111 Emission estimates of the submission 2015 and recalculated value

10.4 PLANNED IMPROVEMENTS, INCLUDING RESPONSE TO THE REVIEW PROCESS

Many recalculations have baeen carried out in resopone to recommendations proposed in review reports.

The following general improvements are planned for the next submissions

- Update and revision of activity data, emission factors and related parameters;
- Conduct further studies for verification of emission factos and assumptions;
- Improvement of uncertainty assessment;
- Improvement of the relation with Branch Business Associations;
- Executive Environment Agency (ExEA) Communication & Information Centre (Data management);
- Further collaboration with external organizations;
- QA/QC activities and audit;
- Documentation and archiving.

All improvements will be conducted to increase TACCC.
For planned improvements please refer to respective chapters "planned improvements" for each source category.

11 KP-LULUCF

11.1 GENERAL INFORMATION

Bulgaria reports emissions/removals from afforestation, reforestation and deforestation under Article 3.3. of Kyoto Protocol and from Forest Management under Article 3.4 of Kyoto Protocol. The estimates of the emissions/removals related to art. 3.3. and 3.4. follow the guidance of the 2013 Revised Supplementary Methods and Guidance Arising from the Kyoto Protocol (2013 KP Supplement) and are consistent with the UNFCCC Decisions (15/CMP.1, 16/CMP.1, 2/CMP.6, 2/CMP.7).

11.1.1 DEFINITION OF FOREST AND ANY OTHER CRITERIA

For defining forest, Bulgaria uses the definition in the Bulgarian Forest Act (last amendment 18.12.2015, SG №100):

"Area over 0.1 ha, covered with forest tree species higher than 5 meters and tree crown cover over 10% or with trees which can reach these parameters in natural environment".

Areas of natural forest regeneration outside urban areas with a size of more than 0.1 ha also represent "forest". City parks with trees, forest shelter belts, and single row trees do not fall under the category "forests.

According to their functions, forests are divided in: forests for timber production, protective and recreation forests and forests in protected areas.

All forests in Bulgaria, are managed.

Forests are also:

- areas which are in a process of recovering and are still under the parameters, but it is expected to reach forest crown cover over 10% and tree height 5 meters;
- areas, which as the result of anthropogenic factors or natural reasons are temporarily deforested, but will be reforested;
- protective forest belts, as well as tree lines with an area over 0.1 ha and width over 10 meters;
- cork oak stands."

For reaching the targets of KP the minimal figures of the defined range of parameters for tree height, tree crown cover and minimum area have been chosen by Bulgaria:

Minimum forest area – 0.1 ha;

Tree crown cover – 10%;

Tree height – 5 meters.

In accordance with Article 7 of the Kyoto Protocol the country will report in the National Inventories the following activities, following the definitions of the forest related activities, as given in **Decision 16/CMP.1 Land use, land-use change and forestry:**

"Afforestation" as a direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources

"Reforestation" as a direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

"Deforestation" as a direct human-induced conversion of forested land to non-forested land

11.1.2 ELECTED ACTIVITIES UNDER ARTICLE 3, PARAGRAPH 4, OF THE KYOTO PROTOCOL

Bulgaria has decided not to elect any of the activities under Article 3, paragraph 4, in the first commitment period. For the second commitment period the accounting of emissions/removals from Forest Management is manadatory. Bulgaria decided to account for this activity in the end of the commitment period.

In regard the others activities under article 3.4, Bulgaria decided not to elect any other than FM activities under Article 3.4 for the second commitment period.

11.1.3 DESCRIPTION OF HOW THE DEFINITIONS OF EACH ACTIVITY UNDER ARTICLE 3.3 AND EACH ELECTED ACTIVITY UNDER ARTICLE 3.4 HAVE BEEN IMPLEMENTED AND APPLIED CONSISTENTLY OVER TIME

Bulgaria has chosen to account for each activity under Article 3, paragraph 3 at the end of the commitment period.

The base year for reporting ARD activities is 1990. The area units reported as Afforestation/Reforestation (AR) and Deforestation (D) have the same basis as the area of land-use change to and from forest under the UNFCCC GHG inventory reporting taking into account the different time frame. All LUC from and to forests are considered to be direct human induced. Afforestation/Reforestation (AR) activities are reported together.

The National Forest Inventory (NFI) and the information from the Forest Management Plans (FMP) are the main sources of information for the ARD units of land (see chapter 11.2.1).

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

The National Forest Inventory (NFI) and the information from the Forest Management Plans (FMP) are the main sources of information for the ARD units of land. The NFI in Bulgaria covers assessments for the entire country territory in 10 years' cycles. In other words all forest stands are surveyed once in every 10 years. Forest inventory presents collection of qualitative and quantitative data about the investigated area. The management planning gives recommendations about the silvicultural operations and activities for the next 10 years period. The process of forest inventory and planning is stable and consistent over time. The measurements of the forest inventory are carried out for all sub-compartments in each and every State Forest Enterprises (SFE). The area of one sub-compartment or forest management unit is from 1-25 ha, when forested. The area of the non-forested unit is 0,1 ha. The territory of one SFE may include the territory of one or several municipalities.

11.2.2 METHODOLOGY USED TO DEVELOP THE LAND TRANSITION MATRIX

Reprting of AR units of land:

The reporting of the AR units of land for the years 2013 and 2014, included in the CRF tables of this Submission, represents extrapolation of the results of the completed project (in 2014) for assessment of the AR units of land. The project has been launched following the the plan for improvement of the estimation of AR units of land as accepted by the ERT team as answer to the related Saturday paper issue of the 2011 review. The plan has been implemented in stages starting in Submission 2012 and completed for the Submission 2014.

Due to financial and technical (incomplete data from NFI) constraints and taking into account that Bulgaria accounts in the end of the CP, It decided that it is not necessary to carry out such an assessment for each year. It is planned to have two assessments of the AR units of lands up to the end of the CP. The first is plan for the next year in order to update the figures according to the data from the last Forest Invetory (2015) and the second just before the end of CP2. In the meanwhile Bulgaria would report preliminary estimates based on extrapolation of the data available.

For transparency issue below it is describe the steps of the AR assessment.

According to this plan the following improvement steps have been implemented in order to fulfil the reporting requirement set out in paragraph 8 (a) of the annex to decision 15/CMP.1.

Bulgaria examined the Forest Management Plans (FMPs – see below) for all State Forest Enterprises (SFE), which were inventoried for the period 1991-2012. Like this all changes since 1992 in forest area for each and every SFE has been traced and identified. For those SFE, where there is an increase in the forest area since 1990, the increase is derived into:

c. New forest areas which are included in the forest total, but which were forested before 1990, so new forests with stands of older age classes.
d. And the new forested areas with stands of the youngest age class, which are due to afforestation and reforestation activities (planting and seeding) on barren areas or afforestation and reforestation activities (planting, manual and natural seeding) on grassland or on croplands.

These improvement steps have been performed by the experts from Executive Forest Agency, by using the following sources of information:

- Forest Inventory and FMPs[35];
- Forestry Fund Reporting Form 1FF[36] (forest area) for the 1990;
- Forest maps

The results (up to 2012) from the revision of the FMPs are given in the table below. The observed increase in forest area due to AR activities for every single SFEs is given for two periods - 1992-2000 and since 2000. The amount of the "new" forest areas since 1.1.1990 which were forested before 1990 (point a) was added to the total forest area in 1991 and the years after according to Forestry Fund Reporting Form 1FF (forest area). The new forest areas between 2012 and 1992 according to point b represent the **net increase** in forest due to planting or seeding (manually or naturally) activities. Changes in forest area for the years 1990, 1991 are based on extrapolation using the same forest change as in the year 1992.

Table 266 Results from the revision of the FMPs for all SFEs for the period 2001-2012, representing the net AR activities since 1992 till 2012

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
I. DISTRICT VIDIN							
1. Vidin	27 483	32 070	-	21	1 438	3 884	-
2. Belogradjik	27 730	27 826	620	6	-	2 128	906
3. Midjur	16 510	23 943	-	-	70	2 548	495
Total	**71 723**	**83 839**	**620**	**27**	**1 508**	**8 560**	**1 401**
II. DISTRICT MONTANA							
1. Montana	28 136	14 950	-	27	242	20	184
2. Chiprovtsi	-	16 506	1	2	19	316	818
3. Berkovitsa	24 346	26 344	59	-	196	1 392	20
4. Lom	4 868	6 237	-	50	110	573	608
5. Govejda	15 862	16 456	-	2 264	-	-	22
6. Burziya	6 919	6 644	-	-	-	-	83
Total	**80 131**	**87 137**	**60**	**2 343**	**567**	**2 301**	**1 735**
III. DISTRICT OF VRATSA							

[35] Forest Inventory and FMPs are carried out for each State Forest Enterprise. The inventory aims measurement and processing of the following main data:

7) Forest area and its changes
8) Tree composition, origin, age, management purpose
9) Tree height and diameter,
10) Annual increment, bonitat, density of the stands
11) Tree growing stock
12) Data about main rock, soil type and soil bonitat and other important habitat characteristics.

The measurements of the Forest Inventory are carried out for each and every SFE once in every 10 years.

[36] The reporting forms 1FF to 7 FF represent the forest fund reporting forms. The data gathered during the forest inventories is used as data base for preparation of the reporting forms of the forest fund

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
1. Vratsa	20 591	24 588	-	-	288	627	1 068
2. Mezdra	26 816	30 140	757	670	2 109	1 260	300
3. Oryahovi	4 628	4 433	-	-	-	47	-
Total	**52 035**	**59 161**	**757**	**670**	**2 397**	**1 934**	**1 368**
IV. DISTRICT OF PLEVEN							
1. Pleven	23 002	31 441	973	-	4 767	3 001	1 320
2. Nikopol	9 645	13 559	-	40	-	198	2 054
Total	**32 647**	**45 000**	**973**	**40**	**4 767**	**3 199**	**3 374**
V. DISTRICT OF LOVECH							
1. Lovech	21 902	26 393	35	3 658	-	4 061	408
2. Teteven	19 589	19 728	119	54	11	589	992
3. Ribaritsa	15 491	20 096	-	18	-	76	2
4. Cherni Vit	9 113	13 735	-	4	314	352	863
5. Troyan	31 280	25 262	35	8	-	1 407	368
6. Rusalka, Apriltsi	11 501	12 863	-	-	334	356	84
7. Cherni Osam	12 900	13 437	-	2	1	312	68
8. Borima	-	7 779	-	3	-	-	-
9. Lesidren	19 729	32 583	159	118	-	1 186	-
10. Lukovit	14 374	-	-	-	-	-	-
Total	**155 879**	**171 876**	**348**	**3 865**	**660**	**8 339**	**2 785**
VI. DISTRICT OF GABROVO							
1. Gabrovo	25 447	28 568	35	11	-	3 228	10
2. Sevlievo	20 059	22 538	-	-	1 525	297	11
3. Rositsa	14 341	14 757	-	7	-	350	90
4. Plachkovtsi	20 969	27 291	-	-	1 327	5 370	77
Total	**80 816**	**93 154**	**35**	**18**	**2 852**	**9 245**	**188**
VII. DISTRICT OF VELIKO TARNOVO							
1. Bolyarka, V.Tarnovo	36 091	42 925	504	841	-	9 440	-
2. Svishtov	3 646	4 874	-	746	13	-	404
3. Gorna Oryahovitsa	17 123	20 587	211	12	4	738	94
4. Elena	30 461	33 418	-	7	-	2 736	284
5. Buinovtsi	14 366	16 507	-	33	-	123	434
Total	**101 687**	**118 311**	**715**	**1 639**	17	**13 037**	**1 216**
VIII. DISTRICT OF ROUSSE							
1. Dunav, Rousse	16 257	20 774	-	192	-	1 784	2 019
2. Byala	15 874	20 176	-	3 381	-	859	584
Total	**32 131**	**40 950**	**-**	**3 573**	**-**	**2 643**	**2 603**

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
IX. DISTRICT OF TARGOVISHTE							
1. Tyrgovishte	15 437	17 272	-	-	16	127	1 005
2. Omurtag	26 170	30 857	3	320	-	1 117	1 998
3. Cherni Lom, Popovo	24 753	28 561	900	484	1 848	654	1 858
Total	**66 360**	**76 690**	**903**	**804**	**1 864**	**1 898**	**4 861**
X. DISTRICT OF SHUMEN							
1. Shumen	16 299	17 395	479	1	760	156	866
2. Preslav	17 391	16 696	184	-	-	737	384
3. Varbitsa	15 489	18 856	221	-	-	515	212
4. Smyadovo	17 467	19 217	-	-	91	537	404
5. Palamara, Venets	30 773	34 025	588	40	-	1 779	816
Total	**97 419**	**106 189**	**1 472**	**41**	**851**	**3 724**	**2 682**
XI. DISTRICT OF RAZGRAD							
1. Razgrad	20 767	22 244	775	1 235	-	446	252
2. Seslav	28 411	30 484	-	-	-	219	623
3. Iri-Hisar	13 553	13 553	-	-	-	-	-
Total	**62 731**	**66 281**	**775**	**1 235**	**-**	**665**	**875**
XII. DISTRICT OF SILISTRA							
1. Silistra	25 550	24 433	-	665	-	914	4 066
2. Karakuz	17 221	25 395	311	59	-	615	452
3. Tutrakan	8 785	10 584	30	922	158	85	579
Total	**51 556**	**60 412**	**341**	**1 646**	**158**	**1 614**	**5 097**
XIII. DISTRICT OF DOBRICH							
1. Dobrich	24 691	16 981	1 199	286	123	246	2 466
2. Balchik	12 239	15 655	778	176	-	224	1 045
3. Tervel	11 096	14 264	586	51	-	519	2 321
4. General Toshevo	-	14 120	2 268	108	26	143	429
Total	**48 026**	**61 020**	**4 831**	**621**	**149**	**1 132**	**6 261**
XIV. DISTRICT OF VARNA							
1. Varna	30 611	31 075	-	-	456	-	768
2. Suvorovo	11 626	12 104	30	25	-	179	294
3. Provadiya	20 067	12 406	394	13	-	270	173
4. Tsonevo	12 168	22 653	644	650	417	70	120
5. Sherba	12 391	14 160	-	30	-	461	864
6. Staro Oryahovo	23 501	23 822	-	-	-	-	-
Total	**110 364**	**116 220**	**1 066**	**718**	**873**	**980**	**2 219**
XV. DISTRICT OF BOURGAS							

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
1. Bourgas	21 967	18 084	428	278	162	406	1 427
2. Nesebar	30 131	35 362	25	104	189	503	2 168
3. Aytos	40 749	42 187	252	128	251	932	1 242
4. Karnobat	6 965	26 047	70	-	-	144	795
5. Sungurlare	36 297	20 413	136	50	775	80	
6. Sredets	34 613	39 885	17	39	294	1 890	3 389
7. Ropotamo	9 696	15 419	88	12	88	77	522
8. Novo Panicharevo	19 542	20 593	133	8	-	226	39
9. Tsarevo	27 844	28 228	-	1	-	609	-
10. Gramatikovo	19 445	20 654	-	-	34	128	1 234
11. Kosti	12 650	12 994	57	-	79	248	-
12. Malko Tarnovo	30 845	20 776	3	2	162	134	3 985
13. Zvezdets	-	19 752	-	18	-	1 394	3 834
Total	**290 744**	**320 394**	**1 208**	**640**	**2 034**	**6 996**	**18 772**
XVI. DISTRICT OF YAMBOL							
1. Tundja, Yambol	19 384	20 376	-	33	18	110	907
2. Elhovo	26 857	31 289	194	703	214	721	2 524
Total	**46 241**	**51 665**	**194**	**736**	**232**	**831**	**3 431**
XVII. DISTRICT OF SLIVEN							
1. Sliven	43 370	44 827	513	38	-	300	294
2. Kotel	37 776	40 771	40	2	-	565	1 079
3. Tvarditsa	27 279	27 140	-	3	-	236	60
4. Nova Zagora	9 921	10 352	83	-	-	99	436
5. Ticha	12 505	12 983	-	12	568	73	638
6. Stara reka	7 536	8 155	-	21	-	67	713
Total	**138 387**	**144 228**	**636**	**76**	**568**	**1 341**	**3 220**
XVIII. DISTRICT OF STARA ZAGORA							
1. Stara Zagora	34 935	36 986	1 008	75	120	143	89
2. Chirpan	21 877	24 646	46	20	572	375	1 174
3. Mazalat	27 878	35 082	171	99	-	147	1 207
4. Gurkovo	21 668	22 493	-	-	-	356	-
5. Maglij	25 675	24 317	19	122	54	539	131
6. Kazanlak	28 956	24 410	14	37	-	-	427
Total	**160 989**	**167 934**	**1 258**	**353**	**746**	**1 560**	**3 028**
XIX. DISTRICT OF HASKOVO							
1. Haskovo	77 076	81 839	-	1 896	567	1 644	121
2.	20 955	21 574	146	172	240	369	275

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
Topolovgrad							
3. Svilengrad	25 647	28 067	607	276	354	1 807	178
4. Ivaylovgrad	44 385	48 956	104	65	244	1 685	1 623
Total	**168 063**	**180 436**	**857**	**2 409**	**1 405**	**5 505**	**2 197**
XX. DISTRICT OF KARDJALI							
1. Kardjali	35 637	22 310	4	5	-	-	29
2. Jenda	3 517	16 964	-	7	-	3	36
3. Momichilgrad	54 424	24 698	21	8	-	-	16
4. Kirkovo	-	29 155	-	2	-	-	-
5. Krumovgrad	42 794	43 205	18	2	-	24	34
6. Ardino	18 339	18 623	9	1	9	16	-
Total	**154 711**	**154 955**	**52**	**25**	**9**	**43**	**115**
XXI. DISTRICT OF SMOLYAN							
1. Smolyan	22 570	29 438	27	46	148	2 143	493
2. Zlatograd	33 180	32 409	-	-	80	27	-
3. Smilyan	30 858	32 028	-	-	11	1 028	-
4. Slaveyno	27 126	29 005	-	-	39	459	-
5. Pamporovo	8 796	-	-	-	-	-	-
6. Chepelare	11 075	-	-	-	-	-	-
7. Hvoyna	11 588	27 280	37	273	895	125	63
8. Shiroka Laka	8 206	9 124	-	-	1	569	347
9. Mihalkovo	13 802	15 430	-	7	356	633	981
10. Izvora	2 255	17 699	12	3	43	569	826
11. Devin	12 879	-	-	-	-	-	-
12. Trigrad	7 731	10 044	256	36	628	595	784
13. Borino	10 476	12 597	-	4	837	160	1 031
14. Dospat	19 421	20 577	5	35	138	461	457
Total	**219 963**	**235 631**	**337**	**404**	**3 176**	**6 769**	**4 982**
XXII. DISTRICT OF PLOVDIV							
1. Plovdiv	25 618	23 715	543	144	-	945	5 255
2. Hisar	23 815	26 157	1 078	50	283	456	651
3. Klisura	7 216	20 731	52	61	-	-	516
4. Rozino	12 472		-	-	-	-	-
5. Karlovo	28 649	30 590	49	55	148	1 130	668
6. Chekeritsa	12 849	31 691	28	26	609	455	901
7. Parvomai	9 796	9 706	112	23	-	177	-
8. Asenovgrad	24 633	28 076	86	285	125	1 670	988

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
9. Kormisosh, Laki	19 347	21 365	200	34	1 099	612	144
10. Krichim	7 978	-	-	-	-	-	-
Total	**172 373**	**192 031**	**2 148**	**678**	**2 264**	**5 445**	**9 123**
XXIII. DISTRICT OF PAZARDJIK							
1. Pazardjik	24 922	26 158	-	27	-	149	483
2. Panagurishte	38 617	39 095	371	50	-	-	207
3. Belovo	22 307	23 375	44	52	357	199	663
4. Yundola	4 977	4 933	-	1	-	-	-
5. Alabak	26 606	26 001	107	121	-	238	457
6. Chepino	2 573	19 504	-	-	18	136	135
7. Chehlyovo	15 078	-	-	-	-	-	-
8. Selishte	15 677	16 126	80	14	-	122	211
9. Shiroka Polyana	15 539	10 942	-	-	-	86	148
10. Rodopi	2 651	19 966	-	1	-	121	181
11. Beglika	12 601	-	-	-	-	-	-
12. Borovo	14 747	15 348	-	-	-	104	478
13. Batak	9 627	10 026	-	-	-	99	238
14. Rakitovo	18 771	19 614	92	109	70	15	379
15. Peshtera	18 873	19 676	476	118	21	17	203
Total	**243 566**	**250 764**	**1 170**	**493**	**466**	**1 286**	**3 783**
XXIV. DISTRICT OF BLAGOEVGRAD							
1. Blagoevgrad	24 418	29 001	16	131	345	2 490	2 559
2. Simitli	31 387	34 172	422	235	301	1 080	388
3. Kresna	21 625	23 062	-	-	92	235	431
4. Strumyani	18 780	21 015	-	3	-	148	970
5. Parvomay	18 629	17 970	252	43	-	442	-
6. Petrich	10 899	11 451	-	-	-	260	79
7. Sandanski	22 412	22 543	242	-	57	290	107
8. Katuntsi	26 629	28 193	-	-	62	48	910
9. Gotse Delchev	28 955	29 327	46	42	129	176	-
10. Dikchan, Satovcha	18 115	18 640	60	91	-	-	-
11. Garmen	24 907	27 039	40	8	-	62	-
12. Mesta	16 925	11 567	49	82	1	6	-
13. Dobrinishte	12 116	18 984	29	80	359	639	429
14. Eleshnitsa	16 607	16 814	179	132	-	546	1 065

State Forest Enterprises	Forest area in ha for 1991	Forest area in ha for 2012.	Planted or manually seeded in ha 1992-2000	Planted or manually seeded in 2001-2012	AR due to natural seeding in ha. 1992-2000	AR due to natural seeding in ha 2001-2012	Forest area forested before 1990
15. Yakoruda	20 161	21 635	1 162	688	-	-	-
16. Belitsa	10 591	11 265	100	269	-	218	907
17. Razlog	18 269	19 596	112	54	461	-	-
Total	**341 425**	**362 284**	**2 709**	**1 858**	**1 807**	**6 640**	**7 845**
XXVI. DISTRICT OF KUSTENDIL							
1. Osogovo	46 737	58 598	-	-	868	5 990	3 175
2. Nevestino	21 703	23 166	407	525	510	497	516
3. Dupnitsa	46 798	48 973	-	-	-	450	2 561
Total	**115 238**	**130 737**	**407**	**525**	**1 378**	**6 937**	**6 252**
XXVII. DISTRICT OF PERNIK							
1. Radomir	25 248	20 589	3 834	216	-	124	135
2. Zemen	15 506	18 484	28	53	740	764	1 743
3. Breznik	8 939	10 415	153	110	-	980	176
4. Tran	30 547	33 947	956	2	797	713	421
5. Vitoshko-Studena	-	8 878	-	-	-	-	128
Total	**80 240**	**92 313**	**4 971**	**381**	**1 537**	**2 581**	**2 603**
XXVIII. DISTRICT OF SOFIA							
1. Sofia	45 229	55 423	-	2 383	-	3 223	3 175
2. Svoge	46 447	45 198	-	405	240	266	221
3. Vitinya	9 179	17 295	-	-	-	-	-
4. Botevgrad	40 797	33 957	-	111	-	1 425	307
5. Godech	10 182	11 107	-	5	14	243	626
6. Etropole	20 994	22 779	144	11	-	1 335	264
7. Pirdop	43 526	45 228	-	46	-	824	883
8. Elin Pelin	25 157	22 129	25	74	150	629	22
9. Aramliets		7 534	-	27	-	3	-
10. Ihtiman	26 682	25 622	-	56	214	625	1 275
11. Kostenets	19 409	21 228	14	208	316	409	265
12. Samokov	65 481	68 994	-	-	192	2 607	14
13. Iskar	3 297	3 470	-	-	-	-	128
Total	**356 380**	**379 964**	**183**	**3 326**	**1 126**	**11 589**	**7 360**
Total for the Country	3 531 825	3 849 576	29 026	29 144	33 411	116 794	109 376

Therefore, the net increase in forest areas plus the annual deforestation areas must represent the annual AR areas:

$$AR_x = FL_x - FL_{x-1} + D_{SMx}$$

Where,

AR – AR area

X - year

FL – forest area

D_{SM} – D area for settlements

The assessment of the former land use of the identified AR units of land was made by using an expert judgment. Land use (cropland, grassland, other land) typically follows ecological site condition. The forestry experts know the dominating land uses in the SFE region or at the region of identified AR lands, so they made an expert judgment of former land use on basis of likelihoods. For example, there are regions where grassland (GL) dominates, because growth/site conditions are not good enough for cropland (CL) plants or CL management or, site conditions are so good that CL dominates. Similarly, other land (OL) can be found in extreme site conditions where FL, CL, GL cannot grow. **It should be noticed** that considering the growing conditions on other land which consist of rocks, landslides and barren areas, regrowth of forests on such lands without planting or manual seeding cannot happen. So, any conversion from OL to FL is based on planting or manual seeding measures and reported as such.

Reprting of D units of land:

All changes of designation of forests are registered in Executive Forest Agency for every single year since 2001. The registry contains administrative information in relation with the orders issued for excluding of forests. For the years before 2001 data on forest loss is available for the period 1990-1994. The information is provided by the experts from ExFA and is gathered from specific books, where all changes of designation of forest for these years were written up. There is no activity data on forest loss for the years 1995-2000, so the forest loss for these years is estimated as an average from the forest loss for the period 1990-1994. Since Bulgaria uses the national boundary as a geographical boundary for reporting of activities under Article 3.3 of KP the total amount of changes in designation of forests and lands from forest fund was used as data source for D reporting. All changes of designation of forests are associated with conversion from forest land to settlement (SM) and are reported as such. In its previous submission Bulgaria reported forest loss also for WL due to probability reasons. It was assumed that the observed increase in WL suggested also a deforestation for WL. The assumed D for WL was estimated as a share of forest land in the totals of forest land, cropland plus grassland (it was supposed that the wetlands increase comes from such lands). Actually the reported D area to WL in the previous submissions of Bulgaria represented an overestimation of D activity since all the information for forest loss due to changes in designation of forest was reported under D to SM. Since the improvements in area representation made for the Submission 2014 LUCs from FL to WL were not calculated. According to experts from the ExFA, the changes of designation of forest in the years 1990-2012 are associated with conversion only to SM. There is only one new dam lake (Tsankov kamak) which was built up in recent years but the forest loss associated with its construction works has been already reported in the 70's. Therefore, Bulgaria reports all information provided by the ExFa for forest loss across the time series (3.76 kha) as D activity associated with conversion to SM.

11.2.3 MAPS AND/OR DATABASE TO IDENTIFY THE GEOGRAPHICAL LOCATIONS, AND THE SYSTEM OF IDENTIFICATION CODES FOR THE GEOGRAPHICAL LOCATIONS

The database used to identify the geographical locations of the ARD activities is the NFI in Bulgaria. All measurements gathered in accordance with the forest inventory and FMP are mapped. Forest Inventory and FMP are carried out for each State Forest Enterprise. The SFE is divided into compartments and sub-compartments. The forest maps in Bulgaria are carried out for each State Forest Enterprise (SFE) as a result of the Forest Inventory (therefore, the maps are updated every 10th years for each SFE). The country territory is divided into almost 180 State Forest Enterprises. The territory of one SFE may include the territory of one or several municipalities. The area of one sub-compartment or forest management unit is between 1-25 ha, when forested. The area of the non-forested unit is 0,1 ha. The sub-compartments are defined based on uniformity of stands by species, age class structure, etc. According to Ordinance N 6 on the Forestry Planning and the Lands from the Forest Fund and the Game management Regions of Republic of Bulgaria (State Gazette 27 /2004) section 2 – Types of forest maps, forest maps are elaborated by SFE. The forest maps have unified consecutive numbering in the adopted geodesic coordinating system (BG, 2000), and contain information on areas or parts of them with permanent use as forests according to the Forest act. Forest maps are maintained separately by Forestry enterprises according to their FMP.

The forest maps give detailed data on:

- state boundary and all administrative boundaries in the scope of the particular map
- the boundaries of the urbanized areas
- the boundaries of the transportation areas
- the boundaries of the agricultural lands
- the boundaries of the State forestry enterprises and State game management areas and their subdivisions (forestry compartments and subcompartments)
- main and secondary watersheds
- roads, track and underground line facilities, within the boundaries of the forestry departments

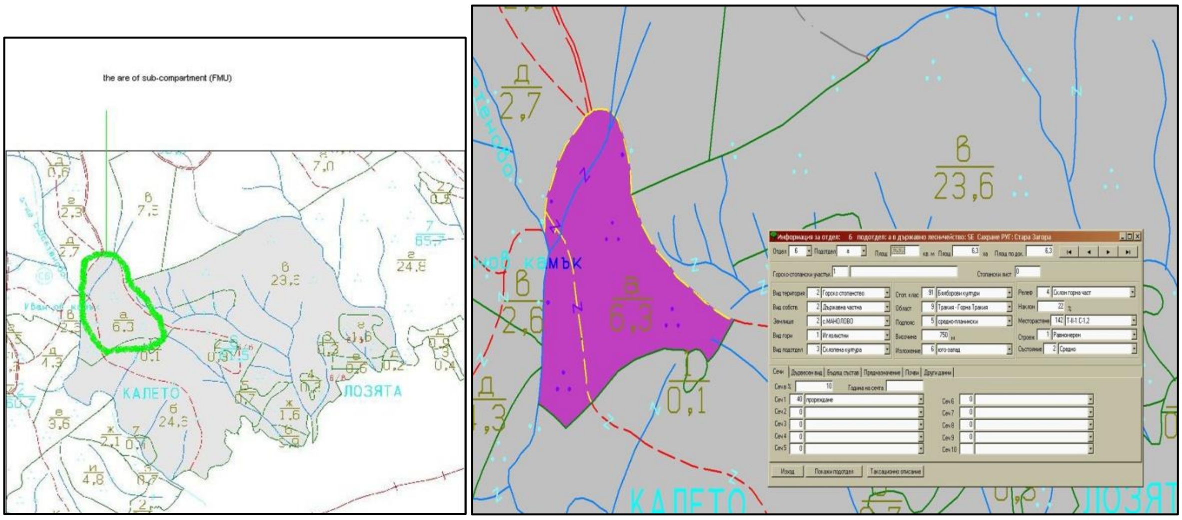


Figure 112 A map of one SFE (on left side), showing a forest land compartment (in grey colour and) and a sub-compartment (green line). On the right side - the area of sub-compartment and its details in the table.

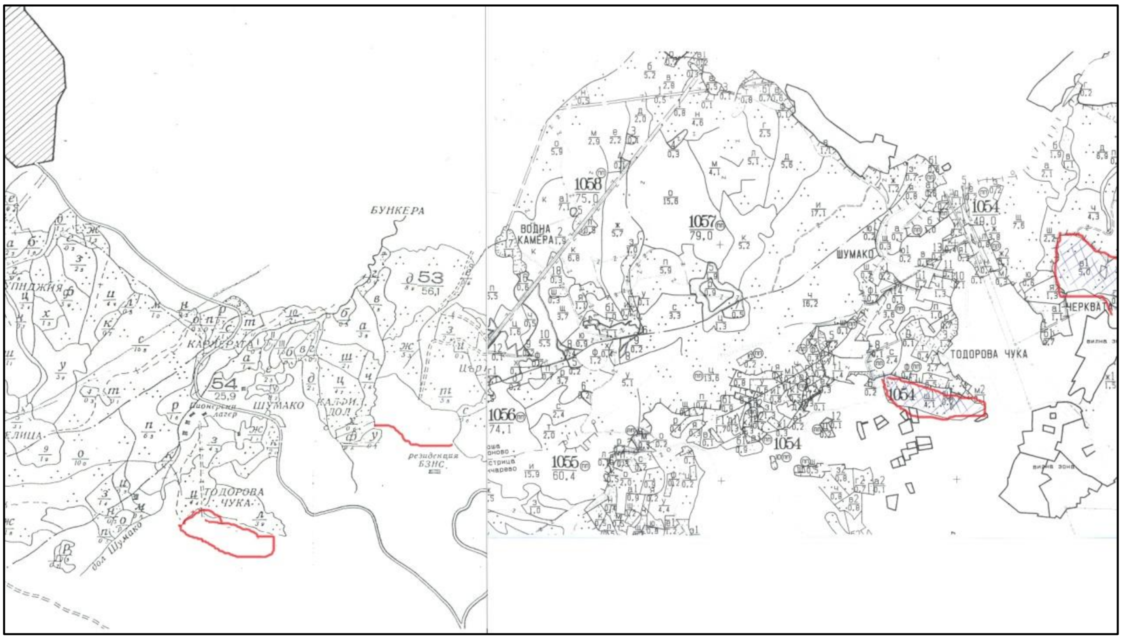


Figure 113 A map of the area of one SFE before (left) and now (right), which trace the changes in the forest land (in red).

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

The methodologies and assumptions used for the reporting under the Kyoto Protocol Art. 3.3. follow completely those for the areas of LUCs from and to forests (see Chapter 6.3.2.2 Lands converted to Forest Land).

The emission factors were estimated in the following manner:

11.3.1.2 Biomass

Data for the tree volume stock for coniferous and deciduous species from different age classes is available for the years 1990,1995, 2000, 2005 and 2010 according to FF reporting form 3 from NFI. Based on this data an average volume stock per ha for forest stands from Ist and IInd age class was estimated as weighed mean depending on the relative share of the stocks of the coniferous and the deciduous species. The average annual stock for the first age class is 6.28 m^3/ha/y obtained by dividing the average volume stock per ha for the first age class by average age of 10 years. Using the same approach the average annual stock for the IInd age class is determined of 12.16 m^3/ha/y.

There are no specific values for the biomass expansion factor (BEF_2) for converting the stemwood + branches stock into total aboveground biomass of the Ist age class. Since the Bulgarian NFI assesses also the stock of branches the biomass expansion factor does not need to account for this tree compartment, so BEF_2 has only to add the leaf biomass. To estimate this specific BEF_2 data from literary sources on results from ecosystem studies for Spruce, Scots pine, Beech and Oaks for the Ist age class stands were used (compiled in Korner et al.1993). The coefficients were recalculated as weighed mean according to the relative share of Spruce, Scots pine, Beech and Oak in the first and second age class of the Bulgarian forests Table 267 presents the values for BEF_2.

Table 267 Biomass expansion factor for converting stemwood +branches into total aboveground biomass (BEF_2) for the first and second age class

Types of forests	Coniferous	Deciduous
BEF2 first age class	1.10	1.08
Mean	1.09	
BEF2 second age class	1.09	1.05
Mean	1.07	

The weighed mean value for wood density (D) was estimated of 0.505 tonnes m^{-3} according to the wood stock of the single species.

For the ratio root-to-shoot of the young trees one coefficient is used (R=0.27). It is being calculated as weighed mean value of the coefficients used in the chapter Forest land Remaining Forest land according to the wood stock of coniferous and deciduous forests for the first age class.

The carbon fraction in the dry matter (CF) is adopted by default and it is 0.5 tonnes C, due to the lack of national data.

Therefore, the calculated living biomass growth rates used for estimating biomass increment in AR is 2.24 t C/ha/yr for the first age class and 4.20 t C/ha/yr for the second age class. The biomass increment for the first age class (2.24 tC//ha/yr) is applied for forest cohorts up to 20 years, while the biomass increment for the second age class (4.20 tC/ha/yr) is applied for forest cohorts greater than 21 years.

For estimating biomass loss associated with deforestation, data from NFI on volume stock over barck was used. The data on volume stocks over the five years period since 1990 was expanded and converted with the related country specific (or default) expansion/conversion factors: wood density (0.43 t/m3 for coniferous, 0.60 t/m3 for deciduous), stemwood plus branches expanded to the whole aboveground tree biomass (1.08 for coniferous, 1.03 for deciduous), root-to-shoot ratios (0.29 for coniferous, 0.24 for deciduous) and C-content (0.51 t C/t d.m. for coniferous and 0.48 t C/t d.m for deciduous). Then it was estimated the share of the coniferous and deciduous stocks in the total biomass stock for the respective years. Like this the weighted means for tree biomass stock were calculated. The means were used for estimating biomass loss from deforestation for the years across the time series.

Table 268 Living forest biomass stocks which are used to calculate emissions from deforestation

		1990	1995	2000	2005	2010
Weighted mean tree biomass stocks	tC/ha	36.04	41.42	45.83	49.50	53.04

For the biomass growth on settlements after deforestation the following values were taken: 0.09 $tCha^{-1}y^{-1}$ and 0.03 $tCha^{-1}y^{-1}$ for annual and perennial plants respectively. Growth of annual plants is accounted only in the year of D, while the growth of the perennial plants at the D areas continues. The annual biomass growth for annual and perennial plants is calculated on the basis of the share of the green areas in the settlements in Bulgaria (2.63% according to study for Sofia) and the following growth rates: for perennials (trees, bushes) it is 1.2 t C/ha.y, and for the annual plants – 3.3 t C/ha.y. These growth rates were derived from a detailed biomass study for Vienna (and is also used for the related estimates in Austria).

11.3.1.3 Dead wood

Due to the young age of the forests at the AR areas it is assumed that there is no dead wood and there is no change in this carbon stock at AR areas. If there was any in the young forests of AR areas it would represent a C stock increase due to the lack of dead wood in the previous land uses. So, the assumption is conservative.

For estimating changes in DW stock due to deforestation activity it was assumed that the dead wood stocks is equal to 5% of the standing biomass stock of the Bulgarian forests. This is a percentage magnitude for dead wood that is frequently reported for managed forests in Europe. The resulting values are given in the table below.

Table 269 Dead wood stocks used for estimating the changes in DW pool after deforestation

		1990	1995	2000	2005	2010
DW stock	tC/ha	1.80	2.07	2.29	2.47	2.65

11.3.1.4 Litter

According to IPCC definition litter pool includes all non-living biomass in a various state of decomposition, so this means – litter layer (fresh dead plant material), fumic and humic layers. As it was explained in chapter Forest remaining forest, changes in carbon stock in soil the source of information in order to estimate a country specific value for the carbon stock in litter is EEA-MOEW. The database resulted from the implementation of the ICP "Assessment and Monitoring of Air Pollution Effects on Forests"-UN/ECE Convention on Long Range Transboundary Air Pollution.

When analysing carbon content in litter Bulgaria follows ICP Forests Manual methodological approach http://www.icp-forests.org/pdf/FINAL_soil.pdf (see Annex 7 Soil horizon designation p.195) where litter definition is:

OL-horizon (Litter, Förna): this organic horizon is characterised by an accumulation of mainly leaves/needles, twigs and woody materials (including bark), fruits etc. This sublayer is generally indicated as litter. It must be recognized that, while the litter is essentially unaltered, it is in some stage of decomposition from the moment it hits the floor and therefore it should be considered as part of the humus layer. There may be some fragmentation, but the plant species can still be identified. So most of the original biomass structures are easily iscernible. Leaves and/or needles may be discoloured and slightly fragmented. Organic fine substance (in which the original organs are not recognisable with a naked eye) amounts to less than 10 % by volume.

According to IPCC-GPG definition this represents the "litter layer" (a horizon consisting of relatively fresh dead plant material). For Bulgaria there is no data gathered for the carbon content in this layer during the soil surveys. However, since the changes in biomass fully account for all leaves and needles (the tree biomass estimates accounts for these pools) that represent the material of the litter layer within one year. Any further accounting of this material would end in double accounting.

OF-horizon (fragmented and/or altered) is a zone immediately below the litter layer. This organic horizon is characterised by an accumulation of partly decomposed (i.e. fragmented, bleached, spotted) organic matter derived mainly from leaves/needles, twigs and woody materials. The material is sufficiently well preserved to permit identification as being of plant origin (no identification of plant species).The proportion of organic fine substance is 10% to 70% by volume. Depending on humus form, decomposition is mainly accomplished by soil fauna (mull, moder) or cellulose-decomposing fungi. Slow decomposition is characterised by a partly decomposed matted layer, permeated by hyphae.

OH-horizon (humus, humification): characterised by an accumulation of well-decomposed, amorphous organic matter. It is partially coprogenic, whereas the F horizon has not yet passed through the bodies of soil fauna. The humified H horizon is often not recognized as such because it can have friable crumb structure and may contain considerable amounts of mineral materials. It is therefore often misinterpreted and designated as the Ah horizon of the mineral soil and not as part of the forest floor as such. To qualify as organic horizon, it should fulfil the FAO requirement, as described above. The original structures and materials are not discernible. Organic fine substance amounts to more than 70% by volume. The OH is either sharply delineated from the mineral soil where humification is dependent on fungal activity (mor) or partly incorporated into the mineral soil (moder).

According to the ICP Forests Manual samples are taken separately for the different depth. OH and OF layers should be sampled together (see Table 5, p. 15 ICP Forests Manual). The data is available for each depth

The estimation for the model carbon stock in litter pool is based on data for carbon content in OFH layers available for the years 2000 – 2002. According to the data available it was estimated that the carbon stock in litter is 5.38 tC/ha.

11.3.1.5 Soil

Emissions/removals of carbon stock in the mineral soils due to AR were evaluated through the annual change in the carbon stock at the AR areas using the equation:

$$\Delta C_{LFmineral} = \frac{\left[\left(SOC_{ref} - SOC_{non-frest\ land}\right) \cdot A_{aff}\right]}{T_{aff}}$$

where:

$\Delta C_{LFmineral}$ - annual change in the carbon stock in mineral soils in the year of assessment, tonnes C/yr

SOC_{ref} – stable carbon stock in forests for a certain soil type, tonnes C/ ha

$SOC_{non-frest\ land}$ - stable carbon stock in the soil of the previous type of land-use (croplands, grasslands and other lands), tonnes C/ ha

A_{aff} - total af-/reforestated area after the conversion, ha

T_{aff} - duration of the transition from SOC Non forest Land to SOCref, yr

The used transition period was 20 years according to IPCC GPG.

For the stable stock of organic carbon in soils (0-40 cm) from forest ecosystems (SOCref) a country specific value is used = 78.3 t C/ha.

For the stable stock of organic carbon in soils (0-40 cm) of previous types of land-use the country specific values obtained for annual or perennial cropland, grassland and other land are used:

- annual crops: 89.9 t C/ha
- perennial crops: 76.5 t C/ha
- grasslands: 103.57 t C/ha
- other land: 69 t C/ha

Following the recommendation from the ERT Bulgaria re-estimated the reference organic carbon stock in soils under other land use. This has been done by using the default SOC reference level as described in table 2.3 in 2006 IPCCC Guidelines. In order to choose the most appropriate default SOC reference level Bulgaria did the following:

According to "Classification scheme for default climate regions" (IPCC, 2006) Bulgaria is in the "warm temperate dry" (appr. 60%), "cool temperate dry" (appr. 20%) and "cool temperate moist" (appr. 20%) regions (please see the map from the link below).

http://forest.jrc.ec.europa.eu/media/cms_page_media/122/BGR_Climate_1.pdf

Concerning the soil type, more than 80% of the territory is under high activity clay soils (please see the map from the link below).

http://forest.jrc.ec.europa.eu/media/cms_page_media/123/BGR_Soil.pdf

Therefore, Bulgaria estimated a weighted mean value for the SOC reference level in soils taking into account the SOC reference levels for HAC soils (table 2.3 from the2006 IPCC Guidelines) for the respective climate regions. The result for the 0-30 cm depth is 51.8 tC/ha. Bulgaria in its inventory estimates the CSC in mineral soils for 0-40 cm depth. Therefore, the value of 51.8 tC/ha had to be corrected for consistency reason. The final result is 69 tC/ha for 0-40 cm.

For C stock changes in soils of D areas the same approach and values as for AR areas were used, but with an appropriate reverse equation. The soil C stock (0-40 cm) used for settlements is:

- Settlements: 2.5 t C/ha

A descripiton of the methods of deriving all these soil C stocks can be found in the respective chapters of these subsectors.

11.3.1.6 Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

No carbon pool is omitted.

Deadwood is assumed not to occur on AR areas. Due to the young age of the forests at AR areas (since 1990) and the assumed lack of dead wood at areas of all other land uses it is assumed that a stock change of dead wood does not occur at AR areas. If there was any in the young forests of AR areas it would represent a C stock increase due to the lack of dead wood in the previous land uses. So, the assumption is conservative.

There is no practice of biomass burning at ARD areas in Bulgaria. Furthermore, forests are not fertilised and liming does not exist in Bulgaria. So, fertilisation at AR areas and liming at ARD areas do not occur.

11.3.1.7 Information on whether or not indirect and natural GHG emissions and removals have been factored out

Due to a lack of available methods in the IPCC GPG and elsewhere, indirect and natural GHG emissions/removals have not been factored out.

11.3.1.8 Changes in data and methods since the previous submission (recalculations)

Comparing the Submission 2014 the racalculations are as a result of implementation of the 2013 KP Supplement and the 2006 IPCC Guidelines in term of the updated default emission factors and coefficents. Complete nad correct KP LULUCF data for the inventoried year 2013 is provided for the first time in the current Submission.

11.3.1.9 Uncertainty estimates

We plan to cary out uncertainty estimates using tier 2 method twice during the CP. The first assessment would be performed next year together with the updated results from the AR assessments. Concerning the FM, uncertainty estimates using tier 2 method is plan also for the next submission after the implementation of the new NFI data into reporting.

11.3.1.10 Information on other methodological issues

The methods used to estimate emissions/removals from ARD activities are of the same tier method as those used for the UNFCCC reporting.

11.3.1.11 The year of the onset of an activity, if after 2008

Bulgaria reports all area subject to the activities under 3.3 and FM since 1990. This information is available in the CRF tables in NIR-2 table.

Concernig FM all forests in Bulgaria are managed, therefore all activities which are carried out in the forests are considered human-induced and those activities were already in place before the starting of the first commitment period of the Kyoto Protocol.

11.4 ARTICLE 3.3

11.4.1 INFORMATION THAT DEMONSTRATES THAT ACTIVITIES UNDER ARTICLE 3.3 BEGAN ON OR AFTER 1 JANUARY 1990 AND BEFORE 31 DECEMBER 2012 AND ARE DIRECT HUMAN-INDUCED

Changes in forest area are traced only after a forest inventory has been performed. Bulgaria reports the following AR activities that occurred on or after 1990:

- Planted or seeded on grasslands and croplands(97% from the total AR units of land due to planting and seeding on GL and around 1% on CL)
- Planted or seeded on other land for protective purposes (i.e erosive lands – around 2% from the total AR units of land due to planting and seeding)
- Abandoned lands – cropland and grassland which are naturally regrown as forest (20% from the total AR units of land due to regrowth on croplands and 80% - regrowth on GL

Table 270 Identified net AR units of land for the period 1992-2012 for each district in Bulgaria[37]

District	Regrowth in ha. 1992-2000	Regrowth on CL	Regrowth on GL	Regrowth in ha 2001-2012.	Regrowth on CL	Regrowth on GL	Planted or manually seeded in ha 1992-2000	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas	Planted or manually seeded in ha 2001-2012	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas
Vidin	**1508**	257	1251	**8560**	2072	6488	**620**	-	496	124	**27**	-	27	-
Montana	**567**	186	381	**2301**	294	2007	**60**	-	56	4	**2343**	-	2313	30
Vrats	**2397**	330	2067	**1934**	121	1813	**757**	12	735	10	**670**	-	624	46
Pleven	**4767**	1656	3111	**3199**	576	2623	**973**	122	851	-	**40**	-	40	-
Lovech	**660**	85	575	**8339**	827	7512	**348**	-	321	27	**3865**	-	3841	24
Gabrovo	**2852**	973	1879	**9245**	2370	6875	**35**	-	35	-	**18**	-	18	-
Veliko Tarnovo	**17**	-	17	**13037**	1440	11597	**715**	15	689	11	**1639**	-	1597	42
Rousse	**-**	-	-	**2643**	303	2340	**-**	-	0	-	**3573**	-	3569	4
Targovishte	**1864**	566	1298	**1898**	431	1467	**903**	25	864	14	**804**	-	804	-
Shumen	**851**	33	818	**3724**	568	3156	**1472**	4	1421	47	**41**	-	41	-
Razgrad	**-**	-	-	**665**	45	620	**775**	5	770	-	**1235**	-	1213	22

[37] Data for AR units of lands by district for 2013 and 2014 is missing because the data for these years is extrapolated. The table with the data up to 2012 is provided for transparency reason.

District	Regrowth in ha. 1992-2000	Regrowth on CL	Regrowth on GL	Regrowth in ha 2001-2012.	Regrowth on CL	Regrowth on GL	Planted or manually seeded in ha 1992-2000	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas	Planted or manually seeded in ha 2001-2012	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas
Silistra	**158**	67	91	**1614**	209	1405	**341**	-	341	-	**1646**	-	1643	3
Dobrich	**149**	-	149	**1132**	138	994	**4831**	20	4767	44	**621**	-	621	-
Varna	**873**	398	475	**980**	257	723	**1066**	1	1031	34	**718**	-	714	4
Burgas	**2034**	469	1565	**6996**	1172	5824	**1208**	6	1175	27	**640**	-	636	4
Yambol	**232**	61	171	**831**	125	706	**194**	-	189	5	**736**	-	724	12
Sliven	**568**	214	354	**1341**	222	1119	**636**	-	622	14	**76**	-	76	-
Stara Zagora	**746**	174	572	**1560**	213	1347	**1258**	5	1218	35	**353**	-	344	9
Haskovo	**1405**	509	896	**5505**	480	5025	**857**	3	806	48	**2409**	-	2405	4
Kardjali	**9**	4	5	**43**	10	33	**52**	1	49	2	**25**	-	24	1
Smolyan	**3176**	644	2532	**6769**	843	5926	**337**	-	324	13	**404**	-	401	3
Plovdiv	**2264**	416	1848	**5445**	386	5059	**2148**	16	2058	74	**678**	-	670	8
Pazardjik	**466**	65	401	**1286**	88	1198	**1170**	9	1131	30	**493**	-	481	12
Blagoevgrad	**1807**	445	1362	**6640**	857	5783	**2709**	15	2669	25	**1858**		1795	63
Kustendil	**1378**	410	968	**6937**	614	6323	**407**	10	373	24	**525**	-	509	16
Pernik	**1537**	214	1323	**2581**	335	2246	**4971**	51	4859	61	**381**	-	358	23

District	Regrowth in ha. 1992-2000	Regrowth on CL	Regrowth on GL	Regrowth in ha 2001-2012.	Regrowth on CL	Regrowth on GL	Planted or manually seeded in ha 1992-2000	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas	Planted or manually seeded in ha 2001-2012	Planted, seeded on CL	Planted, seeded on GL	Planted, seeded on erosive areas
Sofia	**1126**	234	892	**11589**	1694	9895	**183**	-	183	-	**3326**	6	3164	156
Total	**33411**	8410	25001	**116794**	16690	100104	**29026**	320	28033	673	**29144**	6	28652	486

Table 271 Total AR estimates for the period 1990-2012

Years	AR	FLx - FLx-1	Planted or manually seeded (kha)	Naturally seeded (kha)	Dx
2014	12.32	12.17	2.43	9.73	0.15
2013	12.63	12.17	2.43	9.73	0.46
1992-2012	211.94	208.38	58.17	150.21	3.57
1991	6.99	6.94	3.23	3.71	0.05
1990	7.08	6.94	3.23	3.71	0.15
Total	250.96		69.49	177.09	4.37

According to the Annex of Decision 16/CMP.1 art. 1 b) and c)[38] natural A/Rs occurred on abandoned arable lands have to be reported under art. 3.3. as this forest regeneration is based on a human induced promotion. Bulgaria reports these units of land consistent with the requirements. The re-growth in this case is the result of the direct human induced stop of the agricultural management at these lands, which in fact leads to a direct human induced natural seeding from the adjacent forests and (re-)growth of managed forests (all forests in Bulgaria are managed and reported as such).

According to IPCC GPG 2003 it is good practice to provide documentation that all A/R activities included in the identified units of land are direct-human induced. "Relevant documentation includes forest management records or other documentation that demonstrates that a decision had been taken to replant or to allow forest regeneration by other means." This requirement is described in the Annex of Decision 15/CMP.1 art.8 a).

As it is described in the NIR on 11.2.2, all units of land subject to AR activities are identified from the revision of all Forest Management Plans for all State Forest Enterprises (SFE) in Bulgaria. The new forest area identified and reported as AR units is included in FMPs, which by itself is evidence that the AR area is direct-human induced. FMPs are considered by Bulgaria as documentations that demonstrate human induced activity. In addition to this, there is a specific administrative procedure when as a result of the forest inventory assessment an agricultural land (e.g CL and Gl) is identified as becoming a forest. The basics of this procedure is the owner's decision (please see art. 83 and 84 from the Forest Law 2011(last amendment 07.08.2012, SG №60). In the case when the new forest is less than 10 years old the land owner is informed on the risk of conversion of the agricultural land into forest land. If the land owner decides to keep the former agricultural land under

[38] *"Afforestation" is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources*
"Reforestation" is the direct human-induced conversion of non-forested land to forested
land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1

agricultural use, he has to submit a declaration to the Executive director of the Executive Forest Agency. After the submission of the declaration, in 3 years term, the land owner is obliged to cut the re-grown forest vegetation and return the land into an active status of agricultural management. As a consequence of this procedure, it can be assumed that the lack of back conversion of such new forests into agricultural lands afterwards represents clear evidence for the nature of a land owner's decision of an intended land use change into forests.

According to the Forest Act 2011 this procedure is described in the following articles:

Art. 83. (1) Where as a result of the inventory of forest territories it is established, that the farm territories have acquired characteristics of a forest in the meaning of this law, the persons, who have performed the inventory shall produce to the Executive director of the a list of the properties upon the lands of the populated areas.

(2) The list under Para. 1 shall be published in one local and one central daily newspaper and shall be announced in public on the internet site of the relevant regional administration, Regional directorate of forests and the Executive Forest Agency.

(3) On the basis of the list under Para. 1, the Executive director of the Executive Forest Agency or an official, authorized by him shall invite in writing the owners of the relevant properties to declare if they wish to use their properties as farm or forest territories.

(4) ***Within 6-month term*** *from receiving the invitation under Para. 3, the owner,* ***who wishes to use his property as a farm territory*** *shall submit a declaration to the Executive director of the Executive Forest Agency.*

(5) If the owner fails to submit a declaration within the term under Para. 4, the Executive director of the Executive Forest Agency shall propose to the Minister of Agriculture and Food to issue an order for change of function of the properties as forest territory. The proposal shall describe the size of the properties, the type and origin of the forest and a plan of the property shall be attached from the map of the restored ownership or from the cadastre map and taxation characteristics.

(6) The order under Para. 5 shall be sent to the owner, to the relevant Regional directorate of forests, as well as to the relevant Office of geodesy, cartography and cadastre – for reflecting the change in the cadastre map and cadastre registers, or to the Municipal office of agriculture – for reflecting the change in the map of the restored ownership.

(7) The provisions of Para. 1 – 6 shall not apply to territories, provided to sites of the national security and defence.

Art. 84. (1) Where as a result of the inventory of the forest territories it is established, that farm territories have acquired the characteristics of a forest in the meaning of this law and the owner declares in writing before the Executive director of the Executive Forest Agency that he wishes to use his property as a farm territory within the term of 3 years from submitting the declaration he shall be obliged to clean his property from the forest timber vegetation.

(2) In case that within the term of Para. 1 the owner fails to clean his property from forest-timber vegetation, the provision of Art. 83, Para. 4 – 6 shall apply.

(3) Notwithstanding of the inventory under Para. 1, unfit for farm use territories may be included on the forest territories on the basis of a written application of the owner under Art. 83, Para. 5 and 6

When the new forest is older than 10 years, then this forested area belongs to the Forest Fund at once and the land owner cannot change the designation.

The old Forest Act did not contain specific procedure as the one described in the Forest Act 2011. However, under the old Forest act (1997-2011) the following have been taken into account:

The Forest Act (1997-2011) defines the term "Forest" (*"Art. 2. (1) (amend. SG 16/03) Forest, in the context of this law is the land occupied by forest ligneous plants with area not less than 1 decare*."). The Forest Act regulates the way of use and management of forests. The purpose of the law is ensuring the protection of the forest territory and increasing the area covered by forest. The subject of the Act includes only forest land and land within the Forest Fund and their management is done in accordance with the Forest management plans, programs and projects, as prescribed in Regulation № 6 on the structure of the forests and land included in the forest fund and the hunting reserves of Republic of Bulgaria. For the purpose of the management of the forests in the Forest management plans, programs and projects and the relevant reports that are integral part of them, all Afforestation and Reforestation activities in the Forest Fund are described in the Forest Act (1997-2011) (art.42(1)

Art. 42. (amend. SG 16/03) (1) (amend. – SG 64/07; amend. – SG 80/09) The afforestation in the forest fund shall be carried out according to the forest development projects, technical projects for fighting with the erosion and landslides, plans and programs under the conditions and by the order, determined with ordinance by the Minister of Agriculture and Food.

In cases when as a result of the natural regrowth agricultural land has become forest and has met definition of "forest" given by the Forest Act, this area should be managed as forest and is subject to forest inventory and therefore included in FMPs.

(*§ 9. (new – SG 28/92) Farm lands, in which the right of ownership has been restored by the order of art. 10 of this law and which are forests in the sense of the Law of the forests, shall be subordinated to the regime of the Law of the forests and the Law of the hunting economy(**LAW OF THE OWNERSHIP AND THE USE OF THE FARM LAND**)*)

As regards Deforestation activities, Forest Act clearly inscribes all cases in which forest is taken out of the Forest Fund (existing woods). This is followed by LUC and they are transformed from forested to non-forested lands. The procedure for taking out of the Forest Fund is given in the Forest Act (please see the respective articles below). **Therefore all changes in the function or designation of the forests are considered as deforestation and are reported as such.**

All forests in Bulgaria are protected by the Forest Act.

Art. 3. (1) Decreasing the existing woods shall not be allowed:

1. on the territory of the Republic of Bulgaria;

2. on the territory of Municipalities, in which the woods are under 10%.

Forest Act (2009):

*Art. 14. (amend. SG 16/03) (1) Forests and lands of the forest fund **shall be excluded at change of their designation for:***

1. plots for construction of power plants, dams and other hydro-technical and electric-technical facilities, obtaining of underground resources, graveyard parks, waste depots, re-loading stations;

2. tracks for linear sites;

a) located on the surface of the terrain – roads, railways, water canals, cable cars, draglifts and other facilities for technical infrastructure;

b) located under the surface of the terrain – oil pipelines, gas pipelines, heat conduits and water supply pipeline with cross section over 1500 mm;

3. creating of new or expansion of the construction boundaries of existing urbanized territories (settlements and settlement formations), as well as creating or expanding of the boundaries of separate regulated landed properties out of them;

4. (amend. – SG 64/07) creating of new or expanding of the construction boundaries of existing urbanized territories (settlements and settlement formations), as well as creating or expanding of the boundaries of separate regulated landed properties out of them in the cases when disposing actions with payment have been implemented with forests and lands of the state forest fund, in which till March 1, 2003 construction has been implemented in the sense of art. 12 of the Law of Spatial Planning;

5. creating of lands for agricultural use from land not producing timber in the state forest fund;

6. sites, connected with the national security, the defense of the country, the preservation and the reproduction of environment.

(2) The exclusion of forests and lands from the forest fund after fire shall be prohibited for a term of 20 years.

(3) Para 2 shall not be applied in the several cases:

1. when the change of the designation is connected with the defense or the security of the country;

2. when the change of the designation is connected with the fulfillment of investment projects, approved by the Council of Ministers.

Procedure for exclusion:

*Art. 14d. (new – SG 16/03) (1) (amend. - SG 30/06, in force from 12.07.2006; amend. – SG 64/07; amend. – SG 54/08; amend. – SG 80/09) **The Minister of Agriculture and Food upon proposal by the Executive director of the Executive Agency of Forests shall issue an order for excluding of the forests and the lands from the forest fund or propose to the Council of Ministers to take decision***

Forest Act 2011

Art. 73. (1) Change of the function of land properties in forest territories shall be admitted for:

1. grounds for construction of transport equipment (ports, airports, railway stations, bus-stations) production undertakings, extraction of ores and minerals, graveyards, waste depots, waste banks, depositories, electric power stations, damps, purifying stations for drinking or waste waters and other hydro-technical and electro-technical equipment, with the exception of the fundaments of the electric line posts;

2. permanent ways of line objects, placed on the surface of the ground – roads and railway lines, including the equipment to them, water canals;

3. creating new or expanding construction borders of existing urban territories in the cases where there are adopted general territorial plans of the Municipalities or parts of them, in which the properties are situated;

4. creating or expanding separate regulated land properties, which are not state ownership, for which there is an enforced general territorial plan;

5. national sites in the meaning of the Law on State ownership, sites, related to the national security and defence of the country, to the environment protection, for whose construction there is a Council of Ministers decision, as well as Municipal sites of first importance in the meaning of the law on the Territory Planning;

6. construction of posts for lifts and tow-lifts, as well as basic equipment of the wind-generators and photo-voltaic parks;

7. construction of ski-tracks.

Procedure for exclusion:

*Art. 74. (1**) Change of function of land properties in forest territories – public state ownership shall be done by a Council of Ministers decision upon proposal of the Minister of Agriculture and Food. The change of function of forest territories – public state ownership shall be done only for construction of sites, which are state or Municipal ownership.***

(2) The change of function of land properties in forest territories apart from the ones, indicated in Para. 1 shall be done:

1. by a commission in the Regional directorate of forests – for land properties in forest territories with area up to 50 decares falling in the territorial scope of activity of the relevant Regional directorate of forests;

2. by a commission in the Executive Forest Agency – for land properties in forest territories apart from the ones, indicated in Para. 1 and in p. 1.

*Art. 75. (1) **For a change of the function of land properties in forest territories the owner or investor shall make a request for preliminary coordination before:***

1. The Minister of Agriculture and Food – for land properties in forest territories – public state ownership;

2. the relevant commission under Art. 74, Para. 2 – for land properties in forest territories apart from the ones, indicated in p. 1.

(2) The request for preliminary coordination for change of function of land properties in forest territories shall have attached the following documents:

1. a plan of the property from the cadastre map or from the map of the restored ownership, coordinated by the Relevant regional directorate of forests upon location of the property;

2. an approved task for development of a detailed territory plan, drawn up in compliance with the provisions of the Law on the Territory Planning;

3. a Municipal council decision – for land properties in forest territories – ownership of Municipalities.

11.4.2 INFORMATION ON HOW HARVESTING OR FOREST DISTURBANCE THAT IS FOLLOWED BY THE RE-ESTABLISHMENT OF FOREST IS DISTINGUISHED FROM DEFORESTATION

According to the Forest act in Bulgaria all forests are managed.

The forests and the lands of the forest fund shall be constructed, managed and used according to forest development projects, plans and programs. To develop forest management plans (FMP), projects and programs information from NFI is used.

According to the Forest Law (last amendment SG №66/2013) all harvest activities in the forests and lands with forest are planned under the FMP.

Art. 101. (1) Felling shall be conducted for restoration, growing and improving the conditions of forests and for achieving the objectives, laid down in the forestry plans and programmes.

(3) The Minister of Agriculture and Food shall adopt an Ordinance, which shall determine:

Art. 102. Restoring felling shall be conducted at an age not smaller than:

1. 60 years in high-stem forests with the exception of birch and poplar trees, as well as the artificially created plantations out of their natural region of spreading;

2. 20 years and not bigger than 30 years in forests for sucker restoration;

3. 15 years for acacia forests.

Clear cuttings are forbidden by Law.

Art. 104. (1) It shall be prohibited:

1. conducting clear fell in all the forests with the exception of the poplar and low-stem forests;

When there is forest disturbance the owner of the forest should replant the area if it cannot be restored by naturally up to 7 years.

Art. 97. (1) Wood-cutting areas and burned out areas, which cannot be restored naturally up to 7 years after the timber cutting or burning during fire shall be planted by their owner up to 2 years after expiry the 7-year period.

(2) Where the forestry plan or programme envisages restoration in an artificial way, the forestation shall be done within the term of 3 years after cutting the plantation.

It is forbidden by the Law to convert burnt by wildfires area to other land use during the 20 years period after the damage, caused by wildfires.

The delimitation between deforestation[39] and harvesting and forest disturbance is taking into account when Bulgaria reports under the KP. As it was described above there are some obligations by the Law according to harvesting and replanting of the forest area in order to keep the forest fund stable. When there is a plan or a need to convert forest land to non-forest land – according to the Law the owner should exclude the forest area from the forest fund (see chapter 11.4.1).

[39] (15/CMP.1 (par.8.b) "Deforestation" is the direct human-induced conversion of forested land to non-forested land.)

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

In Bulgaria forests are managed and utilized based on forest management plans, projects or programs. According to this, all activities like felling are planned and described in detail. All felling activities are carried out under the Regulation for fellings. The regulation describes the type of fellings and specifies the conditions in which fellings are carried out.

Deforestation needs administrative steps as described above, so there are only two possibilities 1) Forest areas that have lost forest plant cover (e.g. clear cut areas, damaged areas): These areas remain forests by law, and there is no transition to non-forest situation of such areas allowed (obligations for replanting etc., Art. 97. (1) Forest act SG66/2013). 2) Deforestation areas that followed all administrative steps needed to get the permission for deforestation. Only such areas are accounted as D areas in Bulgaria.

The Regulation for felling sets up the following cuttings:

1) Renewable
   - Gradual
   - Selective
   - Clear
2) Thinning
3) Other

When any harvest is conducted the requirements for the density of the stand should be obeyed where the density is different with the different types of harvests, but no less than 0.4, which is within the framework of the Forest Definition of the KP and thus reported as Forest.

As regards clear cuts they are only done in the cases described down here and obligatory followed by afforestation:

Art. 104. (1) It shall be prohibited:

1. conducting clear fell in all the forests with the exception of the poplar and low-stem forests;

Art. 97. (1) Wood-cutting areas and burned out areas, which cannot be restored naturally up to 7 years after the timber cutting or burning during fire shall be planted by their owner up to 2 years after expiry the 7-year period.

(2) Where the forestry plan or programme envisages restoration in an artificial way, the forestation shall be done within the term of 3 years after cutting the plantation.

11.4.4 INFORMATION RELATED TO THE NATURAL DISTURBANCES PROVISION UNDER THE ARTICLA 3.3 OF THE KYOTO PROTOCOL

Bulgaria intends to apply the provision to exclude emissions from Natural disturbances in lands subject to AR activities during the second commitment period in accordance with the paragraph 33 from the Annex to Decision 2/CMP.7. In connection with the provision and following the requirement set out in the Decision 2/CMP.7 an AR background level (BL) of emissions associated with annual disturbances has been developed. The background level is defined as the average of a consistent and initially complete time series containing emissions associated with annual natural disturbances after application of an iterative process to remove outliers, based on twice the standard deviation around the mean until no outliers can be identified. The method used to developed the BL of emissions from natural disturbances follows the default method as described in the 2013 KP Supplement. The following steps have been implemented:

1. Defining the types of natural disturbances – Bulgaria decided to apply the ND provision for wildfires, extreme weather events – windstorms, wet snowfall, ice, others
2. Established a consistent and initially complete time series – Bulgaria uses country-specific data (from Forest and Shade tree pathology Signals) on each type of disturbances. When data on disturbed area is missing the estimates have been derived using the moving average method. Further improvements could be made in order to fill the missing data for the next submissions. The time seris is presented in the table below

Table 272 Historical emissions associated with natural disturbances from lands under Afforestation/Reforestation

Total and area specific emissions from disturbances for the calibration period for AR																									
Distrubance type*	Inventory year during the calibration period																								
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	Total annual emission [Gg CO2 eq.]																								
wildfires	0.15	0.14	2.24	10.27	12.75	0.46	2.43	1.00	10.08	13.30	102.03	45.35	16.59	14.52	3.58	4.97	14.91	188.57	25.41	11.31	34.56	42.98	82.54	22.10	6.45
extreme weather events																									
windstorms	0.38	0.75	1.15	1.54	1.92	2.27	2.99	3.32	3.61	4.76	5.13	6.19	6.35	6.65	6.53	6.57	25.19	11.00	7.79	3.27	6.66	1.71	4.64	13.03	40.98
wet snowfall	0.19	0.39	0.59	0.78	0.97	1.16	1.54	1.76	2.05	2.14	2.52	2.95	3.56	3.75	4.27	6.14	2.88	9.13	2.31	9.90	4.14	9.87	30.36	68.95	20.96
ice	0.02	0.04	0.06	0.08	0.09	0.11	0.16	0.19	0.22	0.22	0.21	0.23	0.33	0.60	0.58	0.66	0.02	0.02	0.00	1.53	4.19	0.00	1.47	0.05	0.00
others e.g. droughts, floods, landslides	0.01	0.01	0.02	0.03	0.04	0.04	0.06	0.06	0.07	0.08	0.09	0.12	0.12	0.14	0.15	0.16	0.26	0.19	0.34	0.10	0.31	0.16	0.22	0.32	0.19
SUM	0.74	1.34	4.05	12.69	15.77	4.05	7.18	6.34	16.04	20.50	109.97	54.84	26.95	25.66	15.11	18.49	43.26	208.91	35.85	26.11	49.86	54.72	119.23	104.44	68.58
For all land under AR	Total area [kha]																								
	6.99	14.07	21.26	28.24	35.26	42.32	49.37	56.42	63.47	70.53	77.58	89.76	102.03	114.27	126.51	138.86	151.18	163.63	176.62	188.88	201.35	213.62	226.01	238.64	250.96
	Area-specific emissions (Emissions per unit of land area under AR, Mg CO2 eq. ha-1)**																								
	0.11	0.10	0.19	0.45	0.45	0.10	0.15	0.11	0.25	0.29	1.42	0.61	0.26	0.22	0.12	0.13	0.29	1.28	0.20	0.14	0.25	0.26	0.53	0.44	0.27

3. Develop the background level and the margin
   a. Calculation of the arithmetic mean of the area-specific annual emissions for AR summed over disturbance types using all years in the calibration period.
   b. Calculation of the corresponding standard deviation (SD) of the annual emissions;
   c. Checking whether any emission estimate is greater than the arithmetic mean plus twice the SD. In this case, such estimate(s) has(ve) been removed from the dataset and go back to step (1) above using the reduced dataset.

When no further outliers can be identified, the arithmetic mean and twice the SD, as calculated in the last step of the iterative process, define the background level and the margin, respectively.

4. Ensuring that the method does not lead to the expectation of net credits and debits - The expectation of net credits has been avoided comparing the emissions resulting by the application of step (3) above with the mean minus twice the SD (in this case the emissions should not be removed from the dataset). The main components related to background level and margin estimation process for AR activities have been reported in the table below

Table 273 Background level and the margin of emissions associated with natural disturbances from lands under article 3.3 of the Kyoto Protocol

Calibration period	1990-2014
Method used	IPCC Default
Background level	0.24 Gg CO2 eq.
Margin	0.13 Gg CO2 eq
BL plus margin	0.50 Gg CO2 eq
Number of excluded years	4
Excluded years	2000, 2001, 2007, 2012

11.4.5 INFORMATION ON HARVESTED WOOD PRODUCT UNDER ARTICLE 3.3 OF THE KYOTO PROTOCOL

Harvested Wood Products (HWPs) originating from *deforestation* activity are not occurring. Emissions from HWPs originated from *afforestation/reforestation* activities have been included in the emissions estimated from HWPs from *forest management* activities. Annual changes in carbon stocks and associated CO_2 emissions and removals from the (HWP) pool under article 3.3 are estimated, following the production approach described in the Annex to Volume 4, Chapter 12, of the 2006 IPCC Guidelines (IPCC, 2006), in line with Decision 2/CMP.7 and the guidance provided by the 2013 KP Supplement (IPCC, 2014).

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

All forests in Bulgaria are managed, therefore all activities which are carried out in the forests are considered human-induced. Therefore, all emissions and removals of all lands which were forests in 1.1.1990 are accounted as Forest Management emissions and removals, except the emissions and removals of the ARD lands since 1.1.1990which are accounted under the Art. 3.3 activity ARD.

11.5.2 INFORMATION RELATING TO FOREST MANAGEMENT

Bulgaria has a long tradition in Forest Management which is characterized by a long-term forestry policy that takes also issues of biodiversity conservation into account. The forest management policy is based on the principles of sustainable forest resources management, which balance the ecological, economic and social functions of the forest. This is ensured with Forest Act (2011). The Forest Act and associated Ordinances define all measures which have to be taken in order to manage, protect and sustain the Bulgarian forests. This includes regulations connected with harvest (e.g. limitations for harvest in stands below the legal minimum age for the rotation period), provisions for natural and artificial regeneration, regulations around deforestation (e.g. principal ban of deforestation) and etc. Therefore, Bulgaria uses a broad definition for Forest Management.

11.5.2.1 Conversion of natural forest to planted forest

There is no conversion of natural forest to planted forest in Bulgaria. Therefore, emissions are not accounted for from such activity.

11.5.2.2 Forest Management Reference Level

The forest management reference level (FMRL) for Bulgaria, inscribed in the appendix to the annex to Decision 2/CMP.7, is equal to –8.168 Mt CO2 eq. per year assuming instantaneous oxidation of HWP, and –7.950 Mt CO2 eq. applying first-order decay function for HWP. Bulgaria is one of the member States of the EU for which the JRC of the European Commission developed projections in collaboration with two EU modeling groups. The FMRL is the averages of the projected forest management (FM) data series for the period 2013-2020, taking account of policies implemented before mid-2009, with emissions/removals from harvested wood product (HWP) using the first order decay functions, and assuming instant oxidation. The contribution of HWP to the reference level of Bulgaria amounts to 0,218 Mt CO2 as described in the Submission of the FMRL by Bulgaria (2011). It was calculated using the C-HWP-Model, which estimates delayed emissions on the basis of the annual stock change of semi-finished wood products.

11.5.2.3 Technical correction of the FMRL

According to Decision 2/CMP.7, methodological consistency between the FMRL and reporting for forest management during the second commitment period has to be ensured, applying technical correction if necessary.
In respect to follow this recommendation Bulgaria in cooperation with JRC plan to have two technical corrections up to the end of the commitment period. In period 2017-2018 it is planned to make TC in order to update the FMRL according to the new NFI data (2016) and to update the HWPs estimates according to the 2013 KP Supplement. Meanwhile in order to ensure the consistency of the reported information, as an interim solution, Bulgaria has carried out a re-calibration of the model results used in construction of the FMRL in 2011. The result of the re-calibration is -8.145 Mt CO2 eq.

11.5.2.4 Information related to the natural disturbances provision under article 3.4

Bulgaria intends to apply the provision to exclude emissions from Natural disturbances in lands subject to AR activities during the second commitment period in accordance with the paragraph 33 from the Annex to Decision 2/CMP.7. In connection with the provision and following the requirement set out in the Decision 2/CMP.7 an AR background level (BL) of emissions associated with annual disturbances has been developed. The background level is defined as the average of a consistent and initially complete time series containing emissions associated with annual natural disturbances after application of an iterative process to remove outliers, based on twice the standard deviation around the mean until no outliers can be identified. The method used to developed the BL of emissions from natural disturbances follows the default method as described in the 2013 KP Supplement. The following steps have been implemented:

1. Defining the types of natural disturbances – Bulgaria decided to apply the ND provision for wildfires, extreme weather events – windstorms, wet snowfall, ice, others
2. Established a consistent and initially complete time series – Bulgaria uses country-specific data (from Forest and Shade tree pathology Signals) on each type of disturbances. When data on disturbed area is missing the estimates have been derived using the moving average method. Further improvements could be made in order to fill the missing data for the next submissions. The time seris is presented in the table below

Table 274 Historical emissions associated with natural disturbances from lands under Forest Management

Total and area specific emissions from disturbances for the calibration period for Forest Management																									
Distrubance type*	Inventory year during the calibration period																								
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
	Total annual emission [Gg CO2 eq.]																								
wildfires	76.0	37.2	381.3	1318.6	1311.4	39.7	178.3	64.3	575.7	683.8	4767.3	1831.3	589.3	460.4	102.5	129.6	357.5	4175.0	521.0	216.8	621.4	728.3	1322.0	335.1	93.0
extreme weather events																									
windstorms	194.9	192.9	195.4	197.1	197.1	194.7	219.6	213.3	206.1	244.5	239.6	250.1	225.6	210.9	187.1	171.4	603.8	243.5	159.6	62.7	119.7	29.1	74.2	197.6	590.9
wet snowfall	100.2	100.5	99.8	100.2	99.3	99.4	113.4	113.1	117.3	109.8	117.5	119.0	126.3	119.0	122.2	160.3	69.1	202.2	47.4	189.8	74.4	167.3	486.2	1045.6	302.2
ice	10.2	10.3	10.2	10.0	9.7	9.6	11.9	12.3	12.7	11.1	9.8	9.4	11.7	19.1	16.7	17.2	0.4	0.4	0.0	29.3	75.4	0.0	23.6	0.7	0.0
others e.g. droughts, floods, landslides	3.7	3.7	3.7	3.7	3.7	3.7	4.2	4.2	4.1	4.2	4.2	4.8	4.4	4.5	4.3	4.1	6.1	4.2	7.0	1.8	5.6	2.8	3.5	4.9	2.7
SUM	385.1	344.7	690.6	1629.5	1621.2	347.0	527.4	407.2	915.9	1053.5	5138.3	2214.7	957.3	814.0	432.8	482.6	1036.8	4625.3	735.1	500.6	896.6	927.4	1909.5	1583.8	988.8
For all land under FM	Total area [kha]																								
	3627	3627	3626	3626	3626	3626	3626	3625	3625	3625	3625	3625	3625	3624	3624	3624	3624	3623	3621	3621	3620	3620	3620	3619	3619
	Area-specific emissions (Emissions per unit of land area under FM, Mg CO2 eq. ha-1)**																								
	0.11	0.10	0.19	0.45	0.45	0.10	0.15	0.11	0.25	0.29	1.42	0.61	0.26	0.22	0.12	0.13	0.29	1.28	0.20	0.14	0.25	0.26	0.53	0.44	0.27

3. Develop the background level and the margin
   d. Calculation of the arithmetic mean of the area-specific annual emissions for AR summed over disturbance types using all years in the calibration period.
   e. Calculation of the corresponding standard deviation (SD) of the annual emissions;
   f. Checking whether any emission estimate is greater than the arithmetic mean plus twice the SD. In this case, such estimate(s) has(ve) been removed from the dataset and go back to step (1) above using the reduced dataset.

When no further outliers can be identified, the arithmetic mean and twice the SD, as calculated in the last step of the iterative process, define the background level and the margin, respectively.

4. Ensuring that the method does not lead to the expectation of net credits and debits - The expectation of net credits has been avoided comparing the emissions resulting by the application of step (3) above with the mean minus twice the SD (in this case the emissions should not be removed from the dataset). The main components related to background level and margin estimation process for AR activities have been reported in the table below

Table 275 Background level and the margin of emissions associated with natural disturbances from Forest Management

Calibration period	1990-2014
Method used	IPCC Default
Background level	738 Gg CO2 eq.
Margin	258 Gg CO2 eq
BL plus margin	1255 Gg CO2 eq
Number of excluded years	7
Excluded years	1993, 1994, 2000, 2001, 2007, 2012, 2013

11.5.2.5 Information of Harvested Wood Products under article 3.4

The HWP estimates have been prepared applying the tier 2 method as suggested by 2014 IPCC KP Supplement using the WoodCarbonMonitor model. Default conversion factors have been applied as listed in Table 2.8.1 (KP Supplement) in conjunction with data from FAOSTAT (FAO 2015). In order to reduce uncertainties, the initial stock has been estimated using Equation 2.8.6 of KP Supplement with t0=1990. The allocation of harvest to forest management and deforestation has been implemented on the basis of data as shown in the table below. The results of HWPs estimates for each product category are presented in the figure .

Table 276 Allocation of harvest production

harvest or roundwood production		
year	from FM	from D
1990	4083784	5216
1991	3634635	15365
1992	3519130	25870
1993	3541784	5216
1994	2676429	8571
1995	2831952	12048
1996	3191105	13895
1997	3027105	13895
1998	3217105	13895
1999	4337772	13895
2000	4769995	13895
2001	3990041	1849
2002	4817044	15846
2003	4822954	9936
2004	5974721	10949
2005	5836428	25242
2006	5969899	22101
2007	5653738	42262
2008	5951433	119567
2009	4584605	14395

harvest or roundwood production		
year	from FM	from D
2010	5623865	44135
2011	6187403	17597
2012	6056510	35490
2013	6082652	71868
2014	6082652	71868

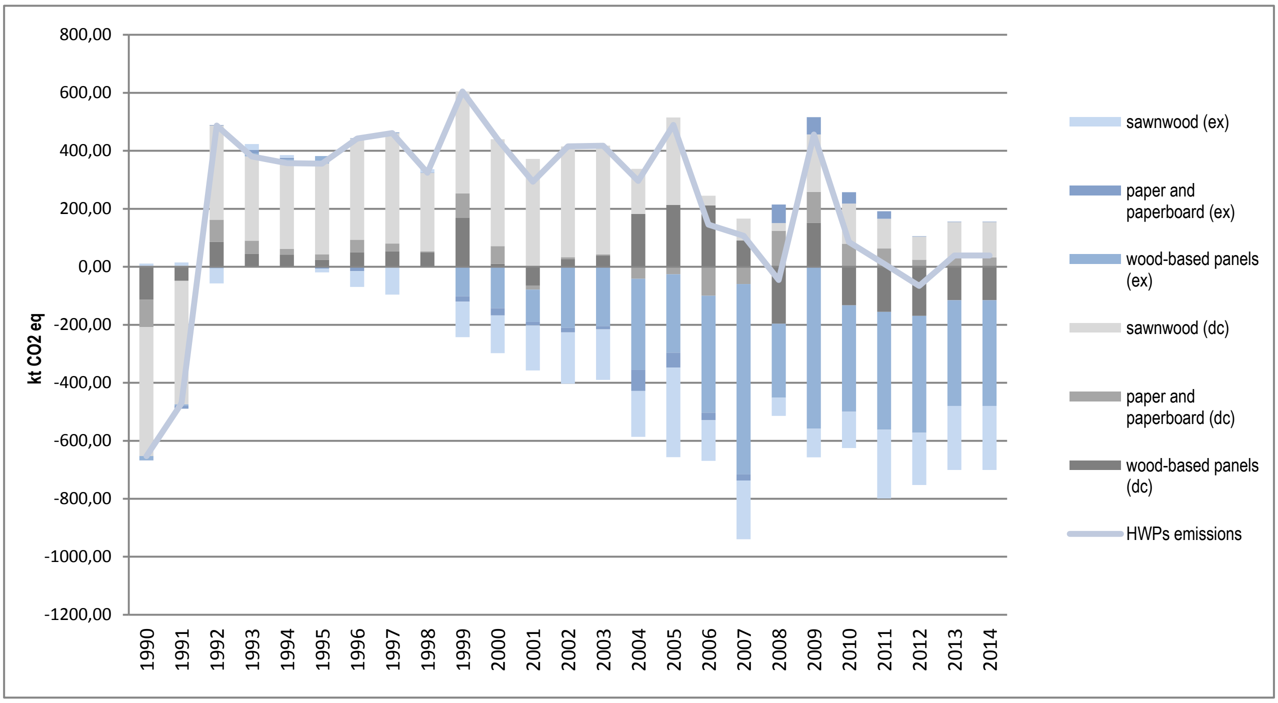


Figure 114 Carbon stock changes in HWPs pool

11.5.3 INFORMATION RELATING TO CROPLAND MANAGEMENT, GRAZING LAND MANAGEMENT, REVEGETATION AND WET DRAINAGE AND REWETTING, IF ELECTED, FOR THE BASE YEAR

NA for Bulgaria

11.6 OTHER INFORMATION

11.6.1 KEY CATEGORY ANALYSIS FOR ARTICLE 3.3 ACTIVITIES AND ANY ELECTED ACTIVITIES UNDER ARTICLE 3.4

Table 277 Key category analysis

Category	Net CO_2	Abs	%	sum
Forest Management	-7769.52	7769.52	84.6%	84.6%
Afforestation/Reforestation	-1326.78	1326.78	14.4%	99.1%
Deforestation	-87.10	87.10	0.9%	100%

11.7 INFORMATION REGARDING TO ARTICLE 6

NA for Bulgaria

12 INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1 BACKGROUND INFORMATION

Annex I parties are required to report from its national registry holding of and transaction of Kyoto Protocol units and inform about related issues as specified in Decision 15/CMP.1 Section E. Information about the transactions of the Kyoto-units is attached in to this document.

12.2 SUMMARY OF INFORMATION REPORTED IN THE SEF TABLES

The Standart Electronic Format (SEF) for providing information on ERUs, CERs, tCERs, lCERs, AAUs and RMUs for 2015.

12.3 DISCREPANCIES AND NOTIFICATION

Further information on Kyoto Protocol units referning to the respective paragraphs on decision 15/CMP 1 will be reported.

Paragraph 12: Discrepancies identified by the transaction log;

No discrepant transaction for the reporting period, pursuant of 15/CMP.1 annex I.E paragraph 12.

Paragraph13 & § 14: No CDM notifications occurred in 2015;

No CDM notifications were received by the National Registry during the reporting period, pursuant of 15/CMP.1 annex I.E paragraph 13 & 14.

Paragraph 15: No non–replacements occurred in 2015;

No non-replacements occurred during the reporting period,pursuant of 15/CMP.1 annex I.E paragraph 15.

Paragraph16: No invalid units exist as at 31 December 2015;

No invalid units exist for the reporting period, pursuant of 15/CMP.1 annex I.E paragraph 16

Paragraph 17: Actions necessary to correct any problem causing a discrepancy.

No actions were taken or changes made to address discrepancies for the period under review;

12.4 PUBLICLY ACCSSIBLE INFORMATION

Section E of the annex to decision 15/CMP.1 outlines provisions for the national registry to support, via a user-interface, non-confidential information being made available to the public. Bulgaria has made this information available on the Executive Environment Agency's website:

http://eea.government.bg/

The actual internet address of the Bulgarian registry in the Union registry is:

https://ets-registry.webgate.ec.europa.eu/euregistry/BG/index.xhtml

The following information has been made accessible to the public in line with the requirements. That this information is non-confidential. Bulgaria considers all information to be confidential that is determined to be confidential according to article 110 of the Commission regulation (EU) No 389/2013. Accounts holding's publicly accessible information:

http://eea.government.bg/bg/r-r/r-te/registry/main2

The registry terms and conditions, operators guide, forms and guidance for opening the holding accounts are available at the website of Executive Environment Agency:

http://eea.government.bg/bg/r-r/r-te/registry/main11

Joint implementation (JI) projects' publicly accessible information:

http://eea.government.bg/bg/r-r/r-te/registry/main2

The information of approved Joint Implementation projects and their documentation is added on the website of the competent authority (Ministry of the Environment and Waters) of JI projects and can be downloaded from the following link:

http://www3.moew.government.bg/?show=top&cid=357&lang=en

Information according to paragraph 45 - 48 of the annex to decision 13/CMP.1:

(a) Account name: the holder of the account

(b) Account type: the type of account (holding, cancellation or retirement)

(c) Commitment period: the commitment period with which a cancellation or retirement account is associated

(d) Representative identifier: the representative of the account holder, using the Party identifier (the two-letter country code defined by ISO 3166) and a number unique to that representative within the Party's registry

(e) Representative names nominated by the account holder and authorized to work with the account.

The Information includes the following Article 6 project information, for each project identifier if the Party has issued ERUs for a project:

(a) Project name: a unique name for the project

(b) Project location: the Party and town or region in which the project is located

(c) Years of ERU issuance: the years in which ERUs have been issued as a result of the Article 6 project

(d) Reports: downloadable electronic versions of all publicly available documentation relating to the project, including proposals, monitoring, verification and issuance of ERUs, where relevant, subject to the confidentiality provisions in decision 9/CMP.1.

The information includes the following holding and transaction information relevant to the national registry, by serial number, for each calendar year:

(a) The total quantity of ERUs, CERs, AAUs and RMUs in each account at the beginning of the year (displayed in the year X+5, according to EU Registry Regulation No 920/2010/EC the information is confidential until the year X+5)

(b) The total quantity of AAUs issued on the basis of the assigned amount pursuant to Article 3, paragraphs 7 and 8 (displayed in the year X+1)

(c) The total quantity of ERUs issued on the basis of Article 6 projects (displayed in the year X+1)

(d) The total quantity of ERUs, CERs, AAUs and RMUs acquired from other registries and the identity of the transferring accounts and registries (displayed in the year X+5, according to Commission regulation (EU) No 389/2013 the information is confidential until the year X+5)

(e) The total quantity of RMUs issued on the basis of each activity under Article 3, paragraphs 3 and 4 (displayed in the year X+1)

(f) The total quantity of ERUs, CERs, AAUs and RMUs transferred to other registries and the identity of the acquiring accounts and registries (displayed in the year X+5, according to Commission regulation (EU) No 389/2013 the information is confidential until the year X+5)

(g) The total quantity of ERUs, CERs, AAUs and RMUs cancelled on the basis of activities under Article 3, paragraphs 3 and 4 (displayed in the year X+1)

(h) The total quantity of ERUs, CERs, AAUs and RMUs cancelled following determination by the Compliance Committee that the Party is not in compliance with its commitment under Article 3, paragraph 1 (displayed in the year X+1)

(i) The total quantity of other ERUs, CERs, AAUs and RMUs cancelled (displayed in the year X+1)

(j) The total quantity of ERUs, CERs, AAUs and RMUs retired (displayed in the year X+1)

(k) The total quantity of ERUs, CERs, and AAUs carried over from the previous commitment period (displayed in the year X+1)

(l) The Information does not include current holdings of ERUs, CERs, AAUs and RMUs in each account because this is confidential according to Commission regulation (EU) No 389/2013.

12.5 CALCULATION OF THE COMMITEMENT PERIOD RESERVE CPR

Parties are required by decision 11/CMP.1 under the Kyoto Protocol and paragraph 18 of Decision 1/CMP.8 to establish and maintain a commitment period reserve as part of their responsibility to manage and account for their assigned amount. The commitment period reserve (CPR) equals the lower of either 90% of a Party's assigned amount pursuant to Article 3(7bis), (8) and (8bis) or 100% of its most recently reviewed inventory, multiplied by 8.

The national commitment period reserve is calculated in accordance with paragraph 6 of the Annex to decision 11/CMP.1 as 90% of the proposed assigned amount or 100% of eight times its most recently reviewed inventory, whichever is the lowest

The first method calculation as 90% of the proposed assigned amount of Bulgaria gives the estimate:

CPR = 0,9 x 222 945 983 = 200 651 385 Mg CO_2 equivalent

The second method calculation as 100% of the most recently reviewed inventory (emission level 2014) of Bulgaria times eight gives the estimate:

CPR = 8 x 57 197 219 = 457 577 755 Mg CO_2 equivalent

Bulgaria has interpreted the 'most recently reviewed inventory' as the year 2014, which will be reviewed by October 2016.

Therefore Bulgaria's estimated CPR is 200 651 385 Mg CO_2 equivalent.

12.6 KP-LULUCF ACCOUNTING

The EU, its Member States and Iceland are fulfilling their quantified emission reduction targets for the second commitment period of the Kyoto Protocol jointly. Bulgaria's assigned amount is fixed in the joint fulfilment agreement between the EU, its Member States and Iceland, to 222 945 983 tonnes CO_2 eq.

In Table 278 data on accounting for the KP-LULUCF activities based on the reporting for the year 2014 are given. According to this information, Bulgaria would at the end of the commitment period be able to issue RMUs.

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	BY	NET EMISSIONS/REMOVALS			Accounting parameters	Accounting quantity (4)
		2013	2014	Total(3)		
	(kt CO_2 eq)					
A. Article 3.3 activities						
A.1. Afforestation/reforestation		-1186.12	-1326.78	-2512.90		-2512.90
Excluded emissions from natural disturbances(5)		NO	NO	NO		NO

Excluded subsequent removals from land subject to natural disturbances(6)						
A.2. Deforestation		155.03	87.11	242.14		242.14
B. Article 3.4 activities						
B.1. Forest management				-15465.55		17286.45
Net emissions/removals		-7696.03	-7769.52	-15465.55		
Excluded emissions from natural disturbances(5)		NO	NO	NO		NO
Excluded subsequent removals from land subject to natural disturbances(6)						
Any debits from newly established forest (CEF-ne)(7),(8)						
Forest management reference level (FMRL)(9)					-8169.00	
Technical corrections to FMRL(10)					-8207.00	
Forest management cap(11)						17286.45
B.2. Cropland management (if elected)		NA	NA	NA		NA
B.3. Grazing land management (if elected)		NA	NA	NA		NA
B.4. Revegetation (if elected)		NA	NA	NA		NA
B.5. Wetland drainage and rewetting (if elected)		NA	NA	NA		NA

Table 278 Information table on accounting for activities under Articles 3.3 and 3.4 of the Kyoto Protocol. (1)(2)

Notes:

(1) All values are reported in table 4(KP) and tables 4(KP-I).A.1.1, 4(KP-I).B.1.1, 4(KP-I).B.1.2 and 4(KP-I).B.1.3 of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.

(2) Net emissions and removals from cropland management, grazing land management, revegetation and/or wetland drainage and rewetting, if elected, in the Party's base year, as established by decision 9/CP.2.

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

(4) The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7.4 of the Kyoto Protocol.

(5) A Party that has indicated their intent to apply the natural disturbance provisions may choose to exclude emissions from natural disturbances either annually or at the end of the commitment period.

(6) Any subsequent removals on lands from which emissions from natural disturbances have been excluded is subtracted from the accounting quantity of the respective activity.

(7) A debit is generated in case the newly established forest does not reach at least the expected carbon stock at the end of the normal harvesting period. Total debits from carbon equivalent forests are subtracted from the accounting quantity forest management.

(8) In case of a projected forest management reference level, Parties should not fill in this row.

(9) Forest management reference level as inscribed in the appendix of the annex to decision 2/CMP.7, in kt CO2 eq per year.

(10) Technical corrections in accordance with paragraphs 14 and 15 of the annex to decision 2/CMP.7 and reported in table 4(KP-I)B.1.1 in kt CO2 eq per year.

(11) For the second commiment period, additions to the assigned amount of a Party resulting from forest management shall, in accordance with paragraph 13 of the annex to decision 2/CMP.7, not exceed 3.5 per cent of the national total emissions excluding LULUCF in the base year times eight.

13 INFORMATION ON CHANGES IN NATIONAL SYSTEM

Regulation of the Council of Ministers 216/05.09.2014 SG 76/2014 on the way and order of organization of the National Inventories of hazardous substances and greenhouse gases in the ambient air are revised and replaced Regulation of the Council of Ministers 215/21.09.2010 SG 76/2010. The main purpose of revision was to adapt to the changing reporting requirements both under the UNFCCC and the EU (MMR). The regulation reinforces the existing institutional agreements by specifying the roles of all data providers.

Order № 296/04.12.2015 by the Executive Director of ExEA (Sector experts/QC experts) has been revised and replaced Order № 150/01.07.2013 by the Executive Director of ExEA in order to reflect relevant staffing changes of the inventory team. The order presents distribution of responsibilities of different departments and experts within the ExEA for inventory planning, preparation and management.

14 INFORMATION ON CHANGES IN NATIONAL REGISTRY

The following changes to the national registry of Bulgaria have therefore occurred in 2015.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	The registry Staff has changed to: • Ms Zornitza Ruseva, email z.ruseva@eea.government.bg, tel. +359 02 940 64 16, • Ms Nina Dilmitrova, email n.dimitrova@eea.government.bg, tel. +359 02 940 64 16 and • Ms Plamena Eneva, email p.eneva@eea.government.bg, tel. +359 02 940 64 16.
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	There was no change to the database structure as it pertains to KP functionality in 2015. Versions of the CSEUR released after 6.3.3.2 (the production version at the time of the last Chapter 14 submission) introduced minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. The database model is provided in Annex A. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex B. Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to the relevant major release of the version to Production (see Annex B). Annex H testing will be carried out in February 2016 and the test report will be submitted thereafter No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	No change of security measures occurred during the reporting period
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	No change of the registry internet address occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	Changes introduced since version 6.3.3.2 of the national registry are listed in Annex B. Both regression testing and tests on the new functionality were successfully carried out prior to release of the version to Production. The site acceptance test was carried out by quality assurance consultants on behalf of and assisted by the European Commission; the report is attached as Annex B. Annex H testing will be carried out in February 2016 and the test report will be submitted thereafter.
The previous Annual Review recommendations	See below

15 INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

According to the Article 3, paragraph 14 of the Kyoto Protocol, Annex I countries shall provide information on how is striving to implement commitments in such a way as to minimize potential adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention.

Impacts on third countries are mostly indirect and frequently cannot be directly attributed to a specific policy. Therefore we cannot consider that there is an adverse social, environmental and economic impact on developing countries due to our national climate change policy.

The application of the Joint Implementation mechanism in our country aims to renew the old tehnologies and improves energy efficiency, with no transboundary effects, as well as the implementation in Bulgaria of the European Union Emission Trading Scheme.

Nonetheless Bulgaria is of the view that taking the actions on mitigation, adaptation, development technology and transfer and capacity building in developing countries is very important for international climate change policy.

In this regard, in 2012 completed the project "Bulgarian contribution to the "short-term financing" 2011-2012: Sharing Bulgarian experience of monitoring, reporting and verification of greenhouse gas in the Republic of Macedonia for participation in the European Union Emission Trading Scheme of greenhouse gases". Through this project, Bulgaria has fulfilled its obligation, which made at the summit of the European Union in December 2009, to provide short-term financing of climate activities.

According to the Article 3, paragraph 14 of the Kyoto Protocol, Annex I countries shall provide information on how give priority, in implementing the commitments under Article 3, paragraph 14, to specific actions.

The majority of Bulgarian legislation measures in the climate change area, are connected mainly with transposing of the European legislation, as well as other activities on implementation of directives, connected with the politics on climate change.

The table below summarizes how the Party gives priority to selected actions, identified in paragraph 24 of the Annex to Decision 15/CMP.1.

Table 279 Selected actions, identified in Para 24 of the Annex to Decision 15/CMP.1.

Action	Implementation by the Party
The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-	**Market imperfection** The Climate Change Mitigation Act and Clean Ambient Air Act and related secondary legislation, including a permit system for meeting minimum standards in accordance with EU regulation on Large Combustion Plants (LPS), participation in the EU ETS and

Action	Implementation by the Party
emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities.	technical inspection (e.g. for cars) etc; The Energy Act, in its part on combined heat and power generation introduces the requirements of the related EU directives and the use preferential feed-in tariffs and mandates the state regulations to the licensed activities in the power sector and purchase obligations for the Transmission and Distribution Companies to buy all electricity produced from high efficient cogeneration, and for district heating companies to buy all utilized waste thermal energy. The Energy from Renewable Sources Act introduces the requirements of the related EU directives and the use of instruments such as green certificates and preferential feed in tariffs, mandates the state regulations to the licensed activities in the power sector and purchase obligations for the Transmission and Distribution Companies to by all electricity produced from renewable sources. It regulates the acceptance and realization of national indicative targets for consumption of bio fuels and other renewable fuels in the transport sector as a part of the total consumption of transport fuels; The Energy Efficiency Act and related secondary legislation, including obligation to adopt municipal energy efficiency programs, requirements for energy efficiency labelling, the use of minimum standards resulting from the EU directive on energy efficient appliances, regulations for energy efficiency labelling of various types of products (appliances, cars), obligatory audits and amendments of the Energy Performance Standards for existing buildings; The Waste Management Act and the related secondary legislation including the obligation for collecting, management and usage (or combustion) of the omitted gases from the new waste deposits; **Fiscal policy** A number of stimulating measures for the subjects of taxation were introduced in the Act on amendment and supplement of the Corporate Income Tax Act and also in the Act on amendment and supplement of the Income Taxes on Natural Persons Act ; The on-going liberalization of energy market is in line with EU policies and directives; The main instrument addressing externalities is emission trading under the EU ETS.

PART 2: ANNEXES TO THE NATIONAL INVENTORY REPORT

ANNEX 1 KEY CATEGORY ANALYSIS (KCA)

The key category analysis is performed according to the 2006 IPCC Guidelines (IPCC 2006, chapter 4): An Approach 1 level and trend assessment is applied with the proposed threshold of 95%. An Approach 2 key category analysis has also been carried out for this submission of all level assessments weighted with their relative source uncertainty. All main source categories have been disaggregated into main sub-sources (e.g. 2A, 2B, 2C etc.) and gases (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6).

The key sources are defined according to the IPCC classification. It is advisably that the key sources in superior degree are correspondent to the structure of the fuels and the activities in the country.

By Approach 1 are defined key sources accounting two rules:

- Rule A – Level assessment of the GHG emissions in absolute value expressed in Gg;

- Rule B – Trend assessment of the emissions from the base year until the current year of the inventory.

By applying rule A is used information for the volume of the source emissions only for the current year of the inventory.

The application of rule B requires information for the GHG emissions for the base year in the country. That means that the trend assessment includes additional information and gives the possibility for thorough analysis of the key sources.

The identification of key categories consists of following steps:

- Identifying categories
- Level Assessment excluding LULUCF
- Level Assessment including LULUCF
- Trend Assessment excluding LULUCF
- Trend Assessment including LULUCF

Table 280 Key category Analysis T1: Trend assessment excluding LULUCF

Source	Gas	Fuel/Cat.	1988 (BY) Gg CO_2-eq.	2014 Gg CO_2-eq.	% excl. (2014)	Trend	Contribution to Trend	cumul. %
1A1	CO2	**Solid fuels**	25 497.3	25 235.7	44.12%	0.438046	25.82%	25.82%
1A2	CO2	**Solid fuels**	10 152.7	522.7	0.91%	0.159196	9.38%	35.20%
1A3b	CO2	**Diesel Oil**	2 635.0	4 935.4	8.63%	0.126785	7.47%	42.67%
1A1	CO2	**Liquid fuels**	10 099.2	1 534.1	2.68%	0.122839	7.24%	49.91%
1A2	CO2	**Liquid fuels**	7 319.8	684.2	1.20%	0.104010	6.13%	56.04%
1A5	CO2	**Stationary - Fossil fuels**	5 100.8	3.1	0.01%	0.089070	5.25%	61.29%
2C1	CO2	**Iron and Steel Production**	3 481.4	40.2	0.07%	0.059459	3.50%	64.80%
5A	CH4	**Solid waste disposal**	3 502.7	3 101.6	5.42%	0.047388	2.79%	67.59%
1A2	CO2	**Gaseous fuels**	-	1 486.0	2.60%	0.052042	3.07%	70.66%
1A4	CO2	**Solid fuel**	3 548.1	563.9	0.99%	0.042285	2.49%	73.15%
1A3b	CO2	**LPG**	-	1 198.3	2.10%	0.041967	2.47%	75.63%
1A1	CO2	**Gaseous fuels**	6 508.6	2 144.2	3.75%	0.038697	2.28%	77.91%
2F	CO2eq	**Product uses as substitutes for ODS - HFCs and PFCs**	-	1 017.4	1.78%	0.035633	2.10%	80.01%
5D	CH4	**Wastewater treatment and discharge**	3 448.2	977.3	1.71%	0.026059	1.54%	81.54%
1A4	CO2	**Liquid fuel**	2 825.1	498.9	0.87%	0.031920	1.88%	83.42%
2B2	N2O	**Nitric Acid Production**	1 932.0	124.7	0.22%	0.029411	1.73%	85.16%
3B3	CH4	**Swine**	1 808.5	209.4	0.37%	0.024286	1.43%	86.59%
2A4d	CO2	**DeSOx - instalations**	-	667.8	1.17%	0.023389	1.38%	87.97%
1A3b	CO2	**Gasoline**	4 384.2	1 575.0	2.75%	0.021491	1.27%	89.23%
3A2	CH4	**Sheep**	1 605.0	240.5	0.42%	0.019639	1.16%	90.39%
2B1	CO2	**Ammonia Production**	802.2	872.5	1.53%	0.016533	0.97%	91.37%
2D	CO2	**Non-energy products from fuels and solvent use**	866.2	31.1	0.05%	0.014054	0.83%	92.19%
2B7	CO2	**Soda ash production**	391.5	586.9	1.03%	0.013709	0.81%	93.00%
1A3e	CO2	**Gaseous fuel**	-	389.8	0.68%	0.013652	0.80%	93.81%
1A4	CO2	**Gaseous fuel**	-	347.2	0.61%	0.012161	0.72%	94.52%
2A1	CO2	**Cement Production**	2 406.3	917.1	1.60%	0.009953	0.59%	95.11%

Table 281 Key category Analysis T1: Trend assessment including LULUCF

Source	Gas	Fuel/Cat.	1988 (BY) Gg CO_2-eq.	2014 Gg CO_2-eq.	% incl. (2014)	Trend	Contribution to Trend	cumul. %
1A1	CO2	**Solid fuels**	25 497.3	25 235.7	34.70%	0.276946	19.42%	19.42%
1A2	CO2	**Solid fuels**	10 152.7	522.7	0.72%	0.126605	8.88%	28.30%
1A1	CO2	**Liquid fuels**	10 099.2	1 534.1	2.11%	0.100719	7.06%	35.37%
1A2	CO2	**Liquid fuels**	7 319.8	684.2	0.94%	0.083635	5.87%	41.23%
4C2	CO2	**Land converted to Grassland**	16.4	2 062.4	2.84%	0.051060	3.58%	44.81%
1A3b	CO2	**Diesel Oil**	2 635.0	4 935.4	6.79%	0.086500	6.07%	50.88%
1A5	CO2	**Stationary - Fossil fuels**	5 100.8	3.1	0.00%	0.070061	4.91%	55.79%
2C1	CO2	**Iron and Steel Production**	3 481.4	40.2	0.06%	0.046871	3.29%	59.08%
4A1	CO2	**Forest Land remaining Forest Land**	13 785.2	9 682.3	13.31%	0.051220	3.59%	62.67%
1A1	CO2	**Gaseous fuels**	6 508.6	2 144.2	2.95%	0.036176	2.54%	65.21%
4F	CO2	**Land converted to other land**	1.7	323.7	0.45%	0.008027	0.56%	65.77%
1A2	CO2	**Gaseous fuels**	-	1 486.0	2.04%	0.036952	2.59%	68.37%
1A4	CO2	**Solid fuel**	3 548.1	563.9	0.78%	0.034766	2.44%	70.80%
5A	CH4	**Solid waste disposal**	3 502.7	3 101.6	4.26%	0.028965	2.03%	72.84%
5D	CH4	**Wastewater treatment and discharge**	3 448.2	977.3	1.34%	0.023112	1.62%	74.46%
1A3b	CO2	**LPG**	-	1 198.3	1.65%	0.029798	2.09%	76.55%
1A4	CO2	**Liquid fuel**	2 825.1	498.9	0.69%	0.026441	1.85%	78.40%
2F	CO2eq	**Product uses as substitutes for ODS - HFCs and PFCs**	-	1 017.4	1.40%	0.025301	1.77%	80.17%
2B2	N2O	**Nitric Acid Production**	1 932.0	124.7	0.17%	0.023465	1.65%	81.82%
1A3b	CO2	**Gasoline**	4 384.2	1 575.0	2.17%	0.021120	1.48%	83.30%
3B3	CH4	**Swine**	1 808.5	209.4	0.29%	0.019661	1.38%	84.68%
3A2	CH4	**Sheep**	1 605.0	240.5	0.33%	0.016090	1.13%	85.81%
2A4d	CO2	**DeSOx - instalations**	-	667.8	0.92%	0.016607	1.16%	86.97%
3Da	N2O	**Direct N2O emissions from managed soils**	4 693.3	2 167.0	2.98%	0.010646	0.75%	87.72%
4E2	CO2	**Land converted to Settlements**	711.6	933.0	1.28%	0.013415	0.94%	88.66%
4A2	CO2	**Land converted to Forest Land**	544.1	783.2	1.08%	0.011996	0.84%	89.50%
2D	CO2	**Non-energy products from fuels and solvent use**	866.2	31.1	0.04%	0.011137	0.78%	90.28%

Source	Gas	Fuel/Cat.	1988 (BY) Gg CO_2-eq.	2014 Gg CO_2-eq.	% incl. (2014)	Trend	Contribution to Trend	cumul. %
2A1	CO2	**Cement Production**	2 406.3	917.1	1.26%	0.010283	0.72%	91.00%
3A1	CH4	**Cattle**	2 715.0	1 131.6	1.56%	0.009193	0.64%	91.65%
2B1	CO2	**Ammonia Production**	802.2	872.5	1.20%	0.010667	0.75%	92.40%
1A3e	CO2	**Gaseous fuel**	-	389.8	0.54%	0.009693	0.68%	93.08%
2B7	CO2	**Soda ash production**	391.5	586.9	0.81%	0.009211	0.65%	93.72%
1B1	CH4	**Solid fuel**	2 075.1	836.6	1.15%	0.007730	0.54%	94.27%
1A4	CO2	**Gaseous fuel**	-	347.2	0.48%	0.008635	0.61%	94.87%
2A4a	CO2	**Ceramics - Bricks and Tails**	566.8	37.9	0.05%	0.006850	0.48%	95.35%

Table 282 Key category Analysis T1: Level Assessment excluding LULUCF 1988

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% excl.	cumul. %
1A1	CO2	**Solid fuels**	25 497.3	22.3%	22.3%
1A2	CO2	**Solid fuels**	10 152.7	8.9%	31.1%
1A1	CO2	**Liquid fuels**	10 099.2	8.8%	39.9%
1A2	CO2	**Liquid fuels**	7 319.8	6.4%	46.3%
1A1	CO2	**Gaseous fuels**	6 508.6	5.7%	52.0%
1A5	CO2	**Stationary - Fossil fuels**	5 100.8	4.5%	56.4%
3Da	N2O	**Direct N2O emissions from managed soils**	4 693.3	4.1%	60.5%
1A3b	CO2	**Gasoline**	4 384.2	3.8%	64.4%
1A4	CO2	**Solid fuel**	3 548.1	3.1%	67.5%
5A	CH4	**Solid waste disposal**	3 502.7	3.1%	70.5%
2C1	CO2	**Iron and Steel Production**	3 481.4	3.0%	73.6%
5D	CH4	**Wastewater treatment and discharge**	3 448.2	3.0%	76.6%
1A4	CO2	**Liquid fuel**	2 825.1	2.5%	79.0%
3A1	CH4	**Cattle**	2 715.0	2.4%	81.4%
1A3b	CO2	**Diesel Oil**	2 635.0	2.3%	83.7%
2A1	CO2	**Cement Production**	2 406.3	2.1%	85.8%
1B1	CH4	**Solid fuel**	2 075.1	1.8%	87.6%
2B2	N2O	**Nitric Acid Production**	1 932.0	1.7%	89.3%

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% excl.	cumul. %
3B3	CH4	**Swine**	1 808.5	1.6%	90.9%
3A2	CH4	**Sheep**	1 605.0	1.4%	92.3%
3Db	N2O	**Indirect N2O Emissions from managed soils**	1 355.8	1.2%	93.5%
3B	N2O	**N2O em. from Manure Management**	1 214.8	1.1%	94.5%
2D	CO2	**Non-energy products from fuels and solvent use**	866.2	0.8%	95.3%

Table 283 Key category Analysis T1: Level Assessment including LULUCF 1988

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% incl.	cumul. %
1A1	CO2	**Solid fuels**	25 497.3	19.4%	19.4%
4A1	CO2	**Forest Land remaining Forest Land**	13 785.2	10.5%	29.9%
1A2	CO2	**Solid fuels**	10 152.7	7.7%	37.6%
1A1	CO2	**Liquid fuels**	10 099.2	7.7%	45.3%
1A2	CO2	**Liquid fuels**	7 319.8	5.6%	50.8%
1A1	CO2	**Gaseous fuels**	6 508.6	4.9%	55.8%
1A5	CO2	**Stationary - Fossil fuels**	5 100.8	3.9%	59.7%
3Da	N2O	**Direct N2O emissions from managed soils**	4 693.3	3.6%	63.2%
1A3b	CO2	**Gasoline**	4 384.2	3.3%	66.6%
1A4	CO2	**Solid fuel**	3 548.1	2.7%	69.3%
5A	CH4	**Solid waste disposal**	3 502.7	2.7%	71.9%
2C1	CO2	**Iron and Steel Production**	3 481.4	2.6%	74.6%
5D	CH4	**Wastewater treatment and discharge**	3 448.2	2.6%	77.2%
1A4	CO2	**Liquid fuel**	2 825.1	2.1%	79.3%
3A1	CH4	**Cattle**	2 715.0	2.1%	81.4%
1A3b	CO2	**Diesel Oil**	2 635.0	2.0%	83.4%
2A1	CO2	**Cement Production**	2 406.3	1.8%	85.2%
1B1	CH4	**Solid fuel**	2 075.1	1.6%	86.8%
2B2	N2O	**Nitric Acid Production**	1 932.0	1.5%	88.3%
3B3	CH4	**Swine**	1 808.5	1.4%	89.7%
3A2	CH4	**Sheep**	1 605.0	1.2%	90.9%
3Db	N2O	**Indirect N2O Emissions from managed soils**	1 355.8	1.0%	91.9%
3B	N2O	**N2O em. from Manure Management**	1 214.8	0.9%	92.8%
4B1	CO2	**Cropland remainig Cropland**	1 121.4	0.9%	93.7%
2D	CO2	**Non-energy products from fuels and solvent use**	866.2	0.7%	94.3%
2B1	CO2	**Ammonia Production**	802.2	0.6%	95.0%
4E2	CO2	**Land converted to Settlements**	711.6	0.5%	95.5%

Table 284 Key category Analysis T1: Level Assessment excluding LULUCF 2014

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% excl.	cumul. %
1A1	CO2	**Solid fuels**	25 235.7	44.1%	44.1%
1A3b	CO2	**Diesel Oil**	4 935.4	8.6%	52.7%
5A	CH4	**Solid waste disposal**	3 101.6	5.4%	58.2%
3Da	N2O	**Direct N2O emissions from managed soils**	2 167.0	3.8%	62.0%
1A1	CO2	**Gaseous fuels**	2 144.2	3.7%	65.7%
1A3b	CO2	**Gasoline**	1 575.0	2.8%	68.5%
1A1	CO2	**Liquid fuels**	1 534.1	2.7%	71.1%
1A2	CO2	**Gaseous fuels**	1 486.0	2.6%	73.7%
1A3b	CO2	**LPG**	1 198.3	2.1%	75.8%
3A1	CH4	**Cattle**	1 131.6	2.0%	77.8%
2F	CO2eq	**Product uses as substitutes for ODS - HFCs and PFCs**	1 017.4	1.8%	79.6%
5D	CH4	**Wastewater treatment and discharge**	977.3	1.7%	81.3%
2A1	CO2	**Cement Production**	917.1	1.6%	82.9%
2B1	CO2	**Ammonia Production**	872.5	1.5%	84.4%
1B1	CH4	**Solid fuel**	836.6	1.5%	85.9%
1A2	CO2	**Liquid fuels**	684.2	1.2%	87.1%
2A4d	CO2	**DeSOx - instalations**	667.8	1.2%	88.3%
2B7	CO2	**Soda ash production**	586.9	1.0%	89.3%
3Db	N2O	**Indirect N2O Emissions from managed soils**	570.4	1.0%	90.3%
1A4	CO2	**Solid fuel**	563.9	1.0%	91.3%
1A2	CO2	**Solid fuels**	522.7	0.9%	92.2%
1A4	CO2	**Liquid fuel**	498.9	0.9%	93.1%
3B	N2O	**N2O em. from Manure Management**	440.3	0.8%	93.8%
1A3e	CO2	**Gaseous fuel**	389.8	0.7%	94.5%
1A4	CO2	**Gaseous fuel**	347.2	0.6%	95.1%

Table 285 Key category Analysis T1: Level Assessment including LULUCF 2014

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% incl.	cumul. %
1A1	CO2	**Solid fuels**	25 235.7	34.7%	34.7%
4A1	CO2	**Forest Land remaining Forest Land**	9 682.3	13.3%	48.0%
1A3b	CO2	**Diesel Oil**	4 935.4	6.8%	54.8%
5A	CH4	**Solid waste disposal**	3 101.6	4.3%	59.1%
3Da	N2O	**Direct N2O emissions from managed soils**	2 167.0	3.0%	62.0%
1A1	CO2	**Gaseous fuels**	2 144.2	2.9%	65.0%
4C2	CO2	**Land converted to Grassland**	2 062.4	2.8%	67.8%
1A3b	CO2	**Gasoline**	1 575.0	2.2%	70.0%
1A1	CO2	**Liquid fuels**	1 534.1	2.1%	72.1%
1A2	CO2	**Gaseous fuels**	1 486.0	2.0%	74.1%
1A3b	CO2	**LPG**	1 198.3	1.6%	75.8%
3A1	CH4	**Cattle**	1 131.6	1.6%	77.4%
2F	CO2eq	**Product uses as substitutes for ODS - HFCs and PFCs**	1 017.4	1.4%	78.8%
5D	CH4	**Wastewater treatment and discharge**	977.3	1.3%	80.1%
4E2	CO2	**Land converted to Settlements**	933.0	1.3%	81.4%
2A1	CO2	**Cement Production**	917.1	1.3%	82.6%
2B1	CO2	**Ammonia Production**	872.5	1.2%	83.8%
1B1	CH4	**Solid fuel**	836.6	1.2%	85.0%
4A2	CO2	**Land converted to Forest Land**	783.2	1.1%	86.1%
1A2	CO2	**Liquid fuels**	684.2	0.9%	87.0%
2A4d	CO2	**DeSOx - instalations**	667.8	0.9%	87.9%
2B7	CO2	**Soda ash production**	586.9	0.8%	88.7%
3Db	N2O	**Indirect N2O Emissions from managed soils**	570.4	0.8%	89.5%
1A4	CO2	**Solid fuel**	563.9	0.8%	90.3%
4G	CO2	**Harvested wood products**	544.0	0.7%	91.0%
1A2	CO2	**Solid fuels**	522.7	0.7%	91.8%
1A4	CO2	**Liquid fuel**	498.9	0.7%	92.4%
4B1	CO2	**Cropland remainig Cropland**	491.5	0.7%	93.1%
3B	N2O	**N2O em. from Manure Management**	440.3	0.6%	93.7%
4B2	CO2	**Land converted to Cropland**	425.5	0.6%	94.3%

Source	Gas	Fuel/Cat.	GHG emission [Gg CO_2 eq]	% incl.	cumul. %
1A3e	CO2	**Gaseous fuel**	389.8	0.5%	94.8%
1A4	CO2	**Gaseous fuel**	347.2	0.5%	95.3%

1.2 Approach 2 for Key Caregory Assessment

With the use of the uncertainty assessments for each key categories in the form of weight factor/coefficient is done, which is the Approach 2 method according to 2006 IPCC Guidelines. It is helpful in prioritising activities to improve inventory quality and to reduce overall uncertainty.

Under Approach 2, the source or sink category uncertainties are incorporated by weighting the Approach 1 level and trend assessment results with the source category’s relative uncertainty.

Therefore the following equation Approach 2 has been applied for the current year submission:

*Level Assessment, with Uncertainty = Approach 1 Level Assessment * Relative Category Uncertainty*

*Trend Assessment, with Uncertainty = Approach 1 Trend Assessment * Relative Category Uncertainty*

The results of the Approach 2 category analysis, without LULUCF categories, are provided in Table 286 and Table 288 for 2014, while in

Table 287 and Table 289 the results, including LULUCF categories, are shown.

Table 286 Key category Analysis T2: Trend assessment excluding LULUCF

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment excluding LULUCF	Cumulative Percentage	T2
79	5A	Solid waste disposal	CH4	0.028	85.440	2.386	0.159	0.159	1
85	5D	Wastewater treatment and discharge	CH4	0.015	100.499	1.544	0.103	0.262	2
75	3Db	Indirect N2O Emissions from managed soils	N2O	0.002	500.009	1.098	0.073	0.336	3
59	2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0.021	50.990	1.071	0.072	0.407	4
68	3B	N2O em. from Manure Management	N2O	0.003	300.007	1.029	0.069	0.476	5
74	3Da	Direct N2O emissions from managed soils	N2O	0.004	250.018	0.908	0.061	0.537	6
39	1B1	Solid fuel	CH4	0.004	200.250	0.824	0.055	0.592	7
2	1A1	Solid fuels	CO2	0.258	2.236	0.577	0.039	0.630	8
1	1A1	Liquid fuels	CO2	0.072	7.616	0.551	0.037	0.667	9
6	1A2	Liquid fuels	CO2	0.061	7.616	0.467	0.031	0.698	10
36	1A5	Stationary - Fossil fuels	CO2	0.052	8.602	0.452	0.030	0.728	11
16	1A3b	Diesel Oil	CO2	0.075	5.831	0.436	0.029	0.757	12
71	3B3	Swine	CH4	0.014	20.100	0.288	0.019	0.777	13
58	2D	Non-energy products from fuels and solvent use	CO2	0.008	31.623	0.262	0.017	0.794	14
54	2C1	Iron and Steel Production	CO2	0.035	7.071	0.248	0.017	0.811	15
65	3A2	Sheep	CH4	0.012	20.100	0.233	0.016	0.826	16
7	1A2	Solid fuels	CO2	0.094	2.236	0.210	0.014	0.840	17
5	1A1	All fuel	N2O	0.001	200.022	0.189	0.013	0.853	18
50	2B2	Nitric Acid Production	N2O	0.017	10.198	0.177	0.012	0.865	19
31	1A4	Liquid fuel	CO2	0.019	8.602	0.162	0.011	0.875	20
41	1B2	Oil and Natural Gas	CH4	0.002	100.125	0.161	0.011	0.886	21
19	1A3b	LPG	CO2	0.025	5.831	0.144	0.010	0.896	22
32	1A4	Solid fuel	CO2	0.025	5.385	0.134	0.009	0.905	23
34	1A4	All fuel	CH4	0.002	50.249	0.116	0.008	0.913	24
11	1A2	All fuel	N2O	0.001	200.022	0.112	0.007	0.920	25
64	3A1	Cattle	CH4	0.005	20.100	0.093	0.006	0.926	26
35	1A4	All fuel	N2O	0.000	200.062	0.092	0.006	0.932	27
15	1A3b	Gasoline	CO2	0.013	5.831	0.074	0.005	0.937	28
49	2B1	Ammonia Production	CO2	0.010	7.280	0.071	0.005	0.942	29
8	1A2	Gaseous fuels	CO2	0.031	2.236	0.069	0.005	0.947	30

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment excluding LULUCF	Cumulative Percentage	T2
56	2C2	Ferroalloys Production	CO2	0.003	25.495	0.067	0.004	0.951	31
73	3C	Rice Cultivation	CH4	0.001	83.815	0.062	0.004	0.955	32
86	5D	Wastewater treatment and discharge	N2O	0.001	100.499	0.053	0.004	0.959	33
3	1A1	Gaseous fuels	CO2	0.023	2.236	0.051	0.003	0.962	34
28	1A3e	Gaseous fuel	CO2	0.008	5.099	0.041	0.003	0.965	35
48	2A4d	DeSOx - instalations	CO2	0.014	2.828	0.039	0.003	0.968	36
33	1A4	Gaseous fuel	CO2	0.007	5.385	0.039	0.003	0.970	37
60	2G	Other product manufacture and use	N2O	0.000	100.499	0.033	0.002	0.972	38
18	1A3b	All fuel	N2O	0.001	40.112	0.032	0.002	0.974	39
45	2A3	Glass production	CO2	0.001	60.299	0.030	0.002	0.976	40
46	2A4a	Ceramics - Bricks and Tails	CO2	0.005	5.831	0.029	0.002	0.978	41
20	1A3b	Gaseous fuel	CO2	0.005	5.831	0.028	0.002	0.980	42
78	3H	Urea application	CO2	0.000	50.040	0.023	0.002	0.982	43
52	2B7	Soda ash production	CO2	0.008	2.828	0.023	0.002	0.983	44
67	3A4	Other livestock	CH4	0.000	50.040	0.023	0.002	0.985	45
66	3A3	Swine	CH4	0.001	20.100	0.023	0.002	0.986	46
38	1A5	Stationary - Fossil fuels	N2O	0.000	200.062	0.020	0.001	0.988	47
43	2A1	Cement Production	CO2	0.006	2.828	0.017	0.001	0.989	48
40	1B2	Oil and Natural Gas	CO2	0.000	100.125	0.016	0.001	0.990	49
62	2G1	Electrical equipment - SF6	CO2eq	0.000	50.990	0.015	0.001	0.991	50
76	3F	Field burning of agricultural residues	CH4	0.000	55.902	0.014	0.001	0.992	51
77	3F	Field burning of agricultural residues	N2O	0.000	201.556	0.014	0.001	0.993	52
12	1A3a	Liquid fuel	CO2	0.002	7.071	0.011	0.001	0.993	53
81	5B	Biological treatment of solid waste	N2O	0.000	104.403	0.009	0.001	0.994	54
25	1A3d	Gas/diesel oil	CO2	0.000	50.249	0.009	0.001	0.995	55
72	3B4	Other livestock	CH4	0.000	50.040	0.008	0.001	0.995	56
70	3B2	Sheep	CH4	0.000	20.100	0.007	0.000	0.996	57
17	1A3b	All fuel	CH4	0.000	40.112	0.006	0.000	0.996	58
9	1A2	Other fossil fuels	CO2	0.001	5.385	0.005	0.000	0.996	59
22	1A3c	Liquid fuel	CO2	0.001	7.071	0.005	0.000	0.997	60
51	2B5b	Calcium Carbide	CO2	0.000	11.180	0.005	0.000	0.997	61

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment excluding LULUCF	Cumulative Percentage	T2
24	1A3c	Liquid fuel	N2O	0.000	60.208	0.005	0.000	0.998	62
10	1A2	All fuel	CH4	0.000	50.090	0.005	0.000	0.998	63
80	5B	Biological treatment of solid waste	CH4	0.000	42.426	0.005	0.000	0.998	64
82	5C	Incineration and open burning of waste	CO2	0.000	101.119	0.004	0.000	0.999	65
69	3B1	Cattle	CH4	0.000	20.100	0.004	0.000	0.999	66
61	2G	Other product manufacture and use	F-gas	0.000	31.623	0.004	0.000	0.999	67
53	2B8	Petrochemical and carbon black production	CH4	0.000	50.249	0.003	0.000	0.999	68
63	2H	Other	CO2	0.000	100.499	0.003	0.000	0.999	69
37	1A5	Stationary - Fossil fuels	CH4	0.000	50.249	0.002	0.000	1.000	70
47	2A4b	Soda ash uses	CO2	0.001	2.236	0.001	0.000	1.000	71
44	2A2	Lime Production	CO2	0.000	2.828	0.001	0.000	1.000	72
4	1A1	All fuel	CH4	0.000	50.090	0.001	0.000	1.000	73
30	1A3e	Gaseous fuel	N2O	0.000	150.003	0.001	0.000	1.000	74
57	2C2	Ferroalloys Production	CH4	0.000	25.495	0.001	0.000	1.000	75
14	1A3a	Liquid fuel	N2O	0.000	40.311	0.001	0.000	1.000	76
84	5C	Incineration and open burning of waste	N2O	0.000	101.119	0.000	0.000	1.000	77
27	1A3d	Gas/diesel oil	N2O	0.000	148.661	0.000	0.000	1.000	78
29	1A3e	Gaseous fuel	CH4	0.000	50.010	0.000	0.000	1.000	79
23	1A3c	Liquid fuel	CH4	0.000	60.208	0.000	0.000	1.000	80
26	1A3d	Gas/diesel oil	CH4	0.000	70.711	0.000	0.000	1.000	81
13	1A3a	Liquid fuel	CH4	0.000	40.311	0.000	0.000	1.000	82
42	1B2	Oil and Natural Gas	N2O	0.000	1000.012	0.000	0.000	1.000	83
83	5C	Incineration and open burning of waste	CH4	0.000	101.119	0.000	0.000	1.000	84
21	1A3b	Other liquid fuels	CO2	0.000	5.831	0.000	0.000	1.000	85
55	2C1	Iron and Steel Production	CH4	0.000	26.926	0.000	0.000	1.000	86

Table 287 Key category Analysis T2: Trend assessment including LULUCF

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment including LULUCF	Cumulative Percentage	T2
83	4C2	Land converted to Grassland	CO2	0.036	444.813	15.929	0.377	0.377	1
79	4A1	Forest Land remaining Forest Land	CO2	0.036	149.451	5.369	0.127	0.504	2
82	4B2	Land converted to Cropland	CO2	0.006	415.466	2.658	0.063	0.567	3
74	3Da	Direct N2O emissions from managed soils	N2O	0.007	250.018	1.867	0.044	0.611	4
88	5A	Solid waste disposal	CH4	0.020	85.440	1.736	0.041	0.653	5
94	5D	Wastewater treatment and discharge	CH4	0.016	100.499	1.629	0.039	0.691	6
75	3Db	Indirect N2O Emissions from managed soils	N2O	0.003	500.009	1.564	0.037	0.728	7
68	3B	N2O em. from Manure Management	N2O	0.004	300.007	1.211	0.029	0.757	8
39	1B1	Solid fuel	CH4	0.005	200.250	1.086	0.026	0.783	9
80	4A2	Land converted to Forest Land	CO2	0.008	122.520	1.031	0.024	0.807	10
59	2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0.018	50.990	0.905	0.021	0.828	11
85	4E2	Land converted to Settlements	CO2	0.009	75.000	0.706	0.017	0.845	12
1	1A1	Liquid fuels	CO2	0.071	7.616	0.538	0.013	0.858	13
6	1A2	Liquid fuels	CO2	0.059	7.616	0.447	0.011	0.868	14
2	1A1	Solid fuels	CO2	0.194	2.236	0.434	0.010	0.879	15
36	1A5	Stationary - Fossil fuels	CO2	0.049	8.602	0.423	0.010	0.889	16
81	4B1	Cropland remainig Cropland	CO2	0.002	184.043	0.413	0.010	0.898	17
16	1A3b	Diesel Oil	CO2	0.061	5.831	0.354	0.008	0.907	18
86	4F	Land converted to other land	CO2	0.006	50.990	0.287	0.007	0.914	19
71	3B3	Swine	CH4	0.014	20.100	0.277	0.007	0.920	20
58	2D	Non-energy products from fuels and solvent use	CO2	0.008	31.623	0.247	0.006	0.926	21
54	2C1	Iron and Steel Production	CO2	0.033	7.071	0.232	0.006	0.932	22
65	3A2	Sheep	CH4	0.011	20.100	0.227	0.005	0.937	23
7	1A2	Solid fuels	CO2	0.089	2.236	0.199	0.005	0.942	24
50	2B2	Nitric Acid Production	N2O	0.016	10.198	0.168	0.004	0.946	25
87	4G	Harvested wood products	CO2	0.003	50.990	0.161	0.004	0.949	26

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment including LULUCF	Cumulative Percentage	T2
31	1A4	Liquid fuel	CO2	0.019	8.602	0.160	0.004	0.953	27
5	1A1	All fuel	N2O	0.001	200.022	0.134	0.003	0.956	28
32	1A4	Solid fuel	CO2	0.024	5.385	0.131	0.003	0.959	29
84	4D2	Land converted to Wetlands	CO2	0.005	26.502	0.130	0.003	0.963	30
64	3A1	Cattle	CH4	0.006	20.100	0.130	0.003	0.966	31
19	1A3b	LPG	CO2	0.021	5.831	0.122	0.003	0.969	32
35	1A4	All fuel	N2O	0.001	200.062	0.117	0.003	0.971	33
11	1A2	All fuel	N2O	0.001	200.022	0.114	0.003	0.974	34
41	1B2	Oil and Natural Gas	CH4	0.001	100.125	0.113	0.003	0.977	35
15	1A3b	Gasoline	CO2	0.015	5.831	0.086	0.002	0.979	36
34	1A4	All fuel	CH4	0.002	50.249	0.082	0.002	0.981	37
56	2C2	Ferroalloys Production	CO2	0.002	25.495	0.063	0.001	0.982	38
8	1A2	Gaseous fuels	CO2	0.026	2.236	0.058	0.001	0.984	39
3	1A1	Gaseous fuels	CO2	0.025	2.236	0.057	0.001	0.985	40
49	2B1	Ammonia Production	CO2	0.007	7.280	0.054	0.001	0.986	41
73	3C	Rice Cultivation	CH4	0.001	83.815	0.043	0.001	0.987	42
45	2A3	Glass production	CO2	0.001	60.299	0.036	0.001	0.988	43
28	1A3e	Gaseous fuel	CO2	0.007	5.099	0.035	0.001	0.989	44
48	2A4d	DeSOx - instalations	CO2	0.012	2.828	0.033	0.001	0.990	45
33	1A4	Gaseous fuel	CO2	0.006	5.385	0.033	0.001	0.990	46
60	2G	Other product manufacture and use	N2O	0.000	100.499	0.031	0.001	0.991	47
67	3A4	Other livestock	CH4	0.001	50.040	0.030	0.001	0.992	48
46	2A4a	Ceramics - Bricks and Tails	CO2	0.005	5.831	0.028	0.001	0.993	49
18	1A3b	All fuel	N2O	0.001	40.112	0.024	0.001	0.993	50
20	1A3b	Gaseous fuel	CO2	0.004	5.831	0.024	0.001	0.994	51
95	5D	Wastewater treatment and discharge	N2O	0.000	100.499	0.022	0.001	0.994	52
66	3A3	Swine	CH4	0.001	20.100	0.022	0.001	0.995	53
43	2A1	Cement Production	CO2	0.007	2.828	0.020	0.000	0.995	54
38	1A5	Stationary - Fossil fuels	N2O	0.000	200.062	0.019	0.000	0.996	55
78	3H	Urea application	CO2	0.000	50.040	0.019	0.000	0.996	56
52	2B7	Soda ash production	CO2	0.006	2.828	0.018	0.000	0.997	57

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment including LULUCF	Cumulative Percentage	T2
40	1B2	Oil and Natural Gas	CO2	0.000	100.125	0.013	0.000	0.997	58
62	2G1	Electrical equipment - SF6	CO2eq	0.000	50.990	0.012	0.000	0.997	59
12	1A3a	Liquid fuel	CO2	0.002	7.071	0.011	0.000	0.997	60
76	3F	Field burning of agricultural residues	CH4	0.000	55.902	0.010	0.000	0.998	61
77	3F	Field burning of agricultural residues	N2O	0.000	201.556	0.010	0.000	0.998	62
72	3B4	Other livestock	CH4	0.000	50.040	0.009	0.000	0.998	63
17	1A3b	All fuel	CH4	0.000	40.112	0.008	0.000	0.998	64
90	5B	Biological treatment of solid waste	N2O	0.000	104.403	0.008	0.000	0.998	65
25	1A3d	Gas/diesel oil	CO2	0.000	50.249	0.008	0.000	0.999	66
70	3B2	Sheep	CH4	0.000	20.100	0.007	0.000	0.999	67
10	1A2	All fuel	CH4	0.000	50.090	0.006	0.000	0.999	68
51	2B5b	Calcium Carbide	CO2	0.000	11.180	0.005	0.000	0.999	69
9	1A2	Other fossil fuels	CO2	0.001	5.385	0.005	0.000	0.999	70
69	3B1	Cattle	CH4	0.000	20.100	0.005	0.000	0.999	71
22	1A3c	Liquid fuel	CO2	0.001	7.071	0.005	0.000	0.999	72
24	1A3c	Liquid fuel	N2O	0.000	60.208	0.005	0.000	0.999	73
89	5B	Biological treatment of solid waste	CH4	0.000	42.426	0.004	0.000	1.000	74
53	2B8	Petrochemical and carbon black production	CH4	0.000	50.249	0.003	0.000	1.000	75
37	1A5	Stationary - Fossil fuels	CH4	0.000	50.249	0.002	0.000	1.000	76
44	2A2	Lime Production	CO2	0.001	2.828	0.002	0.000	1.000	77
61	2G	Other product manufacture and use	F-gas	0.000	31.623	0.002	0.000	1.000	78
63	2H	Other	CO2	0.000	100.499	0.002	0.000	1.000	79
91	5C	Incineration and open burning of waste	CO2	0.000	101.119	0.002	0.000	1.000	80
4	1A1	All fuel	CH4	0.000	50.090	0.002	0.000	1.000	81
47	2A4b	Soda ash uses	CO2	0.000	2.236	0.001	0.000	1.000	82
57	2C2	Ferroalloys Production	CH4	0.000	25.495	0.001	0.000	1.000	83
30	1A3e	Gaseous fuel	N2O	0.000	150.003	0.001	0.000	1.000	84
14	1A3a	Liquid fuel	N2O	0.000	40.311	0.001	0.000	1.000	85
27	1A3d	Gas/diesel oil	N2O	0.000	148.661	0.000	0.000	1.000	86

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	T*U	Relevant trend assessment including LULUCF	Cumulative Percentage	T2
29	1A3e	Gaseous fuel	CH4	0.000	50.010	0.000	0.000	1.000	87
93	5C	Incineration and open burning of waste	N2O	0.000	101.119	0.000	0.000	1.000	88
23	1A3c	Liquid fuel	CH4	0.000	60.208	0.000	0.000	1.000	89
26	1A3d	Gas/diesel oil	CH4	0.000	70.711	0.000	0.000	1.000	90
42	1B2	Oil and Natural Gas	N2O	0.000	1000.012	0.000	0.000	1.000	91
13	1A3a	Liquid fuel	CH4	0.000	40.311	0.000	0.000	1.000	92
92	5C	Incineration and open burning of waste	CH4	0.000	101.119	0.000	0.000	1.000	93
21	1A3b	Other liquid fuels	CO2	0.000	5.831	0.000	0.000	1.000	94
55	2C1	Iron and Steel Production	CH4	0.000	26.926	0.000	0.000	1.000	95

Table 288 Key category Analysis T2: Level Assessment excluding LULUCF 2014

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment excluding LULUCF	Cumulative Percentage	T2
74	3Da	Direct N2O emissions from managed soils	N2O	0.038	250.018	9.472	0.292	0.292	1
75	3Db	Indirect N2O Emissions from managed soils	N2O	0.010	500.009	4.986	0.154	0.445	2
79	5A	Solid waste disposal	CH4	0.054	85.440	4.633	0.143	0.588	3
39	1B1	Solid fuel	CH4	0.015	200.250	2.929	0.090	0.678	4
68	3B	N2O em. from Manure Management	N2O	0.008	300.007	2.310	0.071	0.749	5
85	5D	Wastewater treatment and discharge	CH4	0.017	100.499	1.717	0.053	0.802	6
2	1A1	Solid fuels	CO2	0.441	2.236	0.987	0.030	0.832	7
59	2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0.018	50.990	0.907	0.028	0.860	8
16	1A3b	Diesel Oil	CO2	0.086	5.831	0.503	0.015	0.876	9
5	1A1	All fuel	N2O	0.002	200.022	0.398	0.012	0.888	10
64	3A1	Cattle	CH4	0.020	20.100	0.398	0.012	0.900	11
41	1B2	Oil and Natural Gas	CH4	0.004	100.125	0.353	0.011	0.911	12
35	1A4	All fuel	N2O	0.001	200.062	0.288	0.009	0.920	13
86	5D	Wastewater treatment and discharge	N2O	0.003	100.499	0.255	0.008	0.928	14

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment excluding LULUCF	Cumulative Percentage	T2
34	1A4	All fuel	CH4	0.005	50.249	0.245	0.008	0.935	15
1	1A1	Liquid fuels	CO2	0.027	7.616	0.204	0.006	0.942	16
15	1A3b	Gasoline	CO2	0.028	5.831	0.161	0.005	0.947	17
73	3C	Rice Cultivation	CH4	0.002	83.815	0.146	0.004	0.951	18
19	1A3b	LPG	CO2	0.021	5.831	0.122	0.004	0.955	19
49	2B1	Ammonia Production	CO2	0.015	7.280	0.111	0.003	0.958	20
6	1A2	Liquid fuels	CO2	0.012	7.616	0.091	0.003	0.961	21
11	1A2	All fuel	N2O	0.000	200.022	0.087	0.003	0.964	22
65	3A2	Sheep	CH4	0.004	20.100	0.085	0.003	0.966	23
3	1A1	Gaseous fuels	CO2	0.037	2.236	0.084	0.003	0.969	24
67	3A4	Other livestock	CH4	0.002	50.040	0.083	0.003	0.971	25
31	1A4	Liquid fuel	CO2	0.009	8.602	0.075	0.002	0.974	26
71	3B3	Swine	CH4	0.004	20.100	0.074	0.002	0.976	27
45	2A3	Glass production	CO2	0.001	60.299	0.072	0.002	0.978	28
8	1A2	Gaseous fuels	CO2	0.026	2.236	0.058	0.002	0.980	29
32	1A4	Solid fuel	CO2	0.010	5.385	0.053	0.002	0.982	30
18	1A3b	All fuel	N2O	0.001	40.112	0.048	0.001	0.983	31
43	2A1	Cement Production	CO2	0.016	2.828	0.045	0.001	0.985	32
28	1A3e	Gaseous fuel	CO2	0.007	5.099	0.035	0.001	0.986	33
48	2A4d	DeSOx - instalations	CO2	0.012	2.828	0.033	0.001	0.987	34
33	1A4	Gaseous fuel	CO2	0.006	5.385	0.033	0.001	0.988	35
52	2B7	Soda ash production	CO2	0.010	2.828	0.029	0.001	0.989	36
78	3H	Urea application	CO2	0.001	50.040	0.027	0.001	0.989	37
77	3F	Field burning of agricultural residues	N2O	0.000	201.556	0.026	0.001	0.990	38
76	3F	Field burning of agricultural residues	CH4	0.000	55.902	0.026	0.001	0.991	39
20	1A3b	Gaseous fuel	CO2	0.004	5.831	0.024	0.001	0.992	40
50	2B2	Nitric Acid Production	N2O	0.002	10.198	0.022	0.001	0.992	41
7	1A2	Solid fuels	CO2	0.009	2.236	0.020	0.001	0.993	42
82	5C	Incineration and open burning of waste	CO2	0.000	101.119	0.020	0.001	0.994	43
17	1A3b	All fuel	CH4	0.000	40.112	0.020	0.001	0.994	44

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment excluding LULUCF	Cumulative Percentage	T2
40	1B2	Oil and Natural Gas	CO2	0.000	100.125	0.018	0.001	0.995	45
58	2D	Non-energy products from fuels and solvent use	CO2	0.001	31.623	0.017	0.001	0.995	46
62	2G1	Electrical equipment - SF6	CO2eq	0.000	50.990	0.014	0.000	0.996	47
72	3B4	Other livestock	CH4	0.000	50.040	0.013	0.000	0.996	48
61	2G	Other product manufacture and use	F-gas	0.000	31.623	0.012	0.000	0.997	49
69	3B1	Cattle	CH4	0.001	20.100	0.011	0.000	0.997	50
44	2A2	Lime Production	CO2	0.004	2.828	0.010	0.000	0.997	51
10	1A2	All fuel	CH4	0.000	50.090	0.009	0.000	0.998	52
63	2H	Other	CO2	0.000	100.499	0.009	0.000	0.998	53
81	5B	Biological treatment of solid waste	N2O	0.000	104.403	0.008	0.000	0.998	54
25	1A3d	Gas/diesel oil	CO2	0.000	50.249	0.008	0.000	0.998	55
4	1A1	All fuel	CH4	0.000	50.090	0.008	0.000	0.998	56
66	3A3	Swine	CH4	0.000	20.100	0.008	0.000	0.999	57
54	2C1	Iron and Steel Production	CO2	0.001	7.071	0.005	0.000	0.999	58
9	1A2	Other fossil fuels	CO2	0.001	5.385	0.005	0.000	0.999	59
22	1A3c	Liquid fuel	CO2	0.001	7.071	0.005	0.000	0.999	60
24	1A3c	Liquid fuel	N2O	0.000	60.208	0.005	0.000	0.999	61
80	5B	Biological treatment of solid waste	CH4	0.000	42.426	0.004	0.000	0.999	62
46	2A4a	Ceramics - Bricks and Tails	CO2	0.001	5.831	0.004	0.000	1.000	63
47	2A4b	Soda ash uses	CO2	0.002	2.236	0.004	0.000	1.000	64
12	1A3a	Liquid fuel	CO2	0.000	7.071	0.003	0.000	1.000	65
70	3B2	Sheep	CH4	0.000	20.100	0.002	0.000	1.000	66
51	2B5b	Calcium Carbide	CO2	0.000	11.180	0.002	0.000	1.000	67
84	5C	Incineration and open burning of waste	N2O	0.000	101.119	0.002	0.000	1.000	68
30	1A3e	Gaseous fuel	N2O	0.000	150.003	0.001	0.000	1.000	69
36	1A5	Stationary - Fossil fuels	CO2	0.000	8.602	0.000	0.000	1.000	70
27	1A3d	Gas/diesel oil	N2O	0.000	148.661	0.000	0.000	1.000	71
14	1A3a	Liquid fuel	N2O	0.000	40.311	0.000	0.000	1.000	72
60	2G	Other product manufacture and use	N2O	0.000	100.499	0.000	0.000	1.000	73

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment excluding LULUCF	Cumulative Percentage	T2
29	1A3e	Gaseous fuel	CH4	0.000	50.010	0.000	0.000	1.000	74
42	1B2	Oil and Natural Gas	N2O	0.000	1000.012	0.000	0.000	1.000	75
23	1A3c	Liquid fuel	CH4	0.000	60.208	0.000	0.000	1.000	76
56	2C2	Ferroalloys Production	CO2	0.000	25.495	0.000	0.000	1.000	77
26	1A3d	Gas/diesel oil	CH4	0.000	70.711	0.000	0.000	1.000	78
38	1A5	Stationary - Fossil fuels	N2O	0.000	200.062	0.000	0.000	1.000	79
13	1A3a	Liquid fuel	CH4	0.000	40.311	0.000	0.000	1.000	80
37	1A5	Stationary - Fossil fuels	CH4	0.000	50.249	0.000	0.000	1.000	81
83	5C	Incineration and open burning of waste	CH4	0.000	101.119	0.000	0.000	1.000	82
53	2B8	Petrochemical and carbon black production	CH4	0.000	50.249	0.000	0.000	1.000	83
57	2C2	Ferroalloys Production	CH4	0.000	25.495	0.000	0.000	1.000	84
21	1A3b	Other liquid fuels	CO2	0.000	5.831	0.000	0.000	1.000	85
55	2C1	Iron and Steel Production	CH4	0.000	26.926	0.000	0.000	1.000	86

Table 289 Key category Analysis T2: Level Assessment including LULUCF 2014

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment including LULUCF	Cumulative Percentage	T2
79	4A1	Forest Land remaining Forest Land	CO2	0.133	149.451	19.897	0.307	0.307	1
83	4C2	Land converted to Grassland	CO2	0.028	444.813	12.614	0.195	0.502	2
74	3Da	Direct N2O emissions from managed soils	N2O	0.030	250.018	7.450	0.115	0.617	3
75	3Db	Indirect N2O Emissions from managed soils	N2O	0.008	500.009	3.922	0.061	0.678	4
88	5A	Solid waste disposal	CH4	0.043	85.440	3.644	0.056	0.734	5
82	4B2	Land converted to Cropland	CO2	0.006	415.466	2.431	0.038	0.772	6
39	1B1	Solid fuel	CH4	0.012	200.250	2.303	0.036	0.807	7
68	3B	N2O em. from Manure Management	N2O	0.006	300.007	1.816	0.028	0.836	8
94	5D	Wastewater treatment and discharge	CH4	0.013	100.499	1.350	0.021	0.856	9
80	4A2	Land converted to Forest Land	CO2	0.011	122.520	1.320	0.020	0.877	10

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment including LULUCF	Cumulative Percentage	T2
81	4B1	Cropland remainig Cropland	CO2	0.007	184.043	1.244	0.019	0.896	11
85	4E2	Land converted to Settlements	CO2	0.013	75.000	0.962	0.015	0.911	12
2	1A1	Solid fuels	CO2	0.347	2.236	0.776	0.012	0.923	13
59	2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0.014	50.990	0.713	0.011	0.934	14
16	1A3b	Diesel Oil	CO2	0.068	5.831	0.396	0.006	0.940	15
87	4G	Harvested wood products	CO2	0.007	50.990	0.381	0.006	0.946	16
5	1A1	All fuel	N2O	0.002	200.022	0.313	0.005	0.951	17
64	3A1	Cattle	CH4	0.016	20.100	0.313	0.005	0.956	18
41	1B2	Oil and Natural Gas	CH4	0.003	100.125	0.278	0.004	0.960	19
86	4F	Land converted to other land	CO2	0.004	50.990	0.227	0.004	0.963	20
35	1A4	All fuel	N2O	0.001	200.062	0.227	0.004	0.967	21
95	5D	Wastewater treatment and discharge	N2O	0.002	100.499	0.200	0.003	0.970	22
34	1A4	All fuel	CH4	0.004	50.249	0.193	0.003	0.973	23
1	1A1	Liquid fuels	CO2	0.021	7.616	0.161	0.002	0.975	24
15	1A3b	Gasoline	CO2	0.022	5.831	0.126	0.002	0.977	25
73	3C	Rice Cultivation	CH4	0.001	83.815	0.115	0.002	0.979	26
84	4D2	Land converted to Wetlands	CO2	0.004	26.502	0.103	0.002	0.981	27
19	1A3b	LPG	CO2	0.016	5.831	0.096	0.001	0.982	28
49	2B1	Ammonia Production	CO2	0.012	7.280	0.087	0.001	0.984	29
6	1A2	Liquid fuels	CO2	0.009	7.616	0.072	0.001	0.985	30
11	1A2	All fuel	N2O	0.000	200.022	0.068	0.001	0.986	31
65	3A2	Sheep	CH4	0.003	20.100	0.066	0.001	0.987	32
3	1A1	Gaseous fuels	CO2	0.029	2.236	0.066	0.001	0.988	33
67	3A4	Other livestock	CH4	0.001	50.040	0.065	0.001	0.989	34
31	1A4	Liquid fuel	CO2	0.007	8.602	0.059	0.001	0.990	35
71	3B3	Swine	CH4	0.003	20.100	0.058	0.001	0.991	36
45	2A3	Glass production	CO2	0.001	60.299	0.057	0.001	0.991	37
8	1A2	Gaseous fuels	CO2	0.020	2.236	0.046	0.001	0.992	38
32	1A4	Solid fuel	CO2	0.008	5.385	0.042	0.001	0.993	39
18	1A3b	All fuel	N2O	0.001	40.112	0.038	0.001	0.993	40

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment including LULUCF	Cumulative Percentage	T2
43	2A1	Cement Production	CO2	0.013	2.828	0.036	0.001	0.994	41
28	1A3e	Gaseous fuel	CO2	0.005	5.099	0.027	0.000	0.994	42
48	2A4d	DeSOx - instalations	CO2	0.009	2.828	0.026	0.000	0.995	43
33	1A4	Gaseous fuel	CO2	0.005	5.385	0.026	0.000	0.995	44
52	2B7	Soda ash production	CO2	0.008	2.828	0.023	0.000	0.995	45
78	3H	Urea application	CO2	0.000	50.040	0.021	0.000	0.996	46
77	3F	Field burning of agricultural residues	N2O	0.000	201.556	0.021	0.000	0.996	47
76	3F	Field burning of agricultural residues	CH4	0.000	55.902	0.020	0.000	0.996	48
20	1A3b	Gaseous fuel	CO2	0.003	5.831	0.019	0.000	0.997	49
50	2B2	Nitric Acid Production	N2O	0.002	10.198	0.017	0.000	0.997	50
7	1A2	Solid fuels	CO2	0.007	2.236	0.016	0.000	0.997	51
91	5C	Incineration and open burning of waste	CO2	0.000	101.119	0.016	0.000	0.998	52
17	1A3b	All fuel	CH4	0.000	40.112	0.016	0.000	0.998	53
40	1B2	Oil and Natural Gas	CO2	0.000	100.125	0.014	0.000	0.998	54
58	2D	Non-energy products from fuels and solvent use	CO2	0.000	31.623	0.014	0.000	0.998	55
62	2G1	Electrical equipment - SF6	CO2eq	0.000	50.990	0.011	0.000	0.998	56
72	3B4	Other livestock	CH4	0.000	50.040	0.010	0.000	0.999	57
61	2G	Other product manufacture and use	F-gas	0.000	31.623	0.010	0.000	0.999	58
69	3B1	Cattle	CH4	0.000	20.100	0.008	0.000	0.999	59
44	2A2	Lime Production	CO2	0.003	2.828	0.008	0.000	0.999	60
10	1A2	All fuel	CH4	0.000	50.090	0.007	0.000	0.999	61
63	2H	Other	CO2	0.000	100.499	0.007	0.000	0.999	62
90	5B	Biological treatment of solid waste	N2O	0.000	104.403	0.006	0.000	0.999	63
25	1A3d	Gas/diesel oil	CO2	0.000	50.249	0.006	0.000	0.999	64
4	1A1	All fuel	CH4	0.000	50.090	0.006	0.000	0.999	65
66	3A3	Swine	CH4	0.000	20.100	0.006	0.000	0.999	66
54	2C1	Iron and Steel Production	CO2	0.001	7.071	0.004	0.000	1.000	67
9	1A2	Other fossil fuels	CO2	0.001	5.385	0.004	0.000	1.000	68
22	1A3c	Liquid fuel	CO2	0.001	7.071	0.004	0.000	1.000	69

T1	Source	Fuel/Cat.	GHG	Share	Uncertainty	L*U	Level assessment including LULUCF	Cumulative Percentage	T2
24	1A3c	Liquid fuel	N2O	0.000	60.208	0.004	0.000	1.000	70
89	5B	Biological treatment of solid waste	CH4	0.000	42.426	0.003	0.000	1.000	71
46	2A4a	Ceramics - Bricks and Tails	CO2	0.001	5.831	0.003	0.000	1.000	72
47	2A4b	Soda ash uses	CO2	0.001	2.236	0.003	0.000	1.000	73
12	1A3a	Liquid fuel	CO2	0.000	7.071	0.003	0.000	1.000	74
70	3B2	Sheep	CH4	0.000	20.100	0.002	0.000	1.000	75
51	2B5b	Calcium Carbide	CO2	0.000	11.180	0.001	0.000	1.000	76
93	5C	Incineration and open burning of waste	N2O	0.000	101.119	0.001	0.000	1.000	77
30	1A3e	Gaseous fuel	N2O	0.000	150.003	0.000	0.000	1.000	78
36	1A5	Stationary - Fossil fuels	CO2	0.000	8.602	0.000	0.000	1.000	79
27	1A3d	Gas/diesel oil	N2O	0.000	148.661	0.000	0.000	1.000	80
14	1A3a	Liquid fuel	N2O	0.000	40.311	0.000	0.000	1.000	81
60	2G	Other product manufacture and use	N2O	0.000	100.499	0.000	0.000	1.000	82
29	1A3e	Gaseous fuel	CH4	0.000	50.010	0.000	0.000	1.000	83
42	1B2	Oil and Natural Gas	N2O	0.000	1000.012	0.000	0.000	1.000	84
23	1A3c	Liquid fuel	CH4	0.000	60.208	0.000	0.000	1.000	85
56	2C2	Ferroalloys Production	CO2	0.000	25.495	0.000	0.000	1.000	86
26	1A3d	Gas/diesel oil	CH4	0.000	70.711	0.000	0.000	1.000	87
38	1A5	Stationary - Fossil fuels	N2O	0.000	200.062	0.000	0.000	1.000	88
13	1A3a	Liquid fuel	CH4	0.000	40.311	0.000	0.000	1.000	89
37	1A5	Stationary - Fossil fuels	CH4	0.000	50.249	0.000	0.000	1.000	90
92	5C	Incineration and open burning of waste	CH4	0.000	101.119	0.000	0.000	1.000	91
53	2B8	Petrochemical and carbon black production	CH4	0.000	50.249	0.000	0.000	1.000	92
57	2C2	Ferroalloys Production	CH4	0.000	25.495	0.000	0.000	1.000	93
21	1A3b	Other liquid fuels	CO2	0.000	5.831	0.000	0.000	1.000	94
55	2C1	Iron and Steel Production	CH4	0.000	26.926	0.000	0.000	1.000	95

ANNEX 2 ASSESSMENT OF THE UNCERTAINTY

Introduction

A consistent assessment of uncertainties of the Bulgarian greenhouse gas inventory requires a detailed understanding of the uncertainties of the respective input parameters. In the submission 2016 was prepared the detailed uncertainty evaluation, the Bulgarian inventory compilers have spent considerable effort to obtain uncertainties from individual contributors to the inventory. This leads to a situation where national information or at least national expert knowledge directly from the stage of inventory development may flow into the assessment of uncertainties.

The respective sectoral uncertainties are documented in detail in the sectoral chapters of this report.

Theoretical background

The assessment and propagation of uncertainties in emission inventories has been described in detail by IPCC (IPCC 2006). Principally, two different pathways may be taken to arrive at a total uncertainty, and to develop an inventory uncertainty. The "Approach 1" method is based on error propagation: assuming input information is available in form of normal distribution, and input uncertainties are statistically independent, the approach allows for reliable assessment of inventory uncertainty. More flexibility is possible in the "Approach 2" method. The Monte-Carlo approach allows any probability distribution of input parameters, and it also enables to define statistical dependencies between parameters. The most obvious dependency is a full dependency. This occurs when two values are based on the identical set of measurements. A variation or error in one value would then be fully reflected also in the other value. While "full dependency" theoretically can also be covered in error propagation, this is normally not done and only in a very limited way possible in the IPCC spreadsheets.

The general properties of error propagation allow to combine (add up) information in a way that the relative uncertainty (as percentage of the mean value) of the combination becomes lower than the relative uncertainty of any of the input parameters. This advantage of going into detail is often implicitly taken advantage of, when a problem is disassembled into sub-problems and the sub-results are being recombined. Nevertheless it is not always the most detailed level that yields results of lowest uncertainty. If measurements or assessments at the most detailed level are difficult, a more comprehensive level of information may provide the lower overall uncertainty.

As a consequence, optimizing the approach requires collecting input information at the most detailed level an inventory is prepared at. Attaching uncertainty data then may be done at a level where greatest confidence can be expected on the data. This may be the most detailed level, but more often uncertainty data will not be available, or a "balance" approach (energy balance, solvent balance) will allow more reliability at a more aggregated level.

Procedure

For the uncertainty assessment of the Bulgarian greenhouse gas inventory, the most detailed level of the inventory system was used as the base level. This "base level" of the inventory facilitates compilation of emission data for different purposes.

This approach of starting at the most detailed level the inventory offers facilitated an assessment of emission uncertainty at any level that the most reasonable uncertainty data are available. Very detailed information can be entered directly, for aggregate information the same uncertainty (as a statistically dependent entity) is applied for all input entries concerned.

Uncertainty information was taken from national studies, from international information (as e.g. in the IPCC reports) from variation presented in literature, and by contacting national experts. Structured interviews were held. The difference between an Approach 1 and an Approach 2 uncertainty approach can be explained by covariance of uncertainties between (key) source categories, which occurs when data are statistically dependent. The Approach 1 approach allows considering co-variance between years for one source category, but does not cover co-variances between source categories.

In all input and output parameters, uncertainty has been expressed as normal or lognormal probability density function. In line with the IPCC requirements, the uncertainty range is presented as the range with 95% probability of a given value being within its boundaries. Thus the boundaries were given as the 2.5 and 97.5-percentiles of the respective distribution. For a normal distribution, this is +/- 2 standard deviations from the mean.

Detailed Results of Approach 1 Uncertainty Analysis

The table on the next pages shows the detailed results of Approach 1 Uncertainty analysis. The structure of the table is identical to Table 3.2 of IPCC 2006 Guidelines. For explanations to the columns see pp. 3.30-3.31 in vol. 1 IPCC (2006).

Table 290 Approach 1 Uncertainty Calculation and Reporting, Gg CO_2-eq. (excluding LULUCF)

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A1	Liquid fuels	CO2	10099.15	1534.09	3	7	7.616	0.204	-0.031	0.013	-0.214	0.057	0.222
1A1	Solid fuels	CO2	25497.33	25235.72	1	2	2.236	0.987	0.109	0.220	0.218	0.311	0.380
1A1	Gaseous fuels	CO2	6508.60	2144.18	1	2	2.236	0.084	-0.010	0.019	-0.019	0.026	0.033
1A1	All fuel	CH4	18.85	8.60	3	50	50.090	0.008	0.000	0.000	0.000	0.000	0.000
1A1	All fuel	N2O	136.19	113.84	3	200	200.022	0.398	0.000	0.001	0.080	0.004	0.080
1A2	Liquid fuels	CO2	7319.76	684.23	3	7	7.616	0.091	-0.026	0.006	-0.181	0.025	0.183
1A2	Solid fuels	CO2	10152.70	522.73	1	2	2.236	0.020	-0.040	0.005	-0.079	0.006	0.080
1A2	Gaseous fuels	CO2	0.00	1485.96	1	2	2.236	0.058	0.013	0.013	0.026	0.018	0.032
1A2	Other fossil fuels	CO2	0.00	49.43	5	2	5.385	0.005	0.000	0.000	0.001	0.003	0.003
1A2	All fuel	CH4	31.74	10.74	3	50	50.090	0.009	0.000	0.000	-0.002	0.000	0.002
1A2	All fuel	N2O	103.95	24.81	3	200	200.022	0.087	0.000	0.000	-0.047	0.001	0.047
1A3a	Liquid fuel	CO2	208.93	27.81	5	5	7.071	0.003	-0.001	0.000	-0.003	0.002	0.004
1A3a	Liquid fuel	CH4	0.04	0.01	5	40	40.311	0.000	0.000	0.000	0.000	0.000	0.000
1A3a	Liquid fuel	N2O	1.75	0.25	5	40	40.311	0.000	0.000	0.000	0.000	0.000	0.000
1A3b	Gasoline	CO2	4384.24	1574.98	3	5	5.831	0.161	-0.005	0.014	-0.027	0.058	0.064
1A3b	Diesel Oil	CO2	2634.96	4935.45	3	5	5.831	0.503	0.032	0.043	0.158	0.183	0.242
1A3b	All fuel	CH4	71.52	28.26	3	40	40.112	0.020	0.000	0.000	-0.003	0.001	0.003
1A3b	All fuel	N2O	62.18	69.10	3	40	40.112	0.048	0.000	0.001	0.013	0.003	0.014
1A3b	LPG	CO2	0.00	1198.29	3	5	5.831	0.122	0.010	0.010	0.052	0.044	0.069
1A3b	Gaseous fuel	CO2	0.00	236.52	3	5	5.831	0.024	0.002	0.002	0.010	0.009	0.014

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A3b	Other liquid fuels	CO2	0.00	0.00	3	5	5.831	0.000	0.000	0.000	0.000	0.000	0.000
1A3c	Liquid fuel	CO2	0.00	37.37	5	5	7.071	0.005	0.000	0.000	0.002	0.002	0.003
1A3c	Liquid fuel	CH4	0.00	0.05	5	60	60.208	0.000	0.000	0.000	0.000	0.000	0.000
1A3c	Liquid fuel	N2O	0.00	4.30	5	60	60.208	0.005	0.000	0.000	0.002	0.000	0.002
1A3d	Gas/diesel oil	CO2	0.00	8.58	50	5	50.249	0.008	0.000	0.000	0.000	0.005	0.005
1A3d	Gas/diesel oil	CH4	0.00	0.02	50	50	70.711	0.000	0.000	0.000	0.000	0.000	0.000
1A3d	Gas/diesel oil	N2O	0.00	0.07	50	140	148.661	0.000	0.000	0.000	0.000	0.000	0.000
1A3e	Gaseous fuel	CO2	0.00	389.80	1	5	5.099	0.035	0.003	0.003	0.017	0.005	0.018
1A3e	Gaseous fuel	CH4	0.00	0.18	1	50	50.010	0.000	0.000	0.000	0.000	0.000	0.000
1A3e	Gaseous fuel	N2O	0.00	0.21	1	150	150.003	0.001	0.000	0.000	0.000	0.000	0.000
1A4	Liquid fuel	CO2	2825.06	498.86	5	7	8.602	0.075	-0.008	0.004	-0.056	0.031	0.064
1A4	Solid fuel	CO2	3548.08	563.85	2	5	5.385	0.053	-0.011	0.005	-0.053	0.014	0.054
1A4	Gaseous fuel	CO2	0.00	347.24	5	2	5.385	0.033	0.003	0.003	0.006	0.021	0.022
1A4	All fuel	CH4	334.66	278.94	5	50	50.249	0.245	0.001	0.002	0.049	0.017	0.052
1A4	All fuel	N2O	209.71	82.40	5	200	200.062	0.288	0.000	0.001	-0.039	0.005	0.039
1A5	Stationary - Fossil fuels	CO2	5100.78	3.10	5	7	8.602	0.000	-0.022	0.000	-0.155	0.000	0.155
1A5	Stationary - Fossil fuels	CH4	4.82	0.00	5	50	50.249	0.000	0.000	0.000	-0.001	0.000	0.001
1A5	Stationary - Fossil fuels	N2O	9.79	0.01	5	200	200.062	0.000	0.000	0.000	-0.009	0.000	0.009

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1B1	Solid fuel	CH4	2075.06	836.56	10	200	200.250	2.929	-0.002	0.007	-0.348	0.103	0.363
1B2	Oil and Natural Gas	CO2	4.99	10.27	5	100	100.125	0.018	0.000	0.000	0.007	0.001	0.007
1B2	Oil and Natural Gas	CH4	248.02	201.90	5	100	100.125	0.353	0.001	0.002	0.068	0.012	0.069
1B2	Oil and Natural Gas	N2O	0.02	0.01	5	1000	1000.012	0.000	0.000	0.000	0.000	0.000	0.000
2A1	Cement Production	CO2	2406.34	917.07	2	2	2.828	0.045	-0.002	0.008	-0.005	0.023	0.023
2A2	Lime Production	CO2	450.07	203.55	2	2	2.828	0.010	0.000	0.002	0.000	0.005	0.005
2A3	Glass production	CO2	186.24	68.64	6	60	60.299	0.072	0.000	0.001	-0.013	0.005	0.014
2A4a	Ceramics - Bricks and Tails	CO2	566.79	37.94	5	3	5.831	0.004	-0.002	0.000	-0.006	0.002	0.007
2A4b	Soda ash uses	CO2	126.58	91.33	2	1	2.236	0.004	0.000	0.001	0.000	0.002	0.002
2A4d	DeSOx - instalations	CO2	0.00	667.83	2	2	2.828	0.033	0.006	0.006	0.012	0.016	0.020
2B1	Ammonia Production	CO2	802.19	872.51	2	7	7.280	0.111	0.004	0.008	0.029	0.022	0.036
2B2	Nitric Acid Production	N2O	1932.03	124.71	2	10	10.198	0.022	-0.007	0.001	-0.073	0.003	0.073
2B5b	Calcium Carbide	CO2	63.44	8.26	5	10	11.180	0.002	0.000	0.000	-0.002	0.001	0.002
2B7	Soda ash production	CO2	391.50	586.88	2	2	2.828	0.029	0.003	0.005	0.007	0.014	0.016
2B8	Petrochemical and carbon black production	CH4	6.48	0.00	5	50	50.249	0.000	0.000	0.000	-0.001	0.000	0.001
2C1	Iron and Steel Production	CO2	3481.44	40.22	5	5	7.071	0.005	-0.015	0.000	-0.074	0.002	0.074
2C1	Iron and Steel Production	CH4	32.42	0.00	10	25	26.926	0.000	0.000	0.000	-0.004	0.000	0.004
2C2	Ferroalloys Production	CO2	254.94	0.07	5	25	25.495	0.000	-0.001	0.000	-0.028	0.000	0.028

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
2C2	Ferroalloys Production	CH4	2.28	0.00	5	25	25.495	0.000	0.000	0.000	0.000	0.000	0.000
2D	Non-energy products from fuels and solvent use	CO2	866.20	31.13	10	30	31.623	0.017	-0.004	0.000	-0.105	0.004	0.105
2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0.00	1017.43	10	50	50.990	0.907	0.009	0.009	0.444	0.126	0.461
2G	Other product manufacture and use	N2O	31.90	0.09	10	100	100.499	0.000	0.000	0.000	-0.014	0.000	0.014
2G	Other product manufacture and use	CO2	32.79	21.99	10	30	31.623	0.012	0.000	0.000	0.001	0.003	0.003
2G1	Electrical equipment - SF6	CO2eq	3.30	15.62	10	50	50.990	0.014	0.000	0.000	0.006	0.002	0.006
2H	Other	CO2	6.85	4.93	10	100	100.499	0.009	0.000	0.000	0.001	0.001	0.001
3A1	Cattle	CH4	2715.03	1131.62	2	20	20.100	0.398	-0.002	0.010	-0.039	0.028	0.048
3A2	Sheep	CH4	1605.03	240.47	2	20	20.100	0.085	-0.005	0.002	-0.098	0.006	0.098
3A3	Swine	CH4	151.58	21.37	2	20	20.100	0.008	0.000	0.000	-0.009	0.001	0.009
3A4	Other livestock	CH4	234.66	95.14	2	50	50.040	0.083	0.000	0.001	-0.010	0.002	0.010
3B	N2O em. from Manure Management	N2O	1214.84	440.32	2	300	300.007	2.310	-0.001	0.004	-0.435	0.011	0.435
3B1	Cattle	CH4	79.40	30.70	2	20	20.100	0.011	0.000	0.000	-0.002	0.001	0.002
3B2	Sheep	CH4	46.86	6.99	2	20	20.100	0.002	0.000	0.000	-0.003	0.000	0.003
3B3	Swine	CH4	1808.55	209.39	2	20	20.100	0.074	-0.006	0.002	-0.121	0.005	0.121
3B4	Other livestock	CH4	44.62	14.37	2	50	50.040	0.013	0.000	0.000	-0.003	0.000	0.003
3C	Rice Cultivation	CH4	126.99	99.45	25	80	83.815	0.146	0.000	0.001	0.025	0.031	0.040

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
3Da	Direct N2O emissions from managed soils	N2O	4693.28	2167.04	3	250	250.018	9.472	-0.002	0.019	-0.384	0.080	0.392
3Db	Indirect N2O Emissions from managed soils	N2O	1355.82	570.41	3	500	500.009	4.986	-0.001	0.005	-0.464	0.021	0.465
3F	Field burning of agricultural residues	CH4	29.06	26.64	25	50	55.902	0.026	0.000	0.000	0.005	0.008	0.010
3F	Field burning of agricultural residues	N2O	8.34	7.52	25	200	201.556	0.026	0.000	0.000	0.006	0.002	0.006
3H	Urea application	CO2	17.12	30.86	2	50	50.040	0.027	0.000	0.000	0.010	0.001	0.010
5A	Solid waste disposal	CH4	3502.67	3101.60	30	80	85.440	4.633	0.012	0.027	0.944	1.148	1.487
5B	Biological treatment of solid waste	CH4	0.00	5.86	30	30	42.426	0.004	0.000	0.000	0.002	0.002	0.003
5B	Biological treatment of solid waste	N2O	0.00	4.19	30	100	104.403	0.008	0.000	0.000	0.004	0.002	0.004
5C	Incineration and open burning of waste	CO2	18.51	11.26	15	100	101.119	0.020	0.000	0.000	0.002	0.002	0.003
5C	Incineration and open burning of waste	CH4	0.00	0.00	15	100	101.119	0.000	0.000	0.000	0.000	0.000	0.000
5C	Incineration and open burning of waste	N2O	1.45	0.87	15	100	101.119	0.002	0.000	0.000	0.000	0.000	0.000
5D	Wastewater treatment and discharge	CH4	3448.19	977.27	10	100	100.499	1.717	-0.006	0.009	-0.649	0.121	0.660
5D	Wastewater treatment and discharge	N2O	239.13	144.94	10	100	100.499	0.255	0.000	0.001	0.022	0.018	0.029
Total			**114577.8**	**57197.2**				**12.48**					**1.99**
%			**100.0**	**100.0**									

IPCC Source category	GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A	B	C	D	E	F	G	H	I	J	K	L	M
		Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
National Total		**114577.8**	**57197.2**									

Table 291 Tier 1 Uncertainty Calculation and Reporting, Gg CO_2-eq.(Including LULUCF)

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duced by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A1	Liquid fuels	CO2	10099.15	1534.09	3	7	7.616	0.254	-0.032	0.015	-0.221	0.066	0.230
1A1	Solid fuels	CO2	25497.33	25235.72	1	2	2.236	1.228	0.135	0.254	0.270	0.359	0.450
1A1	Gaseous fuels	CO2	6508.60	2144.18	1	2	2.236	0.104	-0.009	0.022	-0.017	0.031	0.035
1A1	All fuel	CH4	18.85	8.60	3	50	50.090	0.009	0.000	0.000	0.000	0.000	0.000
1A1	All fuel	N2O	136.19	113.84	3	200	200.022	0.496	0.001	0.001	0.102	0.005	0.103
1A2	Liquid fuels	CO2	7319.76	684.23	3	7	7.616	0.113	-0.027	0.007	-0.190	0.029	0.193
1A2	Solid fuels	CO2	10152.70	522.73	1	2	2.236	0.025	-0.042	0.005	-0.084	0.007	0.084
1A2	Gaseous fuels	CO2	0.00	1485.96	1	2	2.236	0.072	0.015	0.015	0.030	0.021	0.037
1A2	Other fossil fuels	CO2	0.00	49.43	5	2	5.385	0.006	0.000	0.000	0.001	0.004	0.004
1A2	All fuel	CH4	31.74	10.74	3	50	50.090	0.012	0.000	0.000	-0.002	0.000	0.002
1A2	All fuel	N2O	103.95	24.81	3	200	200.022	0.108	0.000	0.000	-0.047	0.001	0.047
1A3a	Liquid fuel	CO2	208.93	27.81	5	5	7.071	0.004	-0.001	0.000	-0.003	0.002	0.004
1A3a	Liquid fuel	CH4	0.04	0.01	5	40	40.311	0.000	0.000	0.000	0.000	0.000	0.000
1A3a	Liquid fuel	N2O	1.75	0.25	5	40	40.311	0.000	0.000	0.000	0.000	0.000	0.000
1A3b	Gasoline	CO2	4384.24	1574.98	3	5	5.831	0.200	-0.005	0.016	-0.023	0.067	0.071
1A3b	Diesel Oil	CO2	2634.96	4935.45	3	5	5.831	0.627	0.037	0.050	0.187	0.211	0.282
1A3b	All fuel	CH4	71.52	28.26	3	40	40.112	0.025	0.000	0.000	-0.002	0.001	0.002

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A3b	All fuel	N2O	62.18	69.10	3	40	40.112	0.060	0.000	0.001	0.016	0.003	0.017
1A3b	LPG	CO2	0.00	1198.29	3	5	5.831	0.152	0.012	0.012	0.060	0.051	0.079
1A3b	Gaseous fuel	CO2	0.00	236.52	3	5	5.831	0.030	0.002	0.002	0.012	0.010	0.016
1A3b	Other liquid fuels	CO2	0.00	0.00	3	5	5.831	0.000	0.000	0.000	0.000	0.000	0.000
1A3c	Liquid fuel	CO2	0.00	37.37	5	5	7.071	0.006	0.000	0.000	0.002	0.003	0.003
1A3c	Liquid fuel	CH4	0.00	0.05	5	60	60.208	0.000	0.000	0.000	0.000	0.000	0.000
1A3c	Liquid fuel	N2O	0.00	4.30	5	60	60.208	0.006	0.000	0.000	0.003	0.000	0.003
1A3d	Gas/diesel oil	CO2	0.00	8.58	50	5	50.249	0.009	0.000	0.000	0.000	0.006	0.006
1A3d	Gas/diesel oil	CH4	0.00	0.02	50	50	70.711	0.000	0.000	0.000	0.000	0.000	0.000
1A3d	Gas/diesel oil	N2O	0.00	0.07	50	140	148.661	0.000	0.000	0.000	0.000	0.000	0.000
1A3e	Gaseous fuel	CO2	0.00	389.80	1	5	5.099	0.043	0.004	0.004	0.020	0.006	0.020
1A3e	Gaseous fuel	CH4	0.00	0.18	1	50	50.010	0.000	0.000	0.000	0.000	0.000	0.000
1A3e	Gaseous fuel	N2O	0.00	0.21	1	150	150.003	0.001	0.000	0.000	0.000	0.000	0.000
1A4	Liquid fuel	CO2	2825.06	498.86	5	7	8.602	0.093	-0.008	0.005	-0.057	0.036	0.067
1A4	Solid fuel	CO2	3548.08	563.85	2	5	5.385	0.066	-0.011	0.006	-0.054	0.016	0.057
1A4	Gaseous fuel	CO2	0.00	347.24	5	2	5.385	0.041	0.003	0.003	0.007	0.025	0.026
1A4	All fuel	CH4	334.66	278.94	5	50	50.249	0.305	0.001	0.003	0.063	0.020	0.066
1A4	All fuel	N2O	209.71	82.40	5	200	200.062	0.359	0.000	0.001	-0.029	0.006	0.030

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
1A5	Stationary - Fossil fuels	CO2	5100.78	3.10	5	7	8.602	0.001	-0.024	0.000	-0.166	0.000	0.166
1A5	Stationary - Fossil fuels	CH4	4.82	0.00	5	50	50.249	0.000	0.000	0.000	-0.001	0.000	0.001
1A5	Stationary - Fossil fuels	N2O	9.79	0.01	5	200	200.062	0.000	0.000	0.000	-0.009	0.000	0.009
1B1	Solid fuel	CH4	2075.06	836.56	10	200	200.250	3.647	-0.001	0.008	-0.248	0.119	0.275
1B2	Oil and Natural Gas	CO2	4.99	10.27	5	100	100.125	0.022	0.000	0.000	0.008	0.001	0.008
1B2	Oil and Natural Gas	CH4	248.02	201.90	5	100	100.125	0.440	0.001	0.002	0.088	0.014	0.089
1B2	Oil and Natural Gas	N2O	0.02	0.01	5	1000	1000.012	0.000	0.000	0.000	0.000	0.000	0.000
2A1	Cement Production	CO2	2406.34	917.07	2	2	2.828	0.056	-0.002	0.009	-0.004	0.026	0.026
2A2	Lime Production	CO2	450.07	203.55	2	2	2.828	0.013	0.000	0.002	0.000	0.006	0.006
2A3	Glass production	CO2	186.24	68.64	6	60	60.299	0.090	0.000	0.001	-0.011	0.006	0.012
2A4a	Ceramics - Bricks and Tails	CO2	566.79	37.94	5	3	5.831	0.005	-0.002	0.000	-0.007	0.003	0.007
2A4b	Soda ash uses	CO2	126.58	91.33	2	1	2.236	0.004	0.000	0.001	0.000	0.003	0.003
2A4d	DeSOx - instalations	CO2	0.00	667.83	2	2	2.828	0.041	0.007	0.007	0.013	0.019	0.023
2B1	Ammonia Production	CO2	802.19	872.51	2	7	7.280	0.138	0.005	0.009	0.035	0.025	0.043
2B2	Nitric Acid Production	N2O	1932.03	124.71	2	10	10.198	0.028	-0.008	0.001	-0.077	0.004	0.078
2B5b	Calcium Carbide	CO2	63.44	8.26	5	10	11.180	0.002	0.000	0.000	-0.002	0.001	0.002
2B7	Soda ash production	CO2	391.50	586.88	2	2	2.828	0.036	0.004	0.006	0.008	0.017	0.019
2B8	Petrochemical and carbon black production	CH4	6.48	0.00	5	50	50.249	0.000	0.000	0.000	-0.002	0.000	0.002

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
2C1	Iron and Steel Production	CO2	3481.44	40.22	5	5	7.071	0.006	-0.016	0.000	-0.079	0.003	0.079
2C1	Iron and Steel Production	CH4	32.42	0.00	10	25	26.926	0.000	0.000	0.000	-0.004	0.000	0.004
2C2	Ferroalloys Production	CO2	254.94	0.07	5	25	25.495	0.000	-0.001	0.000	-0.030	0.000	0.030
2C2	Ferroalloys Production	CH4	2.28	0.00	5	25	25.495	0.000	0.000	0.000	0.000	0.000	0.000
2D	Non-energy products from fuels and solvent use	CO2	866.20	31.13	10	30	31.623	0.021	-0.004	0.000	-0.112	0.004	0.112
2F	Product uses as substitutes for ODS - HFCs and PFCs	CO2eq	0.00	1017.43	10	50	50.990	1.129	0.010	0.010	0.512	0.145	0.532
2G	Other product manufacture and use	N2O	31.90	0.09	10	100	100.499	0.000	0.000	0.000	-0.015	0.000	0.015
2G	Other product manufacture and use	CO2	32.79	21.99	10	30	31.623	0.015	0.000	0.000	0.002	0.003	0.004
2G1	Electrical equipment - SF6	CO2eq	3.30	15.62	10	50	50.990	0.017	0.000	0.000	0.007	0.002	0.007
2H	Other	CO2	6.85	4.93	10	100	100.499	0.011	0.000	0.000	0.002	0.001	0.002
3A1	Cattle	CH4	2715.03	1131.62	2	20	20.100	0.495	-0.001	0.011	-0.025	0.032	0.041
3A2	Sheep	CH4	1605.03	240.47	2	20	20.100	0.105	-0.005	0.002	-0.101	0.007	0.101
3A3	Swine	CH4	151.58	21.37	2	20	20.100	0.009	0.000	0.000	-0.010	0.001	0.010
3A4	Other livestock	CH4	234.66	95.14	2	50	50.040	0.104	0.000	0.001	-0.007	0.003	0.007
3B	N2O em. from Manure Management	N2O	1214.84	440.32	2	300	300.007	2.876	-0.001	0.004	-0.367	0.013	0.368
3B1	Cattle	CH4	79.40	30.70	2	20	20.100	0.013	0.000	0.000	-0.001	0.001	0.001
3B2	Sheep	CH4	46.86	6.99	2	20	20.100	0.003	0.000	0.000	-0.003	0.000	0.003

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
3B3	Swine	CH4	1808.55	209.39	2	20	20.100	0.092	-0.006	0.002	-0.126	0.006	0.126
3B4	Other livestock	CH4	44.62	14.37	2	50	50.040	0.016	0.000	0.000	-0.003	0.000	0.003
3C	Rice Cultivation	CH4	126.99	99.45	25	80	83.815	0.181	0.000	0.001	0.033	0.035	0.048
3Da	Direct N2O emissions from managed soils	N2O	4693.28	2167.04	3	250	250.018	11.795	0.000	0.022	-0.010	0.093	0.093
3Db	Indirect N2O Emissions from managed soils	N2O	1355.82	570.41	3	500	500.009	6.209	-0.001	0.006	-0.286	0.024	0.287
3F	Field burning of agricultural residues	CH4	29.06	26.64	25	50	55.902	0.032	0.000	0.000	0.007	0.009	0.012
3F	Field burning of agricultural residues	N2O	8.34	7.52	25	200	201.556	0.033	0.000	0.000	0.007	0.003	0.008
3H	Urea application	CO2	17.12	30.86	2	50	50.040	0.034	0.000	0.000	0.012	0.001	0.012
4A1	Forest Land remaining Forest Land	CO2	-13785.23	-9682.29	3	149.4	149.451	-31.503	-0.033	-0.098	-4.981	-0.414	4.998
4A2	Land converted to Forest Land	CO2	-544.07	-783.23	10	122.1	122.520	-2.089	-0.005	-0.008	-0.654	-0.112	0.663
4B1	Cropland remainig Cropland	CO2	-1121.39	491.50	3	184.0	184.043	1.969	0.010	0.005	1.872	0.021	1.872
4B2	Land converted to Cropland	CO2	106.18	425.47	10	415.3	415.466	3.848	0.004	0.004	1.574	0.061	1.575
4C2	Land converted to Grassland	CO2	16.38	-2062.37	10	444.7	444.813	-19.972	-0.021	-0.021	-9.270	-0.294	9.274
4D2	Land converted to Wetlands	CO2	0.00	281.98	10	24.5	26.502	0.163	0.003	0.003	0.070	0.040	0.080
4E2	Land converted to Settlements	CO2	711.64	932.96	10	74.3	75.000	1.523	0.006	0.009	0.452	0.133	0.471
4F	Land converted to other land	CO2	-1.73	-323.73	10	50	50.990	-0.359	-0.003	-0.003	-0.163	-0.046	0.169
4G	Harvested wood products	CO2	-656.48	-544.01	10	50	50.990	-0.604	-0.002	-0.005	-0.121	-0.077	0.144

IPCC Source category		GHG	Base year emissions (1988)	Year 2014 emissions	Activity data (AD) uncertainty	Emission factor (EF) uncertainty	Combined uncertainty	Combined uncertainty as % of total national emissions in year 2014	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions intro-duced by EF uncertainty	Uncertainty in trend in national emissions intro-duceed by AD uncertainty	Uncertainty introduced into the trend in total national emissions
A		B	C	D	E	F	G	H	I	J	K	L	M
			Gg CO_2 eq.		%	%	%	%	%	%	%	%	%
5A	Solid waste disposal	CH4	3502.67	3101.60	30	80	85.440	5.769	0.015	0.031	1.193	1.325	1.783
5B	Biological treatment of solid waste	CH4	0.00	5.86	30	30	42.426	0.005	0.000	0.000	0.002	0.003	0.003
5B	Biological treatment of solid waste	N2O	0.00	4.19	30	100	104.403	0.010	0.000	0.000	0.004	0.002	0.005
5C	Incineration and open burning of waste	CO2	18.51	11.26	15	100	101.119	0.025	0.000	0.000	0.003	0.002	0.004
5C	Incineration and open burning of waste	CH4	0.00	0.00	15	100	101.119	0.000	0.000	0.000	0.000	0.000	0.000
5C	Incineration and open burning of waste	N2O	1.45	0.87	15	100	101.119	0.002	0.000	0.000	0.000	0.000	0.000
5D	Wastewater treatment and discharge	CH4	3448.19	977.27	10	100	100.499	2.138	-0.006	0.010	-0.622	0.139	0.637
5D	Wastewater treatment and discharge	N2O	239.13	144.94	10	100	100.499	0.317	0.000	0.001	0.035	0.021	0.040
Total			**99303.1**	**45933.5**				**40.73**					**11.06**
%			**100.0**	**100.0**									
National Total			**99303.1**	**45933.5**									

* Considering LULUCF sector, values for the uncertainty related to activity data and emission factor have been assigned by expert judgment, taking into account the final combined uncertainty.

ANNEX 3 DETAILED METHODOLOGICAL DESCRIPTION AND DATA FOR ESTIMATING CO2 EMISSIONS FROM FOSSIL FUEL COMBUSTION

The emission estimates were prepared according to the following allocation between Eurostat energy balance categories and CRF categories and by using the following corresponding NCVs in the calculation model:

Eurostat Category	CRF Category	NCV applied
Indigenous Production		Production (net)
Underground Production		
Surface Production		
From Other Sources		
From Other Sources - Oil		
From Other Sources - Natural Gas		
From Other Sources - Renewables		
Total Imports (Balance)		Imports (net)
Total Exports (Balance)		Exports (net)
International Marine Bunkers		
Stock Changes (National Territory)		
Inland Consumption (Calculated)		
Statistical Differences		
Transformation Sector		
Main Activity Producer Electricity Plants	1A1ai	Used in Main Activity Plants (net)
Main Activity Producer CHP Plants	1A1aii	Used in Main Activity Plants (net)
Main Activity Producer Heat Plants	1A1aiii	Used in Main Activity Plants (net)
Autoproducer Electricity Plants	1A2gviii	Used in industry (net)
Autoproducer CHP Plants	1A2gviii	Used in industry (net)
Autoproducer Heat Plants	1A2gviii	Used in industry (net)
Patent Fuel Plants (Transformation)		Used in industry (net)
Coke Ovens (Transformation)		Used in coke ovens (net)
BKB/PB plants (Transformation)		Used in industry (net)
Gas Works (Transformation)		
Blast Furnaces (Transformation)		Used in blast furnaces (net)
Coal Liquefaction Plants (Transformation)		
For Blended Natural Gas		
Not elsewhere specified (Transformation)		
Energy Sector		
Own Use in Electricity, CHP and Heat Plants	1A1ai	Used in Main Activity Plants (net)
Coal Mines	1A1ci	Production (net)
Patent Fuel Plants (Energy)	1A1ci	Production (net)
Coke Ovens (Energy)	1A1ci	Used in coke ovens (net)
BKB/PB plants (Energy)	1A1ci	Production (net)
Gas Works (Energy)		
Blast Furnaces (Energy)	1A2a	Used in blast furnaces (net)
Oil refineries	1A1b	Used in industry (net)
Coal Liquefaction Plants (Energy)		
Not elsewhere specified (Energy industry own use)	1A1ciii	For Other Uses (net)
Distribution Losses		
Total Final Consumption		
Total Non-Energy Use		
Non-Energy Use Industry/Transformation/Energy		
Of which: Non-Energy Use-		

Eurostat Category	CRF Category	NCV applied
Chemical/Petrochem		
Non-Energy Use in Transport		
Non-Energy Use in Other Sectors		
Final Energy Consumption		
Industry Sector		
Iron and Steel	1A2a	Used in industry (net)
Chemical and petrochemical	1A2c	Used in industry (net)
Non-Ferrous Metals	1A2b	Used in industry (net)
Non-Metallic Minerals	1A2f	Used in industry (net)
Transport Equipment	1A2gii	Used in industry (net)
Machinery	1A2gi	Used in industry (net)
Mining and Quarrying	1A2giii	Used in industry (net)
Food, Beverages and Tobacco	1A2e	Used in industry (net)
Paper, Pulp and Printing	1A2d	Used in industry (net)
Wood and Wood Products	1A2giv	Used in industry (net)
Construction	1A2gv	Used in industry (net)
Textiles and Leather	1A2gvi	Used in industry (net)
Not elsewhere specified (Industry)	1A2gviii	Used in industry (net)
Transport Sector		
Rail	1A3c	
Domestic Navigation	1A3d	
Not elsewhere specified (Transport)	1A3eii	
Other Sectors		
Commercial and Public Services	1A4ai	For Other Uses (net)
Residential	1A4bi	For Other Uses (net)
Agriculture/Forestry	1A4ci	For Other Uses (net)
Fishing	1A4ci	For Other Uses (net)
Not elsewhere specified (Other)	1A5a	For Other Uses (net)

For the sectoral approach were considered all fuels for which there was reported energy consumption.

Solid fuels:	**Liquid fuels:**
Anthracite Coking Coal Other Bituminous Coal Sub-bituminous Coal Lignite/Brown Coal Coke Oven Coke Coal Tar BKB/PB Coke Oven Gas Blast Furnace Gas	Crude Oil Refinery Gas LPG Motor Gasoline Aviation Gasoline Kerosene Type Jet Fuel Gas-Diesel Oil Residual Fuel Oil Petroleum Coke Other Products
Gaseous fuels: Natural Gas	

In order to avoid double counting in the Energy sector, the following categories were not considered:

- Lignite/Brown coal used in BKB Plants (Transformation). The quantities which were considered instead are BKBs in all sectors.
- Coking coal used in Coke Ovens (Transformation). The quantities which were considered instead are:
  - Coke oven coke used in Blast Furnaces (Transformation) and Iron and Steel industry sector
  - Coke oven gas used in Autoproducer CHP Plants, Blast Furnaces (Energy) and Iron and Steel industry sector.
- Blast Furnace Gas used in Autoproducer CHP Plants, Blast Furnaces (Energy) and Iron and Steel industry sector and also the quantities of Coke oven coke used in Blast Furnaces (Transformation). These fuels are accounted under the Industrial processes sector since the emissions are calculated based on mass balance approach.

In addition, following the recommendation of the Technical review of GHG inventories under the EU Effort Sharing Decision (ESD) in 2012, we revised the methodology concerning Iron & Steel sector in order to remove the double counting with the IP sector. The following quantities were disregarded from the Energy sector:

- Coke Oven Gas reported under blast furnaces;
- Blast Furnace Gas reported under blast furnaces, Autoproducers and Iron & Steel subcategories;
- Coke oven coke in blast furnaces.

ANNEX 4 CO2 REFERENCE APPROACH AND COMPARISON WITH SECTORAL APPROACH, AND RELEVANT INFORMATION ON THE NATIONAL ENERGY BALANCE

For the reference approach both fuels were considered for which there was reported energy and non-energy consumption.

Solid fuels:	**Liquid fuels:**
Anthracite Coking Coal Other Bituminous Coal Sub-bituminous Coal Lignite/Brown Coal Coke Oven Coke Coal Tar BKB/PB	Crude Oil LPG Motor Gasoline Aviation Gasoline Kerosene Type Jet Fuel Other Kerosene Gas-Diesel Oil Residual Fuel Oil Petroleum Coke
Gaseous fuels: Natural Gas	Other Products Naphtha White spirit Lubricants Bitumen Paraffin waxes Refinery Feedstocks

In order to avoid double counting, the apparent consumption for different fuels was calculated according to the 2006 IPCC Guidelines, Vol. 2, Ch. 6.4.1.

The carbon used as feedstock, reductant, or as non-energy products has been excluded from the estimates.

For the purposes of the reference approach only were calculated weighted average net calorific value for solid fuels from production, imports and exports for each fuel and each year:

Table 292 Weighted average net calorific value for solid fuels

[MJ/t]	Anthracite	Coking Coal	Other Bituminous Coal	Sub-bituminous Coal	Lignite/Brown Coal	Coke Oven Coke	Coal Tar	BKB/PB
1988	-	24.702	24.702	-	7.034	28.200	-	20.097
1989	-	24.702	24.702	-	7.034	28.200	-	20.097
1990	-	24.366	25.571	-	6.682	25.061	-	18.367
1991	-	24.366	26.444	11.669	6.268	26.380	-	18.367
1992	-	27.215	24.369	11.669	6.813	26.380	-	18.359

1993	-	32.481	23.488	11.776	6.838	31.059	-	18.569
1994	-	31.863	24.933	11.583	6.733	30.019	-	18.680
1995	-	30.148	26.020	11.537	6.584	29.832	-	18.683
1996	-	32.804	24.414	11.643	6.680	29.714	-	18.722
1997	-	32.709	25.207	-	7.014	30.061	36.649	18.757
1998	-	32.658	25.712	-	7.020	30.141	36.649	17.917
1999	-	32.659	25.897	-	7.025	30.220	40.427	17.077
2000	-	33.412	23.283	-	6.762	30.117	40.421	15.739
2001	-	30.480	24.911	-	7.036	29.969	35.576	16.082
2002	-	27.457	25.527	-	7.089	30.031	37.679	16.459
2003	-	29.326	24.673	-	7.106	29.955	37.693	16.490
2004	24.804	28.610	24.227	-	7.161	27.423	33 356	15.976
2005	24.465	28.638	24.365	-	7.079	27.270	32 070	15.125
2006	24.916	25.122	25.131	-	7.010	29.700	34 540	11.712
2007	23.899	27.973	24.645	-	6.973	28.500	37 700	11.504
2008	22.728	28.610	25.527	-	6.987	28.500	35.862	12.568
2009	25.200	-	25.756	-	7.006	28.500	-	12.212
2010	24.812	-	26.254	-	7.004	28.500	-	12.768
2011	24.349	-	26.754	-	6.973	28.500	-	13.064
2012	26.155	-	25.563	-	6.992	28.500	-	12.475
2013	26.379	-	25.737	-	6.961	28.500	-	10.175
2014	28.716	-	26.630	-	6.820	28.500	-	12.191

For the sectoral approach were used the NCVs per sector, as indicated in the National Energy Balance.

ANNEX 5 NATIONAL ENERGY BALANCE

The national energy balance will be provided to the ERT during the review due to the confidentiality of information.

ANNEX 6 ASSESSMENT OF COMPLETENESS AND (POTENTIAL) SOURCES AND SINKS OF GREENHOUSE GAS EMISSIONS AND REMOVALS EXCLUDED FOR THE ANNUAL INVENTORY SUBMISSION

Provided in Chapter 1.7

ANNEX 7 VEHICLE FLEET AND MILEAGE DATA FOR ROAD TRANSPORT

Table 293 Vehicle fleet data for Road transport (number of vehicles) 1988-2000

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PC Gasoline 0,8 - 1,4 l	PRE ECE	690547	718360	670759	616117	556701	533820	505411	467326	423310	370174	333234	307752	281845
PC Gasoline 0,8 - 1,4 l	ECE 15/00-01	0	0	29997	61611	93360	100090	100602	98475	94132	86561	81613	78583	74640
PC Gasoline 0,8 - 1,4 l	ECE 15/02	0	0	14999	30806	46680	66726	88290	109527	129407	144594	163719	169046	154845
PC Gasoline 0,8 - 1,4 l	ECE 15/03	0	0	12499	25671	38900	55605	73575	91272	107839	120495	136433	156524	176294
PC Gasoline 0,8 - 1,4 l	ECE 15/04	0	0	10780	22142	33551	47960	63458	78722	93011	103927	117673	135002	152053
PC Gasoline 0,8 - 1,4 l	Improved Conventional	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 0,8 - 1,4 l	Open Loop	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 0,8 - 1,4 l	PC Euro 1 - 91/441/EEC	0	0	0	0	10556	22633	35936	49534	62705	73567	86382	101935	117419
PC Gasoline 0,8 - 1,4 l	PC Euro 2 - 94/12/EEC	0	0	0	0	0	0	0	0	11897	23263	35120	48351	61883
PC Gasoline 0,8 - 1,4 l	PC Euro 3 - 98/69/EC Stage2000	0	0	0	0	0	0	0	0	0	0	0	0	12924
PC Gasoline 0,8 - 1,4 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 0,8 - 1,4 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 0,8 - 1,4 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 1,4 - 2,0 l	PRE ECE	304709	316992	295997	271893	245680	235591	223060	206258	186837	163390	147090	135847	124415
PC Gasoline 1,4 - 2,0 l	ECE 15/00-01	0	0	13237	27189	41201	44172	44400	43463	41547	38207	36024	34688	32948
PC Gasoline 1,4 - 2,0 l	ECE 15/02	0	0	6619	13595	20601	29448	38966	48341	57117	63822	72266	74620	68353
PC Gasoline 1,4 - 2,0 l	ECE 15/03	0	0	5516	11329	17167	24540	32472	40284	47597	53185	60222	69092	77822
PC Gasoline 1,4 - 2,0 l	ECE 15/04	0	0	4757	9771	14807	21166	28007	34745	41053	45872	51941	59592	67121
PC Gasoline 1,4 - 2,0 l	Improved Conventional	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 1,4 - 2,0 l	Open Loop	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	0	0	0	0	4658	9989	15860	21862	27676	32472	38129	44996	51832
PC Gasoline 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	0	0	0	0	0	0	0	0	5251	10268	15502	21343	27317
PC Gasoline 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	0	0	0	0	0	0	0	0	0	0	0	0	5705
PC Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline >2,0 l	PRE ECE	225529	234606	219054	201204	181796	174319	165038	152597	138221	120867	108803	100480	92019
PC Gasoline >2,0 l	ECE 15/00-01	0	0	9796	20120	30488	32684	32851	32155	30736	28263	26647	25657	24369
PC Gasoline >2,0 l	ECE 15/02	0	0	4898	10060	15244	21790	28830	35764	42255	47212	53455	55193	50555
PC Gasoline >2,0 l	ECE 15/03	0	0	4082	8383	12703	18158	24025	29803	35212	39343	44546	51105	57558
PC Gasoline >2,0 l	ECE 15/04	0	0	3521	7231	10957	15661	20722	25705	30370	33934	38421	44078	49644
PC Gasoline >2,0 l	PC Euro 1 - 91/441/EEC	0	0	0	0	3447	7391	11735	16174	20475	24021	28204	33282	38336

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PC Gasoline >2,0 l	PC Euro 2 - 94/12/EEC	0	0	0	0	0	0	0	0	3885	7596	11467	15786	20204
PC Gasoline >2,0 l	PC Euro 3 - 98/69/EC Stage2000	0	0	0	0	0	0	0	0	0	0	0	0	4219
PC Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline >2,0 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline >2,0 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Diesel 1,4 - 2,0 l	Conventional	0	0	3423	6961	10472	13993	17517	21044	24261	27417	30529	33505	35832
PC Diesel 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	0	0	0	0	144	394	757	1233	1795	2443	3167	4033	5011
PC Diesel 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	0	0	0	0	0	0	0	0	340	772	1288	1913	2641
PC Diesel 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	0	0	0	0	0	0	0	0	0	0	0	0	551
PC Diesel 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Diesel 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Diesel 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Diesel >2,0 l	Conventional	0	0	7504	14893	21865	28518	34854	40889	46041	50824	55292	59297	61975
PC Diesel >2,0 l	PC Euro 1 - 91/441/EEC	0	0	0	0	300	803	1507	2396	3406	4528	5736	7137	8666
PC Diesel >2,0 l	PC Euro 2 - 94/12/EEC	0	0	0	0	0	0	0	0	646	1432	2332	3385	4567
PC Diesel >2,0 l	PC Euro 3 - 98/69/EC Stage2000	0	0	0	0	0	0	0	0	0	0	0	0	954
PC Diesel >2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Diesel >2,0 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Diesel >2,0 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC LPG	Conventional	0	0	0	0	0	0	0	0	0	10792	21043	30720	39244
PC LPG	PC Euro 1 - 91/441/EEC	0	0	0	0	0	0	0	0	0	961	2183	3697	5488
PC LPG	PC Euro 2 - 94/12/EEC	0	0	0	0	0	0	0	0	0	304	888	1754	2892
PC LPG	PC Euro 3 - 98/69/EC Stage2000	0	0	0	0	0	0	0	0	0	0	0	0	604
PC LPG	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
PC LPG	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC LPG	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC CNG	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
PC CNG	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC CNG	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC 2-Stroke	Conventional	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Hybrid Gasoline <1,4 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Hybrid Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PC Hybrid Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
LDV Gasoline <3,5t	Conventional	131735	138431	145504	156413	163334	172816	176384	177364	172424	164528	162527	163402	160097
LDV Gasoline <3,5t	LD Euro 1 - 93/59/EEC	0	0	0	0	4337	9489	15035	20889	26339	31338	37585	39390	40116
LDV Gasoline <3,5t	LD Euro 2 - 96/69/EEC	0	0	0	0	0	0	0	0	4097	8125	12528	17507	22390
LDV Gasoline <3,5t	LD Euro 3 - 98/69/EC Stage2000	0	0	0	0	0	0	0	0	0	0	0	0	4183
LDV Gasoline <3,5t	LD Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
LDV Gasoline <3,5t	LD Euro 5 - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
LDV Gasoline <3,5t	LD Euro 6	0	0	0	0	0	0	0	0	0	0	0	0	0
LDV Diesel <3,5 t	Conventional	51685	53074	54498	55957	55968	55919	55806	55624	54253	52849	51410	51212	50030
LDV Diesel <3,5 t	LD Euro 1 - 93/59/EEC	0	0	0	0	1486	3070	4757	6551	8287	10066	11889	12345	12536
LDV Diesel <3,5 t	LD Euro 2 - 96/69/EEC	0	0	0	0	0	0	0	0	1289	2610	3963	5487	6997
LDV Diesel <3,5 t	LD Euro 3 - 98/69/EC Stage2000	0	0	0	0	0	0	0	0	0	0	0	0	1307
LDV Diesel <3,5 t	LD Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
LDV Diesel <3,5 t	LD Euro 5 - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
LDV Diesel <3,5 t	LD Euro 6	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Gasoline >3,5 t	Conventional	6380	6487	6591	6841	7073	7408	7482	7444	7306	7034	7008	6925	6785
HDV Rigid <=7,5 t	Conventional	6093	6083	6069	6053	5878	5698	5515	5328	5033	4746	4466	4300	4058
HDV Rigid <=7,5 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	156	313	470	627	769	904	1033	1037	1017
HDV Rigid <=7,5 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	120	234	344	461	567
HDV Rigid <=7,5 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	106
HDV Rigid <=7,5 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid <=7,5 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid <=7,5 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 7,5 - 12 t	Conventional	2585	2611	2636	2662	2618	2571	2523	2472	2370	2269	2169	2123	2038
HDV Rigid 7,5 - 12 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	70	141	215	291	362	432	502	512	511
HDV Rigid 7,5 - 12 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	56	112	167	227	285
HDV Rigid 7,5 - 12 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	53
HDV Rigid 7,5 - 12 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 7,5 - 12 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 7,5 - 12 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 12 - 14 t	Conventional	855	859	862	865	846	826	805	784	746	710	674	655	624
HDV Rigid 12 - 14 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	22	45	69	92	114	135	156	158	156

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HDV Rigid 12 - 14 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	18	35	52	70	87
HDV Rigid 12 - 14 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	16
HDV Rigid 12 - 14 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 12 - 14 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 12 - 14 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 14 - 20 t	Conventional	2800	2809	2817	2824	2757	2689	2618	2545	2420	2298	2178	2113	2009
HDV Rigid 14 - 20 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	73	148	223	300	370	438	504	509	503
HDV Rigid 14 - 20 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	58	113	168	226	281
HDV Rigid 14 - 20 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	53
HDV Rigid 14 - 20 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 14 - 20 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 14 - 20 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 20 - 26 t	Conventional	2455	2456	2456	2455	2389	2322	2253	2182	2068	1955	1846	1783	1689
HDV Rigid 20 - 26 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	63	127	192	257	316	372	427	430	423
HDV Rigid 20 - 26 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	49	97	142	191	236
HDV Rigid 20 - 26 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	44
HDV Rigid 20 - 26 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 20 - 26 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 20 - 26 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 26 - 28 t	Conventional	369	378	386	394	393	391	388	385	374	363	351	348	339
HDV Rigid 26 - 28 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	10	21	33	45	57	69	81	84	85
HDV Rigid 26 - 28 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	9	18	27	37	47
HDV Rigid 26 - 28 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	9
HDV Rigid 26 - 28 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 26 - 28 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 26 - 28 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 28 - 32 t	Conventional	280	290	301	313	316	319	321	323	318	313	307	309	304
HDV Rigid 28 - 32 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	8	18	27	38	49	60	71	74	76
HDV Rigid 28 - 32 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	8	15	24	33	43
HDV Rigid 28 - 32 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	8
HDV Rigid 28 - 32 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid 28 - 32 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HDV Rigid 28 - 32 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid >32 t	Conventional	199	203	206	210	209	207	205	202	196	189	183	180	175
HDV Rigid >32 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	6	11	17	24	30	36	42	43	44
HDV Rigid >32 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	5	9	14	19	24
HDV Rigid >32 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	5
HDV Rigid >32 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid >32 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Rigid >32 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 14 - 20 t	Conventional	81	99	117	136	152	168	183	198	207	216	224	236	244
HDV Articulated 14 - 20 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	4	9	16	23	32	41	52	57	61
HDV Articulated 14 - 20 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	5	11	17	25	34
HDV Articulated 14 - 20 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	6
HDV Articulated 14 - 20 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 14 - 20 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 14 - 20 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 20 - 28 t	Conventional	274	279	283	288	285	282	278	275	265	256	246	243	235
HDV Articulated 20 - 28 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	8	15	24	32	40	49	57	58	59
HDV Articulated 20 - 28 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	6	13	19	26	33
HDV Articulated 20 - 28 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	6
HDV Articulated 20 - 28 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 20 - 28 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 20 - 28 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 28 - 34 t	Conventional	431	427	424	420	404	389	374	358	335	313	291	277	259
HDV Articulated 28 - 34 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	11	21	32	42	51	60	67	67	65
HDV Articulated 28 - 34 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	8	15	22	30	36
HDV Articulated 28 - 34 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	7
HDV Articulated 28 - 34 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 28 - 34 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 28 - 34 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 34 - 40 t	Conventional	2588	2566	2542	2516	2423	2329	2233	2137	1998	1863	1733	1648	1534
HDV Articulated 34 - 40 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	64	128	190	252	305	355	401	397	384
HDV Articulated 34 - 40 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	47	92	134	177	215

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HDV Articulated 34 - 40 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	40
HDV Articulated 34 - 40 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 34 - 40 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 34 - 40 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 40 - 50 t	Conventional	1953	1996	2041	2086	2078	2067	2054	2039	1980	1921	1861	1846	1796
HDV Articulated 40 - 50 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	55	113	175	240	302	366	430	445	450
HDV Articulated 40 - 50 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	47	95	143	198	251
HDV Articulated 40 - 50 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	47
HDV Articulated 40 - 50 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 40 - 50 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 40 - 50 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 50 - 60 t	Conventional	43	46	49	52	54	56	58	59	60	60	60	61	61
HDV Articulated 50 - 60 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	1	3	5	7	9	11	14	15	15
HDV Articulated 50 - 60 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	1	3	5	7	9
HDV Articulated 50 - 60 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	2
HDV Articulated 50 - 60 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 50 - 60 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
HDV Articulated 50 - 60 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Midi <=15 t	Conventional	563	667	774	979	1128	1336	1448	1466	1396	1309	1348	1366	1353
BUS Urban Midi <=15 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	30	73	122	170	210	244	304	319	315
BUS Urban Midi <=15 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	33	63	101	142	182
BUS Urban Midi <=15 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	36
BUS Urban Midi <=15 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Midi <=15 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Midi <=15 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Standard 15 - 18 t	Conventional	1126	1334	1549	1959	2256	2672	2897	2931	2792	2617	2696	2733	2706
BUS Urban Standard 15 - 18 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	60	146	245	341	419	488	607	639	631
BUS Urban Standard 15 - 18 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	65	126	202	284	365
BUS Urban Standard 15 - 18 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	73
BUS Urban Standard 15 - 18 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Standard 15 - 18 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Standard 15 - 18 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
BUS Urban Articulated >18 t	Conventional	188	222	258	326	376	445	483	489	465	436	449	455	451
BUS Urban Articulated >18 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	10	24	41	57	70	81	101	106	105
BUS Urban Articulated >18 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	11	21	34	47	61
BUS Urban Articulated >18 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	12
BUS Urban Articulated >18 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Articulated >18 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Articulated >18 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Coaches Standard <=18 t	Conventional	3574	4200	4838	6070	6934	8148	8763	8797	8313	7731	7901	7947	7808
BUS Coaches Standard <=18 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	184	445	740	1022	1248	1441	1780	1857	1819
BUS Coaches Standard <=18 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	194	374	593	825	1053
BUS Coaches Standard <=18 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	209
BUS Coaches Standard <=18 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Coaches Standard <=18 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Coaches Standard <=18 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Coaches Articulated >18 t	Conventional	36	42	49	61	70	82	89	89	84	78	80	80	79
BUS Coaches Articulated >18 t	HD Euro I - 91/542/EEC Stage I	0	0	0	0	2	4	7	10	13	15	18	19	18
BUS Coaches Articulated >18 t	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	2	4	6	8	11
BUS Coaches Articulated >18 t	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	2
BUS Coaches Articulated >18 t	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Coaches Articulated >18 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Coaches Articulated >18 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban CNG	HD Euro I - 91/542/EEC Stage I	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban CNG	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban CNG	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban CNG	EEV	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	Conventional	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro I - 91/542/EEC Stage I	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MOP 2-stroke <50 cm³	Conventional	276901	279077	281270	282137	282792	283963	284571	285901	286760	288690	281749	284031	282436
MOP 2-stroke <50 cm³	Mop - Euro I	0	0	0	0	0	0	0	0	0	0	0	0	3611
MOP 2-stroke <50 cm³	Mop - Euro II	0	0	0	0	0	0	0	0	0	0	0	0	0
MOP 2-stroke <50 cm³	Mop - Euro III	0	0	0	0	0	0	0	0	0	0	0	0	0
MOT 2-stroke >50 cm³	Conventional	44998	45124	45235	44769	44324	44027	43612	43043	42578	42053	40888	40344	39277
MOT 2-stroke >50 cm³	Mot - Euro I	0	0	0	0	0	0	0	0	0	0	0	0	502
MOT 2-stroke >50 cm³	Mot - Euro II	0	0	0	0	0	0	0	0	0	0	0	0	0
MOT 2-stroke >50 cm³	Mot - Euro III	0	0	0	0	0	0	0	0	0	0	0	0	0
MOT 4-stroke <250 cm³	Conventional	51709	52888	54089	54625	55203	55982	56632	57097	57712	58262	57919	58451	58220
MOT 4-stroke <250 cm³	Mot - Euro I	0	0	0	0	0	0	0	0	0	0	0	0	744
MOT 4-stroke <250 cm³	Mot - Euro II	0	0	0	0	0	0	0	0	0	0	0	0	0
MOT 4-stroke <250 cm³	Mot - Euro III	0	0	0	0	0	0	0	0	0	0	0	0	0
MOT 4-stroke 250 - 750 cm³	Conventional	86181	88146	90149	91042	92005	93304	94387	95161	96186	97103	96532	97418	97033
MOT 4-stroke 250 - 750 cm³	Mot - Euro I	0	0	0	0	0	0	0	0	0	0	0	0	1241
MOT 4-stroke 250 - 750 cm³	Mot - Euro II	0	0	0	0	0	0	0	0	0	0	0	0	0
MOT 4-stroke 250 - 750 cm³	Mot - Euro III	0	0	0	0	0	0	0	0	0	0	0	0	0
MOT 4-stroke >750 cm³	Conventional	34472	35258	36060	36417	36802	37322	37755	38064	38474	38841	38613	38967	38813
MOT 4-stroke >750 cm³	Mot - Euro I	0	0	0	0	0	0	0	0	0	0	0	0	496
MOT 4-stroke >750 cm³	Mot - Euro II	0	0	0	0	0	0	0	0	0	0	0	0	0
MOT 4-stroke >750 cm³	Mot - Euro III	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 294 Vehicle fleet data for Road transport (number of vehicles) 2000-2014

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PC Gasoline 0,8 - 1,4 l	PRE ECE	258166	238539	230425	221872	208673	115492	115689	112599	102584	91061	81109	73360	66100	58816
PC Gasoline 0,8 - 1,4 l	ECE 15/00-01	70477	66646	65326	63165	58889	31780	28474	23238	15780	7830	0	0	0	0
PC Gasoline 0,8 - 1,4 l	ECE 15/02	139893	125213	114386	100700	82292	36320	35922	33915	29275	23824	18517	13458	8251	2954
PC Gasoline 0,8 - 1,4 l	ECE 15/03	196955	203461	189649	171772	146561	69614	73163	74391	70453	64641	59115	54461	49507	41362
PC Gasoline 0,8 - 1,4 l	ECE 15/04	169874	190108	221111	255035	286051	177003	194561	207718	207509	201902	197041	195182	192527	186128
PC Gasoline 0,8 - 1,4 l	Improved Conventional	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 0,8 - 1,4 l	Open Loop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 0,8 - 1,4 l	PC Euro 1 - 91/441/EEC	133610	151825	178878	208614	236235	156619	187098	216318	233300	244401	245647	224166	201408	185477
PC Gasoline 0,8 - 1,4 l	PC Euro 2 - 94/12/EEC	76050	91655	113129	137010	160076	108957	133119	156926	172139	183041	194433	208901	222824	245565
PC Gasoline 0,8 - 1,4 l	PC Euro 3 - 98/69/EC Stage2000	26470	41017	59065	79481	100290	72401	92668	113443	128391	140163	152270	166808	180967	178078
PC Gasoline 0,8 - 1,4 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	12043	14904	25038	36327	46253	55084	63998	73960	83820	92251
PC Gasoline 0,8 - 1,4 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	5541	11037	16740	22486	24986
PC Gasoline 0,8 - 1,4 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 1,4 - 2,0 l	PRE ECE	113966	105305	101727	97954	92107	50998	51072	49732	45325	40185	35817	32396	29191	25975
PC Gasoline 1,4 - 2,0 l	ECE 15/00-01	31112	29421	28840	27886	25993	14033	12570	10264	6972	3456	0	0	0	0
PC Gasoline 1,4 - 2,0 l	ECE 15/02	61755	55277	50498	44458	36323	16038	15858	14979	12935	10514	8177	5943	3644	1305
PC Gasoline 1,4 - 2,0 l	ECE 15/03	86945	89820	83725	75835	64691	30740	32298	32857	31129	28526	26105	24050	21863	18267
PC Gasoline 1,4 - 2,0 l	ECE 15/04	74990	83925	97615	112595	126262	78161	85890	91744	91685	89099	87011	86193	85024	82201
PC Gasoline 1,4 - 2,0 l	Improved Conventional	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 1,4 - 2,0 l	Open Loop	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	58981	67025	78970	92101	104273	69160	82596	95542	103080	107854	108475	98993	88945	81913
PC Gasoline 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	33572	40462	49944	60488	70657	48113	58766	69311	76057	80776	85860	92252	98403	108450
PC Gasoline 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	11685	18107	26075	35090	44268	31971	40909	50105	56727	61854	67241	73663	79919	78645
PC Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	5316	6581	11053	16045	20436	24309	28261	32661	37017	40741
PC Gasoline 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	2445	4874	7393	9930	11034
PC Gasoline 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Gasoline >2,0 l	PRE ECE	84286	77876	75225	72431	67874	37729	37882	36950	33320	29703	26473	23943	21573	19195
PC Gasoline >2,0 l	ECE 15/00-01	23009	21758	21326	20620	19154	10382	9324	7626	5125	2554	0	0	0	0
PC Gasoline >2,0 l	ECE 15/02	45672	40878	37343	32874	26767	11865	11763	11129	9509	7771	6044	4392	2693	964
PC Gasoline >2,0 l	ECE 15/03	64302	66424	61913	56075	47671	22741	23957	24411	22884	21085	19295	17775	16158	13499

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PC Gasoline >2,0 l	ECE 15/04	55460	62065	72184	83257	93042	57824	63709	68163	67401	65858	64312	63704	62836	60746
PC Gasoline >2,0 l	PC Euro 1 - 91/441/EEC	43621	49566	58397	68103	76839	51165	61265	70985	75778	79720	80177	73164	65734	60533
PC Gasoline >2,0 l	PC Euro 2 - 94/12/EEC	24829	29923	36932	44727	52067	35594	43590	51496	55912	59705	63461	68182	72724	80144
PC Gasoline >2,0 l	PC Euro 3 - 98/69/EC Stage2000	8642	13391	19282	25947	32621	23652	30344	37227	41702	45719	49700	54443	59063	58118
PC Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	3917	4869	8199	11921	15023	17968	20888	24139	27357	30108
PC Gasoline >2,0 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	1807	3602	5464	7339	8154
PC Gasoline >2,0 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Diesel 1,4 - 2,0 l	Conventional	37995	39806	40964	41709	41940	63715	85492	103264	110202	113395	115460	122365	127645	130563
PC Diesel 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	6077	7335	8926	10709	12662	23196	35719	49435	60409	71196	79718	81525	81257	83718
PC Diesel 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	3459	4428	5645	7033	8580	16137	25414	35862	44572	53321	63098	75974	89898	110840
PC Diesel 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	1204	1982	2947	4080	5376	10723	17691	25925	33245	40831	49415	60665	73011	80379
PC Diesel 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	646	2207	4780	8302	11976	16046	20769	26898	33817	41639
PC Diesel 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	1614	3582	6088	9072	11278
PC Diesel 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC Diesel >2,0 l	Conventional	64233	65786	66189	65898	64017	96855	127803	149658	155527	156097	156339	162131	165505	165674
PC Diesel >2,0 l	PC Euro 1 - 91/441/EEC	10274	12122	14423	16919	19327	35261	53397	71645	85254	98007	107943	108019	105359	106232
PC Diesel >2,0 l	PC Euro 2 - 94/12/EEC	5848	7318	9122	11112	13096	24530	37992	51975	62904	73401	85439	100664	116562	140648
PC Diesel >2,0 l	PC Euro 3 - 98/69/EC Stage2000	2035	3275	4762	6446	8205	16300	26447	37573	46918	56207	66911	80380	94666	101995
PC Diesel >2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	985	3355	7146	12032	16902	22089	28122	35639	43848	52837
PC Diesel >2,0 l	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	2222	4850	8067	11762	14311
PC Diesel >2,0 l	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC LPG	Conventional	47000	53775	59116	56540	53258	49185	46410	43491	40552	37384	34911	37943	40279	46963
PC LPG	PC Euro 1 - 91/441/EEC	7517	9909	12882	14516	16079	17906	19390	20820	22229	23472	24104	25279	25641	30113
PC LPG	PC Euro 2 - 94/12/EEC	4279	5982	8147	9534	10895	12457	13796	15104	16402	17579	19079	23558	28367	39869
PC LPG	PC Euro 3 - 98/69/EC Stage2000	1489	2677	4253	5531	6826	8277	9604	10919	12233	13461	14941	18811	23039	28912
PC LPG	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	820	1704	2595	3496	4407	5290	6280	8341	10671	14978
PC LPG	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	532	1083	1888	2863	4057
PC LPG	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC CNG	PC Euro 4 - 98/69/EC Stage2005	0	0	0	266	532	797	1067	1337	1605	1858	3718	6354	8934	12046
PC CNG	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	10	41	105	200	304
PC CNG	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PC 2-Stroke	Conventional	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PC Hybrid Gasoline <1,4 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	3	29	68	186	303	507
PC Hybrid Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	2	13	30	82	134	224
PC Hybrid Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	1	9	22	61	99	166
LDV Gasoline <3,5t	Conventional	158070	158721	161324	162935	160845	52019	44691	38302	33936	30729	27232	22257	17240	11724
LDV Gasoline <3,5t	LD Euro 1 - 93/59/EEC	41252	43232	45969	48697	50567	17258	16569	16994	16568	15291	13380	15167	17730	20775
LDV Gasoline <3,5t	LD Euro 2 - 96/69/EEC	27757	29226	30841	32420	33402	11309	12145	12992	13719	13285	12911	12444	12270	12757
LDV Gasoline <3,5t	LD Euro 3 - 98/69/EC Stage2000	8643	13651	19445	25869	32388	12957	13166	12753	11694	12862	13617	14405	14597	14224
LDV Gasoline <3,5t	LD Euro 4 - 98/69/EC Stage2005	0	0	0	0	8062	5529	9051	9904	9051	7681	7133	8014	8811	8297
LDV Gasoline <3,5t	LD Euro 5 - 2008 Standards	0	0	0	0	0	0	0	3301	6034	7944	9228	9853	11441	12969
LDV Gasoline <3,5t	LD Euro 6	0	0	0	0	0	0	0	0	0	0	0	0	0	1859
LDV Diesel <3,5 t	Conventional	48779	48402	47993	47472	45458	64419	72921	77175	78023	79164	79087	70917	59041	43028
LDV Diesel <3,5 t	LD Euro 1 - 93/59/EEC	12730	13184	13676	14188	14291	21372	27036	34242	38092	39392	38858	48325	60720	76246
LDV Diesel <3,5 t	LD Euro 2 - 96/69/EEC	8566	8912	9175	9446	9440	14005	19816	26178	31541	34225	37496	39648	42021	46818
LDV Diesel <3,5 t	LD Euro 3 - 98/69/EC Stage2000	2667	4163	5785	7537	9153	16046	21482	25696	26885	33135	39544	45899	49991	52204
LDV Diesel <3,5 t	LD Euro 4 - 98/69/EC Stage2005	0	0	0	0	2279	6847	14769	19956	20810	19788	20715	25533	30174	30452
LDV Diesel <3,5 t	LD Euro 5 - 2008 Standards	0	0	0	0	0	0	0	6652	13873	20465	26801	31395	39183	47597
LDV Diesel <3,5 t	LD Euro 6	0	0	0	0	0	0	0	0	0	0	0	0	0	6824
HDV Gasoline >3,5 t	Conventional	6695	6585	6540	6449	5822	2022	1951	1923	1857	887	1128	990	869	754
HDV Rigid <=7,5 t	Conventional	3818	3653	3489	3322	3200	4070	4360	4489	4358	4492	4087	3487	2757	1904
HDV Rigid <=7,5 t	HD Euro I - 91/542/EEC Stage I	996	995	994	993	1006	1350	1616	1992	2127	2235	2008	2376	2836	3375
HDV Rigid <=7,5 t	HD Euro II - 91/542/EEC Stage II	670	673	667	661	665	885	1185	1523	1762	1942	1938	1950	1963	2072
HDV Rigid <=7,5 t	HD Euro III - 2000 Standards	209	314	421	527	644	1014	1284	1495	1502	1880	2043	2257	2335	2311
HDV Rigid <=7,5 t	HD Euro IV - 2005 Standards	0	0	0	0	160	433	883	1161	1162	1123	1070	1256	1409	1348
HDV Rigid <=7,5 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	387	775	1161	1385	1544	1830	2107
HDV Rigid <=7,5 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	302
HDV Rigid 7,5 - 12 t	Conventional	1952	1902	1853	1800	1696	2383	2581	2720	2650	2733	2633	2316	1891	1352
HDV Rigid 7,5 - 12 t	HD Euro I - 91/542/EEC Stage I	509	518	528	538	533	790	957	1207	1294	1360	1294	1578	1945	2396
HDV Rigid 7,5 - 12 t	HD Euro II - 91/542/EEC Stage II	343	350	354	358	352	518	701	922	1071	1181	1248	1295	1346	1471
HDV Rigid 7,5 - 12 t	HD Euro III - 2000 Standards	107	164	223	286	342	593	760	905	913	1144	1317	1499	1602	1640
HDV Rigid 7,5 - 12 t	HD Euro IV - 2005 Standards	0	0	0	0	85	253	523	703	707	683	690	834	967	957
HDV Rigid 7,5 - 12 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	234	471	706	892	1025	1255	1495
HDV Rigid 7,5 - 12 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	214

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
HDV Rigid 12 - 14 t	Conventional	593	573	554	533	498	695	742	773	761	758	728	634	511	361
HDV Rigid 12 - 14 t	HD Euro I - 91/542/EEC Stage I	155	156	158	159	156	230	275	343	371	377	358	432	526	640
HDV Rigid 12 - 14 t	HD Euro II - 91/542/EEC Stage II	104	106	106	106	103	151	202	262	308	328	345	354	364	393
HDV Rigid 12 - 14 t	HD Euro III - 2000 Standards	32	49	67	85	100	173	219	257	262	317	364	410	433	438
HDV Rigid 12 - 14 t	HD Euro IV - 2005 Standards	0	0	0	0	25	74	150	200	203	189	191	228	261	255
HDV Rigid 12 - 14 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	67	135	196	247	280	339	399
HDV Rigid 12 - 14 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	57
HDV Rigid 14 - 20 t	Conventional	1907	1840	1774	1705	1580	2191	2400	2464	2408	2365	2290	1986	1598	1125
HDV Rigid 14 - 20 t	HD Euro I - 91/542/EEC Stage I	498	501	506	510	497	727	890	1093	1175	1177	1125	1354	1644	1993
HDV Rigid 14 - 20 t	HD Euro II - 91/542/EEC Stage II	335	339	339	339	328	476	652	836	973	1023	1086	1110	1137	1224
HDV Rigid 14 - 20 t	HD Euro III - 2000 Standards	104	158	214	271	318	546	707	820	830	990	1145	1286	1353	1364
HDV Rigid 14 - 20 t	HD Euro IV - 2005 Standards	0	0	0	0	79	233	486	637	642	591	600	715	817	796
HDV Rigid 14 - 20 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	212	428	611	776	879	1061	1244
HDV Rigid 14 - 20 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	178
HDV Rigid 20 - 26 t	Conventional	1595	1532	1469	1405	1279	1793	1989	1957	1895	1886	1799	1547	1234	860
HDV Rigid 20 - 26 t	HD Euro I - 91/542/EEC Stage I	416	417	419	420	402	595	737	868	925	938	884	1054	1269	1524
HDV Rigid 20 - 26 t	HD Euro II - 91/542/EEC Stage II	280	282	281	280	266	390	540	664	766	815	853	865	878	936
HDV Rigid 20 - 26 t	HD Euro III - 2000 Standards	87	132	177	223	258	447	586	652	653	789	900	1001	1045	1043
HDV Rigid 20 - 26 t	HD Euro IV - 2005 Standards	0	0	0	0	64	191	403	506	505	471	471	557	631	608
HDV Rigid 20 - 26 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	169	337	487	610	685	819	951
HDV Rigid 20 - 26 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	136
HDV Rigid 26 - 28 t	Conventional	329	325	321	316	293	428	493	512	512	502	512	457	379	275
HDV Rigid 26 - 28 t	HD Euro I - 91/542/EEC Stage I	86	89	91	94	92	142	183	227	250	250	251	312	390	488
HDV Rigid 26 - 28 t	HD Euro II - 91/542/EEC Stage II	58	60	61	63	61	93	134	174	207	217	243	256	270	299
HDV Rigid 26 - 28 t	HD Euro III - 2000 Standards	18	28	39	50	59	107	145	170	177	210	256	296	321	334
HDV Rigid 26 - 28 t	HD Euro IV - 2005 Standards	0	0	0	0	15	45	100	132	137	125	134	165	194	195
HDV Rigid 26 - 28 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	44	91	130	173	202	252	304
HDV Rigid 26 - 28 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	44
HDV Rigid 28 - 32 t	Conventional	299	299	299	299	284	409	483	504	506	516	524	473	396	291
HDV Rigid 28 - 32 t	HD Euro I - 91/542/EEC Stage I	78	82	85	89	89	136	179	224	247	257	257	322	408	515
HDV Rigid 28 - 32 t	HD Euro II - 91/542/EEC Stage II	53	55	57	59	59	89	131	171	205	223	248	264	282	316
HDV Rigid 28 - 32 t	HD Euro III - 2000 Standards	16	26	36	47	57	102	142	168	174	216	262	306	336	353

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
HDV Rigid 28 - 32 t	HD Euro IV - 2005 Standards	0	0	0	0	14	43	98	130	135	129	137	170	203	206
HDV Rigid 28 - 32 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	43	90	133	178	209	263	322
HDV Rigid 28 - 32 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	46
HDV Rigid >32 t	Conventional	169	167	164	161	150	216	243	258	254	252	254	226	187	135
HDV Rigid >32 t	HD Euro I - 91/542/EEC Stage I	44	45	47	48	47	72	90	115	124	125	125	154	192	239
HDV Rigid >32 t	HD Euro II - 91/542/EEC Stage II	30	31	31	32	31	47	66	88	103	109	120	126	133	147
HDV Rigid >32 t	HD Euro III - 2000 Standards	9	14	20	26	30	54	72	86	88	105	127	146	158	164
HDV Rigid >32 t	HD Euro IV - 2005 Standards	0	0	0	0	8	23	49	67	68	63	66	81	95	96
HDV Rigid >32 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	22	45	65	86	100	124	149
HDV Rigid >32 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	21
HDV Articulated 14 - 20 t	Conventional	250	260	270	279	282	403	460	555	560	563	594	549	470	352
HDV Articulated 14 - 20 t	HD Euro I - 91/542/EEC Stage I	65	71	77	83	89	134	170	246	274	280	292	374	484	624
HDV Articulated 14 - 20 t	HD Euro II - 91/542/EEC Stage II	44	48	52	55	58	88	125	188	226	243	282	307	335	383
HDV Articulated 14 - 20 t	HD Euro III - 2000 Standards	14	22	33	44	57	100	135	185	193	236	297	355	398	427
HDV Articulated 14 - 20 t	HD Euro IV - 2005 Standards	0	0	0	0	14	43	93	143	149	141	156	198	240	249
HDV Articulated 14 - 20 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	48	100	146	201	243	312	389
HDV Articulated 14 - 20 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	56
HDV Articulated 20 - 28 t	Conventional	226	222	218	214	204	278	322	339	329	336	332	294	243	175
HDV Articulated 20 - 28 t	HD Euro I - 91/542/EEC Stage I	59	61	62	64	64	92	120	151	161	167	163	201	250	310
HDV Articulated 20 - 28 t	HD Euro II - 91/542/EEC Stage II	40	41	42	43	42	60	88	115	133	145	157	165	173	191
HDV Articulated 20 - 28 t	HD Euro III - 2000 Standards	12	19	26	34	41	69	95	113	113	141	166	191	206	212
HDV Articulated 20 - 28 t	HD Euro IV - 2005 Standards	0	0	0	0	10	30	65	88	88	84	87	106	124	124
HDV Articulated 20 - 28 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	29	59	87	112	130	161	194
HDV Articulated 20 - 28 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	28
HDV Articulated 28 - 34 t	Conventional	240	227	214	200	180	238	270	251	230	233	209	172	131	86
HDV Articulated 28 - 34 t	HD Euro I - 91/542/EEC Stage I	63	62	61	60	57	79	100	111	112	116	103	117	135	153
HDV Articulated 28 - 34 t	HD Euro II - 91/542/EEC Stage II	42	42	41	40	37	52	73	85	93	101	99	96	93	94
HDV Articulated 28 - 34 t	HD Euro III - 2000 Standards	13	20	26	32	36	59	79	84	79	97	104	111	111	105
HDV Articulated 28 - 34 t	HD Euro IV - 2005 Standards	0	0	0	0	9	25	55	65	61	58	55	62	67	61
HDV Articulated 28 - 34 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	22	41	60	71	76	87	95
HDV Articulated 28 - 34 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	14
HDV Articulated 34 - 40 t	Conventional	1423	1341	1259	1177	1021	1414	1617	1493	1336	1289	1197	980	739	483

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
HDV Articulated 34 - 40 t	HD Euro I - 91/542/EEC Stage I	371	365	359	352	321	469	600	663	652	641	588	668	760	856
HDV Articulated 34 - 40 t	HD Euro II - 91/542/EEC Stage II	250	247	241	234	212	308	439	507	540	557	567	548	526	525
HDV Articulated 34 - 40 t	HD Euro III - 2000 Standards	78	115	152	187	206	352	476	497	460	539	598	634	625	586
HDV Articulated 34 - 40 t	HD Euro IV - 2005 Standards	0	0	0	0	51	150	328	386	356	322	314	353	378	342
HDV Articulated 34 - 40 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	129	238	333	406	434	490	534
HDV Articulated 34 - 40 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	77
HDV Articulated 40 - 50 t	Conventional	1744	1724	1702	1677	1596	2239	2526	2722	2817	2632	2720	2430	2016	1463
HDV Articulated 40 - 50 t	HD Euro I - 91/542/EEC Stage I	455	469	485	501	502	743	936	1208	1375	1310	1336	1656	2073	2593
HDV Articulated 40 - 50 t	HD Euro II - 91/542/EEC Stage II	306	317	325	334	331	487	686	923	1139	1138	1290	1359	1435	1592
HDV Articulated 40 - 50 t	HD Euro III - 2000 Standards	95	148	205	266	321	558	744	906	971	1102	1360	1573	1707	1776
HDV Articulated 40 - 50 t	HD Euro IV - 2005 Standards	0	0	0	0	80	238	512	704	751	658	712	875	1030	1036
HDV Articulated 40 - 50 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	235	501	680	922	1076	1338	1619
HDV Articulated 40 - 50 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	232
HDV Articulated 50 - 60 t	Conventional	61	62	63	63	62	88	105	112	116	117	120	110	93	69
HDV Articulated 50 - 60 t	HD Euro I - 91/542/EEC Stage I	16	17	18	19	19	29	39	50	56	58	59	75	96	122
HDV Articulated 50 - 60 t	HD Euro II - 91/542/EEC Stage II	11	11	12	13	13	19	28	38	47	51	57	61	66	75
HDV Articulated 50 - 60 t	HD Euro III - 2000 Standards	3	5	8	10	12	22	31	37	40	49	60	71	79	84
HDV Articulated 50 - 60 t	HD Euro IV - 2005 Standards	0	0	0	0	3	9	21	29	31	29	32	40	48	49
HDV Articulated 50 - 60 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	10	21	30	41	49	62	76
HDV Articulated 50 - 60 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	11
BUS Urban Midi <=15 t	Conventional	1354	1358	1381	815	865	1038	1026	1028	984	921	848	702	553	377
BUS Urban Midi <=15 t	HD Euro I - 91/542/EEC Stage I	314	314	318	187	198	236	276	327	354	354	329	416	527	653
BUS Urban Midi <=15 t	HD Euro II - 91/542/EEC Stage II	228	238	242	143	151	181	220	243	272	280	300	307	313	351
BUS Urban Midi <=15 t	HD Euro III - 2000 Standards	76	118	168	129	173	254	285	307	295	338	366	392	403	380
BUS Urban Midi <=15 t	HD Euro IV - 2005 Standards	0	0	0	0	46	115	200	263	260	217	207	257	297	295
BUS Urban Midi <=15 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	88	173	225	238	212	226	290
BUS Urban Midi <=15 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	23
BUS Urban Standard 15 - 18 t	Conventional	2708	2716	2763	1631	1731	2075	2051	2055	1968	1842	1697	1404	1105	754
BUS Urban Standard 15 - 18 t	HD Euro I - 91/542/EEC Stage I	629	628	637	374	395	472	551	653	708	708	658	831	1053	1306
BUS Urban Standard 15 - 18 t	HD Euro II - 91/542/EEC Stage II	456	476	484	286	303	363	440	485	544	561	599	615	626	702
BUS Urban Standard 15 - 18 t	HD Euro III - 2000 Standards	151	237	335	259	345	508	570	615	590	677	733	784	806	760
BUS Urban Standard 15 - 18 t	HD Euro IV - 2005 Standards	0	0	0	0	91	230	401	525	520	434	414	514	595	590

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
BUS Urban Standard 15 - 18 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	175	347	450	476	423	452	579
BUS Urban Standard 15 - 18 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	46
BUS Urban Articulated >18 t	Conventional	451	453	460	272	288	346	342	343	328	307	283	234	184	126
BUS Urban Articulated >18 t	HD Euro I - 91/542/EEC Stage I	105	105	106	62	66	79	92	109	118	118	110	139	176	218
BUS Urban Articulated >18 t	HD Euro II - 91/542/EEC Stage II	76	79	81	48	50	60	73	81	91	93	100	102	104	117
BUS Urban Articulated >18 t	HD Euro III - 2000 Standards	25	39	56	43	58	85	95	102	98	113	122	131	134	127
BUS Urban Articulated >18 t	HD Euro IV - 2005 Standards	0	0	0	0	15	38	67	88	87	72	69	86	99	98
BUS Urban Articulated >18 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	29	58	75	79	71	75	97
BUS Urban Articulated >18 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	8
BUS Coaches Standard <=18 t	Conventional	7752	7714	7786	4560	4741	5662	5761	5644	5247	4868	4495	3690	2883	1951
BUS Coaches Standard <=18 t	HD Euro I - 91/542/EEC Stage I	1800	1785	1794	1046	1083	1286	1548	1795	1888	1871	1743	2185	2747	3381
BUS Coaches Standard <=18 t	HD Euro II - 91/542/EEC Stage II	1305	1353	1365	798	829	989	1235	1332	1451	1482	1587	1616	1633	1817
BUS Coaches Standard <=18 t	HD Euro III - 2000 Standards	433	673	945	724	946	1385	1601	1688	1573	1789	1940	2061	2102	1968
BUS Coaches Standard <=18 t	HD Euro IV - 2005 Standards	0	0	0	0	250	627	1125	1443	1387	1148	1097	1350	1552	1527
BUS Coaches Standard <=18 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	481	924	1190	1260	1113	1180	1500
BUS Coaches Standard <=18 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	120
BUS Coaches Articulated >18 t	Conventional	78	78	79	46	48	57	58	57	53	49	45	37	29	20
BUS Coaches Articulated >18 t	HD Euro I - 91/542/EEC Stage I	18	18	18	11	11	13	16	18	19	19	18	22	28	34
BUS Coaches Articulated >18 t	HD Euro II - 91/542/EEC Stage II	13	14	14	8	8	10	12	13	15	15	16	16	16	18
BUS Coaches Articulated >18 t	HD Euro III - 2000 Standards	4	7	10	7	10	14	16	17	16	18	20	21	21	20
BUS Coaches Articulated >18 t	HD Euro IV - 2005 Standards	0	0	0	0	3	6	11	15	14	12	11	14	16	15
BUS Coaches Articulated >18 t	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	5	9	12	13	11	12	15
BUS Coaches Articulated >18 t	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BUS Urban CNG	HD Euro I - 91/542/EEC Stage I	0	0	0	22	42	59	73	84	97	108	127	140	153	173
BUS Urban CNG	HD Euro II - 91/542/EEC Stage II	0	0	0	3	6	8	12	15	20	24	32	38	44	59
BUS Urban CNG	HD Euro III - 2000 Standards	0	0	0	3	7	12	16	19	21	29	40	49	57	64
BUS Urban CNG	EEV	0	0	0	0	2	5	11	22	31	38	48	59	74	102
BUS Urban Biodiesel	Conventional	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro I - 91/542/EEC Stage I	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro IV - 2005 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
BUS Urban Biodiesel	HD Euro V - 2008 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	HD Euro VI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOP 2-stroke <50 cm³	Conventional	280919	279343	273219	40334	42519	27593	30636	33607	35465	36394	36590	37137	37472	38351
MOP 2-stroke <50 cm³	Mop - Euro I	7371	11288	15125	2870	3736	2913	3703	4261	4199	5043	6227	7235	7393	7202
MOP 2-stroke <50 cm³	Mop - Euro II	0	0	4883	1483	2412	2150	3037	4426	4560	4250	4562	5733	7059	7374
MOP 2-stroke <50 cm³	Mop - Euro III	0	0	0	0	0	716	2024	4507	7042	9296	10639	11735	13555	16056
MOT 2-stroke >50 cm³	Conventional	38249	37283	35838	13084	12775	5363	5819	6256	6178	6403	6183	6070	5966	6028
MOT 2-stroke >50 cm³	Mot - Euro I	1004	1507	1984	931	1123	566	703	793	731	887	1052	1182	1177	1132
MOT 2-stroke >50 cm³	Mot - Euro II	0	0	641	481	725	418	577	824	794	748	771	937	1124	1159
MOT 2-stroke >50 cm³	Mot - Euro III	0	0	0	0	0	139	384	839	1227	1635	1798	1918	2158	2524
MOT 4-stroke <250 cm³	Conventional	58028	57912	57018	21330	21789	9027	10133	11073	11914	12057	12109	12227	12371	12874
MOT 4-stroke <250 cm³	Mot - Euro I	1523	2340	3156	1518	1914	953	1225	1404	1411	1671	2061	2382	2441	2418
MOT 4-stroke <250 cm³	Mot - Euro II	0	0	1019	784	1236	703	1004	1458	1532	1408	1510	1888	2330	2475
MOT 4-stroke <250 cm³	Mot - Euro III	0	0	0	0	0	234	669	1485	2366	3080	3521	3863	4475	5390
MOT 4-stroke 250 - 750 cm³	Conventional	96714	96520	95030	35550	36314	15044	16888	18455	19856	20096	20181	20378	20618	21457
MOT 4-stroke 250 - 750 cm³	Mot - Euro I	2538	3900	5261	2530	3191	1588	2041	2340	2351	2785	3435	3970	4068	4030
MOT 4-stroke 250 - 750 cm³	Mot - Euro II	0	0	1699	1307	2060	1172	1674	2430	2553	2347	2516	3146	3884	4126
MOT 4-stroke 250 - 750 cm³	Mot - Euro III	0	0	0	0	0	391	1116	2475	3943	5133	5868	6439	7458	8983
MOT 4-stroke >750 cm³	Conventional	38686	38608	38012	14220	14526	6018	6755	7382	7942	8038	8072	8151	8247	8583
MOT 4-stroke >750 cm³	Mot - Euro I	1015	1560	2104	1012	1276	635	817	936	940	1114	1374	1588	1627	1612
MOT 4-stroke >750 cm³	Mot - Euro II	0	0	679	523	824	469	670	972	1021	939	1007	1258	1554	1650
MOT 4-stroke >750 cm³	Mot - Euro III	0	0	0	0	0	156	446	990	1577	2053	2347	2576	2983	3593

Table 295 Mileage data for Road transport (average km/year/vehicle) 1988-2000

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PC Gasoline 0,8 - 1,4 l	PRE ECE	9668	10326	9036	4187	4925	5380	5132	5384	4405	2817	3526	3269	2540
PC Gasoline 0,8 - 1,4 l	ECE 15/00-01	11646	12439	10886	5044	5932	6481	6182	6486	5306	3393	4247	3938	3060
PC Gasoline 0,8 - 1,4 l	ECE 15/02	11794	12596	11023	5108	6008	6563	6260	6568	5373	3436	4301	3988	3099
PC Gasoline 0,8 - 1,4 l	ECE 15/03	13897	14843	12989	6019	7079	7733	7377	7739	6332	4049	5068	4699	3651
PC Gasoline 0,8 - 1,4 l	ECE 15/04	18669	19940	17450	8086	9510	10389	9910	10397	8506	5440	6809	6312	4905
PC Gasoline 0,8 - 1,4 l	Improved Conventional	15336	16380	14335	6643	7812	8534	8141	8541	6987	4469	5593	5185	4029

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PC Gasoline 0,8 - 1,4 l	Open Loop	16636	17768	15550	7206	8475	9258	8831	9265	7580	4847	6067	5625	4371
PC Gasoline 0,8 - 1,4 l	PC Euro 1 - 91/441/EEC	22475	24004	21008	9734	11448	12506	11930	12516	10240	6549	8196	7599	5905
PC Gasoline 0,8 - 1,4 l	PC Euro 2 - 94/12/EEC	26042	27814	24342	11279	13266	14491	13823	14503	11865	7588	9497	8805	6842
PC Gasoline 0,8 - 1,4 l	PC Euro 3 - 98/69/EC Stage2000	30049	32094	28087	13015	15307	16721	15950	16735	13691	8755	10959	10160	7895
PC Gasoline 0,8 - 1,4 l	PC Euro 4 - 98/69/EC Stage2005	31832	33997	29754	13787	16215	17713	16897	17727	14503	9275	11609	10763	8363
PC Gasoline 0,8 - 1,4 l	PC Euro 5 - EC 715/2007	35619	38042	33293	15428	18144	19821	18907	19837	16228	10378	12990	12043	9358
PC Gasoline 0,8 - 1,4 l	PC Euro 6 - EC 715/2007	35619	38042	33293	15428	18144	19821	18907	19837	16228	10378	12990	12043	9358
PC Gasoline 1,4 - 2,0 l	PRE ECE	10362	11067	9685	4488	5278	5766	5500	5771	4721	3019	3779	3504	2723
PC Gasoline 1,4 - 2,0 l	ECE 15/00-01	12405	13249	11595	5373	6319	6903	6585	6909	5652	3615	4524	4194	3259
PC Gasoline 1,4 - 2,0 l	ECE 15/02	13015	13900	12165	5637	6630	7242	6908	7248	5930	3792	4746	4401	3420
PC Gasoline 1,4 - 2,0 l	ECE 15/03	14919	15934	13944	6462	7599	8302	7919	8308	6797	4347	5441	5044	3920
PC Gasoline 1,4 - 2,0 l	ECE 15/04	20062	21427	18753	8690	10220	11164	10649	11173	9141	5846	7317	6783	5271
PC Gasoline 1,4 - 2,0 l	Improved Conventional	15336	16380	14335	6643	7812	8534	8141	8541	6987	4469	5593	5185	4029
PC Gasoline 1,4 - 2,0 l	Open Loop	18883	20168	17650	8179	9619	10508	10024	10516	8603	5502	6887	6385	4961
PC Gasoline 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	24829	26518	23208	10754	12647	13816	13179	13827	11312	7234	9055	8395	6523
PC Gasoline 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	27998	29903	26170	12127	14262	15580	14862	15592	12756	8158	10211	9467	7356
PC Gasoline 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	32306	34504	30197	13993	16456	17977	17148	17992	14719	9413	11782	10923	8488
PC Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	35857	38297	33516	15532	18265	19953	19033	19969	16337	10448	13077	12124	9421
PC Gasoline 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	39596	42290	37011	17151	20170	22034	21018	22051	18040	11537	14440	13388	10403
PC Gasoline 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	39596	42290	37011	17151	20170	22034	21018	22051	18040	11537	14440	13388	10403
PC Gasoline >2,0 l	PRE ECE	10897	11639	10185	4720	5551	6064	5784	6069	4965	3175	3974	3684	2863
PC Gasoline >2,0 l	ECE 15/00-01	13037	13924	12186	5647	6641	7255	6920	7261	5940	3799	4754	4408	3425
PC Gasoline >2,0 l	ECE 15/02	13263	14166	12397	5745	6756	7380	7040	7386	6043	3865	4837	4484	3485
PC Gasoline >2,0 l	ECE 15/03	15732	16803	14705	6814	8014	8754	8351	8761	7168	4584	5737	5319	4133
PC Gasoline >2,0 l	ECE 15/04	20872	22292	19510	9040	10632	11614	11079	11624	9509	6081	7612	7057	5484
PC Gasoline >2,0 l	PC Euro 1 - 91/441/EEC	25436	27167	23776	11017	12957	14154	13502	14166	11589	7411	9276	8600	6683
PC Gasoline >2,0 l	PC Euro 2 - 94/12/EEC	29883	31917	27933	12943	15222	16629	15863	16643	13615	8707	10898	10104	7852
PC Gasoline >2,0 l	PC Euro 3 - 98/69/EC Stage2000	33269	35533	31097	14410	16947	18513	17660	18528	15158	9694	12133	11249	8741
PC Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	37401	39946	34960	16201	19052	20813	19853	20829	17040	10898	13640	12646	9827
PC Gasoline >2,0 l	PC Euro 5 - EC 715/2007	41318	44129	38620	17897	21047	22992	21932	23010	18825	12039	15068	13970	10856
PC Gasoline >2,0 l	PC Euro 6 - EC 715/2007	41318	44129	38620	17897	21047	22992	21932	23010	18825	12039	15068	13970	10856
PC Diesel 1,4 - 2,0 l	Conventional	48474	45040	24797	18588	11853	10711	6676	6447	11054	19287	21954	22316	18828

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
PC Diesel 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	54607	50739	27935	20940	13352	12066	7521	7262	12453	21727	24731	25139	21211
PC Diesel 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	64321	59765	32904	24665	15727	14212	8859	8554	14668	25592	29131	29611	24984
PC Diesel 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	72983	67814	37336	27987	17845	16126	10052	9706	16643	29039	33054	33599	28349
PC Diesel 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	73627	68412	37665	28234	18003	16269	10141	9792	16790	29295	33346	33895	28599
PC Diesel 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	82813	76947	42364	31756	20249	18298	11406	11014	18885	32950	37506	38124	32167
PC Diesel 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	82813	76947	42364	31756	20249	18298	11406	11014	18885	32950	37506	38124	32167
PC Diesel >2,0 l	Conventional	53530	49738	27384	20527	13089	11828	7373	7119	12207	21299	24244	24643	20792
PC Diesel >2,0 l	PC Euro 1 - 91/441/EEC	60645	56349	31024	23256	14829	13400	8353	8065	13830	24130	27466	27919	23556
PC Diesel >2,0 l	PC Euro 2 - 94/12/EEC	68178	63349	34878	26144	16671	15065	9390	9067	15548	27127	30878	31387	26482
PC Diesel >2,0 l	PC Euro 3 - 98/69/EC Stage2000	79700	74055	40772	30563	19488	17610	10977	10600	18175	31712	36096	36691	30957
PC Diesel >2,0 l	PC Euro 4 - 98/69/EC Stage2005	82466	76625	42187	31623	20164	18222	11358	10968	18806	32812	37349	37965	32032
PC Diesel >2,0 l	PC Euro 5 - EC 715/2007	91992	85477	47060	35276	22493	20326	12670	12234	20978	36603	41663	42350	35732
PC Diesel >2,0 l	PC Euro 6 - EC 715/2007	91992	85477	47060	35276	22493	20326	12670	12234	20978	36603	41663	42350	35732
PC LPG	Conventional	0	0	0	0	0	0	0	0	0	94954	42489	39876	70496
PC LPG	PC Euro 1 - 91/441/EEC	0	0	0	0	0	0	0	0	0	107779	48228	45262	80018
PC LPG	PC Euro 2 - 94/12/EEC	0	0	0	0	0	0	0	0	0	114430	51204	48055	84955
PC LPG	PC Euro 3 - 98/69/EC Stage2000	0	0	0	0	0	0	0	0	0	119951	53675	50374	89054
PC LPG	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	117260	52471	49244	87056
PC LPG	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	123348	55195	51800	91576
PC LPG	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	123348	55195	51800	91576
PC CNG	PC Euro 4 - 98/69/EC Stage2005	0	0	0	0	0	0	0	0	0	0	0	0	0
PC CNG	PC Euro 5 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC CNG	PC Euro 6 - EC 715/2007	0	0	0	0	0	0	0	0	0	0	0	0	0
PC 2-Stroke	Conventional	8075	8624	7548	3497	4113	4493	4286	4497	3679	2353	2945	2730	2122
PC Hybrid Gasoline <1,4 l	PC Euro 4 - 98/69/EC Stage2005	39053	41710	36503	16916	19893	21731	20730	21749	17793	11379	14242	13204	10261
PC Hybrid Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	39759	42464	37163	17222	20253	22125	21105	22142	18115	11585	14500	13443	10446
PC Hybrid Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	46340	49492	43315	20072	23605	25787	24598	25808	21113	13502	16900	15668	12175
LDV Gasoline <3,5t	Conventional	26526	28331	24795	11489	13512	14761	14081	14773	12086	7729	9674	8969	6969
LDV Gasoline <3,5t	LD Euro 1 - 93/59/EEC	30532	32609	28538	13224	15553	16990	16207	17003	13910	8896	11135	10323	8022
LDV Gasoline <3,5t	LD Euro 2 - 96/69/EEC	34153	36477	31924	14793	17397	19005	18129	19020	15561	9951	12455	11548	8973
LDV Gasoline <3,5t	LD Euro 3 - 98/69/EC Stage2000	38744	41380	36214	16782	19736	21560	20566	21577	17652	11289	14129	13100	10180
LDV Gasoline <3,5t	LD Euro 4 - 98/69/EC Stage2005	43809	46789	40949	18976	22316	24378	23254	24398	19960	12765	15977	14812	11510

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
LDV Gasoline <3,5t	LD Euro 5 - 2008 Standards	47915	51174	44787	20754	24408	26663	25434	26685	21831	13961	17474	16201	12589
LDV Gasoline <3,5t	LD Euro 6	47915	51174	44787	20754	24408	26663	25434	26685	21831	13961	17474	16201	12589
LDV Diesel <3,5 t	Conventional	49920	46385	25537	19143	12206	11030	6876	6639	11384	19863	22609	22982	19390
LDV Diesel <3,5 t	LD Euro 1 - 93/59/EEC	57913	53811	29626	22208	14161	12796	7977	7702	13207	23043	26229	26661	22495
LDV Diesel <3,5 t	LD Euro 2 - 96/69/EEC	63706	59193	32590	24429	15577	14076	8774	8473	14528	25348	28852	29328	24745
LDV Diesel <3,5 t	LD Euro 3 - 98/69/EC Stage2000	69507	64584	35557	26654	16995	15358	9573	9244	15850	27656	31479	31999	26998
LDV Diesel <3,5 t	LD Euro 4 - 98/69/EC Stage2005	80145	74468	40999	30733	19597	17709	11039	10659	18276	31889	36297	36896	31130
LDV Diesel <3,5 t	LD Euro 5 - 2008 Standards	85943	79856	43965	32957	21014	18990	11837	11430	19599	34196	38923	39565	33382
LDV Diesel <3,5 t	LD Euro 6	85943	79856	43965	32957	21014	18990	11837	11430	19599	34196	38923	39565	33382
HDV Gasoline >3,5 t	Conventional	34900	37275	32622	15116	17778	19421	18525	19436	15901	10169	12728	11800	9170
HDV Rigid <=7,5 t	Conventional	72267	67149	36969	27712	17670	15968	9954	9611	16480	28754	32730	33269	28070
HDV Rigid <=7,5 t	HD Euro I - 91/542/EEC Stage I	84733	78731	43346	32493	20718	18722	11671	11269	19323	33714	38375	39008	32912
HDV Rigid <=7,5 t	HD Euro II - 91/542/EEC Stage II	99832	92761	51071	38283	24410	22059	13750	13277	22766	39722	45214	45959	38777
HDV Rigid <=7,5 t	HD Euro III - 2000 Standards	116820	108545	59761	44797	28564	25812	16090	15536	26640	46481	52907	53780	45376
HDV Rigid <=7,5 t	HD Euro IV - 2005 Standards	126323	117375	64622	48441	30888	27912	17399	16800	28807	50262	57211	58155	49067
HDV Rigid <=7,5 t	HD Euro V - 2008 Standards	126323	117375	64622	48441	30888	27912	17399	16800	28807	50262	57211	58155	49067
HDV Rigid <=7,5 t	HD Euro VI	126323	117375	64622	48441	30888	27912	17399	16800	28807	50262	57211	58155	49067
HDV Rigid 7,5 - 12 t	Conventional	74343	69078	38031	28509	18178	16427	10240	9887	16953	29580	33670	34225	28877
HDV Rigid 7,5 - 12 t	HD Euro I - 91/542/EEC Stage I	93358	86746	47759	35800	22827	20628	12859	12416	21290	37146	42282	42979	36263
HDV Rigid 7,5 - 12 t	HD Euro II - 91/542/EEC Stage II	109647	101881	56092	42046	26810	24227	15102	14582	25004	43627	49659	50478	42590
HDV Rigid 7,5 - 12 t	HD Euro III - 2000 Standards	129672	120488	66336	49726	31707	28652	17860	17246	29571	51595	58728	59697	50368
HDV Rigid 7,5 - 12 t	HD Euro IV - 2005 Standards	141558	131531	72416	54283	34613	31278	19497	18826	32281	56324	64111	65168	54985
HDV Rigid 7,5 - 12 t	HD Euro V - 2008 Standards	141558	131531	72416	54283	34613	31278	19497	18826	32281	56324	64111	65168	54985
HDV Rigid 7,5 - 12 t	HD Euro VI	141558	131531	72416	54283	34613	31278	19497	18826	32281	56324	64111	65168	54985
HDV Rigid 12 - 14 t	Conventional	64832	60240	33166	24861	15852	14325	8930	8622	14784	25796	29362	29846	25182
HDV Rigid 12 - 14 t	HD Euro I - 91/542/EEC Stage I	84681	78683	43320	32473	20706	18711	11663	11262	19311	33694	38352	38984	32892
HDV Rigid 12 - 14 t	HD Euro II - 91/542/EEC Stage II	101233	94062	51787	38820	24753	22368	13943	13463	23085	40279	45848	46604	39321
HDV Rigid 12 - 14 t	HD Euro III - 2000 Standards	126300	117354	64610	48432	30882	27907	17396	16797	28802	50253	57201	58144	49058
HDV Rigid 12 - 14 t	HD Euro IV - 2005 Standards	130253	121027	66633	49948	31849	28780	17940	17323	29703	51826	58991	59964	50593
HDV Rigid 12 - 14 t	HD Euro V - 2008 Standards	130253	121027	66633	49948	31849	28780	17940	17323	29703	51826	58991	59964	50593
HDV Rigid 12 - 14 t	HD Euro VI	130253	121027	66633	49948	31849	28780	17940	17323	29703	51826	58991	59964	50593
HDV Rigid 14 - 20 t	Conventional	81594	75815	41741	31289	19951	18029	11238	10852	18607	32465	36954	37563	31693

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HDV Rigid 14 - 20 t	HD Euro I - 91/542/EEC Stage I	102315	95069	52341	39235	25018	22607	14092	13607	23332	40710	46338	47102	39742
HDV Rigid 14 - 20 t	HD Euro II - 91/542/EEC Stage II	117908	109557	60318	45214	28830	26053	16240	15681	26888	46914	53400	54281	45799
HDV Rigid 14 - 20 t	HD Euro III - 2000 Standards	136703	127021	69933	52422	33426	30206	18829	18181	31174	54393	61913	62934	53099
HDV Rigid 14 - 20 t	HD Euro IV - 2005 Standards	139701	129806	71466	53571	34159	30868	19242	18579	31858	55585	63270	64313	54263
HDV Rigid 14 - 20 t	HD Euro V - 2008 Standards	139701	129806	71466	53571	34159	30868	19242	18579	31858	55585	63270	64313	54263
HDV Rigid 14 - 20 t	HD Euro VI	139701	129806	71466	53571	34159	30868	19242	18579	31858	55585	63270	64313	54263
HDV Rigid 20 - 26 t	Conventional	81715	75928	41803	31336	19981	18056	11255	10868	18635	32514	37009	37619	31740
HDV Rigid 20 - 26 t	HD Euro I - 91/542/EEC Stage I	103678	96335	53038	39758	25351	22908	14280	13789	23643	41252	46956	47730	40271
HDV Rigid 20 - 26 t	HD Euro II - 91/542/EEC Stage II	118890	110469	60820	45591	29070	26270	16375	15812	27112	47305	53845	54733	46180
HDV Rigid 20 - 26 t	HD Euro III - 2000 Standards	141199	131198	72233	54146	34525	31199	19448	18779	32199	56182	63949	65003	54845
HDV Rigid 20 - 26 t	HD Euro IV - 2005 Standards	128641	119530	65808	49330	31455	28424	17718	17109	29336	51185	58261	59222	49968
HDV Rigid 20 - 26 t	HD Euro V - 2008 Standards	128641	119530	65808	49330	31455	28424	17718	17109	29336	51185	58261	59222	49968
HDV Rigid 20 - 26 t	HD Euro VI	128641	119530	65808	49330	31455	28424	17718	17109	29336	51185	58261	59222	49968
HDV Rigid 26 - 28 t	Conventional	81389	75624	41636	31210	19901	17984	11210	10824	18560	32384	36861	37469	31614
HDV Rigid 26 - 28 t	HD Euro I - 91/542/EEC Stage I	100179	93083	51248	38416	24495	22135	13798	13323	22845	39860	45371	46119	38912
HDV Rigid 26 - 28 t	HD Euro II - 91/542/EEC Stage II	115165	107008	58914	44163	28160	25447	15862	15316	26262	45823	52158	53018	44733
HDV Rigid 26 - 28 t	HD Euro III - 2000 Standards	135326	125741	69228	51894	33089	29901	18639	17998	30860	53845	61289	62299	52564
HDV Rigid 26 - 28 t	HD Euro IV - 2005 Standards	138993	129149	71104	53300	33986	30712	19144	18485	31696	55304	62950	63988	53989
HDV Rigid 26 - 28 t	HD Euro V - 2008 Standards	138993	129149	71104	53300	33986	30712	19144	18485	31696	55304	62950	63988	53989
HDV Rigid 26 - 28 t	HD Euro VI	138993	129149	71104	53300	33986	30712	19144	18485	31696	55304	62950	63988	53989
HDV Rigid 28 - 32 t	Conventional	81577	75799	41732	31282	19947	18025	11236	10849	18603	32459	36946	37555	31687
HDV Rigid 28 - 32 t	HD Euro I - 91/542/EEC Stage I	101490	94301	51918	38918	24816	22425	13979	13498	23144	40382	45964	46722	39421
HDV Rigid 28 - 32 t	HD Euro II - 91/542/EEC Stage II	116773	108503	59737	44779	28553	25802	16084	15530	26629	46463	52886	53758	45358
HDV Rigid 28 - 32 t	HD Euro III - 2000 Standards	138658	128837	70933	53172	33904	30638	19098	18441	31620	55171	62798	63834	53858
HDV Rigid 28 - 32 t	HD Euro IV - 2005 Standards	130700	121443	66862	50120	31958	28879	18002	17382	29805	52004	59194	60170	50767
HDV Rigid 28 - 32 t	HD Euro V - 2008 Standards	130700	121443	66862	50120	31958	28879	18002	17382	29805	52004	59194	60170	50767
HDV Rigid 28 - 32 t	HD Euro VI	130700	121443	66862	50120	31958	28879	18002	17382	29805	52004	59194	60170	50767
HDV Rigid >32 t	Conventional	100508	93389	51416	38542	24576	22208	13843	13367	22920	39991	45520	46270	39040
HDV Rigid >32 t	HD Euro I - 91/542/EEC Stage I	110900	103045	56733	42527	27117	24504	15275	14749	25290	44126	50226	51055	43076
HDV Rigid >32 t	HD Euro II - 91/542/EEC Stage II	136083	126444	69615	52184	33274	30068	18743	18098	31032	54146	61632	62648	52858
HDV Rigid >32 t	HD Euro III - 2000 Standards	156735	145632	80180	60103	38324	34632	21588	20845	35742	62363	70985	72155	60880
HDV Rigid >32 t	HD Euro IV - 2005 Standards	143579	133409	73450	55058	35107	31725	19776	19095	32742	57128	65027	66099	55770

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HDV Rigid >32 t	HD Euro V - 2008 Standards	143579	133409	73450	55058	35107	31725	19776	19095	32742	57128	65027	66099	55770
HDV Rigid >32 t	HD Euro VI	143579	133409	73450	55058	35107	31725	19776	19095	32742	57128	65027	66099	55770
HDV Articulated 14 - 20 t	Conventional	106277	98750	54368	40754	25986	23483	14638	14134	24236	42286	48133	48926	41281
HDV Articulated 14 - 20 t	HD Euro I - 91/542/EEC Stage I	128428	119331	65699	49248	31402	28377	17689	17080	29287	51100	58165	59124	49885
HDV Articulated 14 - 20 t	HD Euro II - 91/542/EEC Stage II	153659	142775	78607	58924	37572	33952	21164	20436	35041	61139	69592	70739	59685
HDV Articulated 14 - 20 t	HD Euro III - 2000 Standards	191586	178014	98008	73467	46845	42332	26388	25480	43689	76229	86768	88199	74416
HDV Articulated 14 - 20 t	HD Euro IV - 2005 Standards	203367	188961	104036	77985	49726	44935	28010	27047	46376	80917	92104	93623	78993
HDV Articulated 14 - 20 t	HD Euro V - 2008 Standards	203367	188961	104036	77985	49726	44935	28010	27047	46376	80917	92104	93623	78993
HDV Articulated 14 - 20 t	HD Euro VI	203367	188961	104036	77985	49726	44935	28010	27047	46376	80917	92104	93623	78993
HDV Articulated 20 - 28 t	Conventional	117842	109495	60284	45189	28814	26038	16231	15672	26873	46888	53370	54250	45773
HDV Articulated 20 - 28 t	HD Euro I - 91/542/EEC Stage I	139992	130077	71615	53683	34230	30932	19282	18618	31924	55701	63402	64448	54377
HDV Articulated 20 - 28 t	HD Euro II - 91/542/EEC Stage II	167630	155755	85753	64281	40988	37039	23088	22294	38226	66698	75919	77171	65112
HDV Articulated 20 - 28 t	HD Euro III - 2000 Standards	203148	188757	103924	77901	49672	44887	27980	27017	46326	80830	92005	93522	78907
HDV Articulated 20 - 28 t	HD Euro IV - 2005 Standards	203367	188961	104036	77985	49726	44935	28010	27047	46376	80917	92104	93623	78993
HDV Articulated 20 - 28 t	HD Euro V - 2008 Standards	203367	188961	104036	77985	49726	44935	28010	27047	46376	80917	92104	93623	78993
HDV Articulated 20 - 28 t	HD Euro VI	203367	188961	104036	77985	49726	44935	28010	27047	46376	80917	92104	93623	78993
HDV Articulated 28 - 34 t	Conventional	126513	117552	64720	48514	30934	27954	17425	16826	28850	50338	57298	58242	49141
HDV Articulated 28 - 34 t	HD Euro I - 91/542/EEC Stage I	148453	137938	75943	56927	36299	32802	20447	19743	33853	59068	67234	68343	57663
HDV Articulated 28 - 34 t	HD Euro II - 91/542/EEC Stage II	177555	164977	90830	68087	43415	39232	24455	23614	40490	70647	80414	81740	68967
HDV Articulated 28 - 34 t	HD Euro III - 2000 Standards	214135	198966	109544	82114	52359	47314	29493	28479	48831	85201	96981	98580	83175
HDV Articulated 28 - 34 t	HD Euro IV - 2005 Standards	233141	216626	119267	89402	57006	51514	32111	31006	53166	92764	105588	107330	90557
HDV Articulated 28 - 34 t	HD Euro V - 2008 Standards	233141	216626	119267	89402	57006	51514	32111	31006	53166	92764	105588	107330	90557
HDV Articulated 28 - 34 t	HD Euro VI	233141	216626	119267	89402	57006	51514	32111	31006	53166	92764	105588	107330	90557
HDV Articulated 34 - 40 t	Conventional	120646	112101	61718	46264	29500	26658	16617	16045	27512	48004	54640	55541	46862
HDV Articulated 34 - 40 t	HD Euro I - 91/542/EEC Stage I	155100	144114	79344	59476	37924	34271	21363	20628	35369	61713	70245	71403	60245
HDV Articulated 34 - 40 t	HD Euro II - 91/542/EEC Stage II	183963	170931	94108	70544	44981	40648	25338	24466	41951	73196	83316	84690	71455
HDV Articulated 34 - 40 t	HD Euro III - 2000 Standards	222107	206374	113623	85171	54308	49076	30592	29539	50649	88374	100591	102250	86272
HDV Articulated 34 - 40 t	HD Euro IV - 2005 Standards	235448	218770	120447	90287	57570	52024	32429	31313	53692	93682	106633	108392	91454
HDV Articulated 34 - 40 t	HD Euro V - 2008 Standards	235448	218770	120447	90287	57570	52024	32429	31313	53692	93682	106633	108392	91454
HDV Articulated 34 - 40 t	HD Euro VI	235448	218770	120447	90287	57570	52024	32429	31313	53692	93682	106633	108392	91454
HDV Articulated 40 - 50 t	Conventional	139282	129417	71252	53411	34056	30775	19184	18524	31762	55419	63081	64121	54101
HDV Articulated 40 - 50 t	HD Euro I - 91/542/EEC Stage I	170853	158750	87402	65517	41776	37751	23532	22722	38961	67980	77378	78654	66363

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HDV Articulated 40 - 50 t	HD Euro II - 91/542/EEC Stage II	210225	195333	107544	80615	51403	46451	28955	27959	47940	83646	95210	96780	81656
HDV Articulated 40 - 50 t	HD Euro III - 2000 Standards	251052	233269	128430	96271	61386	55472	34577	33389	57250	99891	113701	115575	97515
HDV Articulated 40 - 50 t	HD Euro IV - 2005 Standards	235448	218770	120447	90287	57570	52024	32429	31313	53692	93682	106633	108392	91454
HDV Articulated 40 - 50 t	HD Euro V - 2008 Standards	235448	218770	120447	90287	57570	52024	32429	31313	53692	93682	106633	108392	91454
HDV Articulated 40 - 50 t	HD Euro VI	235448	218770	120447	90287	57570	52024	32429	31313	53692	93682	106633	108392	91454
HDV Articulated 50 - 60 t	Conventional	128090	119017	65526	49119	31320	28302	17642	17035	29210	50966	58012	58968	49753
HDV Articulated 50 - 60 t	HD Euro I - 91/542/EEC Stage I	152129	141353	77824	58337	37198	33614	20953	20232	34692	60530	68899	70035	59091
HDV Articulated 50 - 60 t	HD Euro II - 91/542/EEC Stage II	184199	171151	94229	70635	45039	40700	25370	24497	42005	73290	83423	84799	71547
HDV Articulated 50 - 60 t	HD Euro III - 2000 Standards	224438	208539	114815	86065	54878	49591	30913	29849	51181	89301	101647	103323	87177
HDV Articulated 50 - 60 t	HD Euro IV - 2005 Standards	235448	218770	120447	90287	57570	52024	32429	31313	53692	93682	106633	108392	91454
HDV Articulated 50 - 60 t	HD Euro V - 2008 Standards	235448	218770	120447	90287	57570	52024	32429	31313	53692	93682	106633	108392	91454
HDV Articulated 50 - 60 t	HD Euro VI	235448	218770	120447	90287	57570	52024	32429	31313	53692	93682	106633	108392	91454
BUS Urban Midi <=15 t	Conventional	129202	120050	66095	49545	31592	28548	17795	17183	29463	51408	58515	59480	50185
BUS Urban Midi <=15 t	HD Euro I - 91/542/EEC Stage I	159076	147808	81378	61001	38896	35149	21910	21156	36276	63295	72045	73233	61789
BUS Urban Midi <=15 t	HD Euro II - 91/542/EEC Stage II	169790	157762	86858	65109	41516	37516	23386	22581	38719	67557	76897	78165	65951
BUS Urban Midi <=15 t	HD Euro III - 2000 Standards	181118	168288	92653	69453	44286	40019	24946	24088	41302	72065	82028	83380	70351
BUS Urban Midi <=15 t	HD Euro IV - 2005 Standards	171101	158980	87529	65612	41836	37806	23566	22755	39018	68079	77491	78769	66460
BUS Urban Midi <=15 t	HD Euro V - 2008 Standards	173255	160982	88631	66438	42363	38282	23863	23042	39509	68936	78467	79760	67296
BUS Urban Midi <=15 t	HD Euro VI	173255	160982	88631	66438	42363	38282	23863	23042	39509	68936	78467	79760	67296
BUS Urban Standard 15 - 18 t	Conventional	136807	127118	69986	52462	33451	30229	18843	18195	31198	54434	61960	62981	53140
BUS Urban Standard 15 - 18 t	HD Euro I - 91/542/EEC Stage I	166272	154494	85059	63761	40656	36739	22901	22113	37917	66158	75304	76546	64584
BUS Urban Standard 15 - 18 t	HD Euro II - 91/542/EEC Stage II	185331	172203	94808	71069	45316	40950	25526	24648	42263	73741	83936	85320	71987
BUS Urban Standard 15 - 18 t	HD Euro III - 2000 Standards	197638	183638	101105	75788	48325	43669	27221	26285	45069	78638	89509	90985	76767
BUS Urban Standard 15 - 18 t	HD Euro IV - 2005 Standards	191355	177799	97890	73379	46789	42281	26356	25449	43637	76137	86664	88093	74327
BUS Urban Standard 15 - 18 t	HD Euro V - 2008 Standards	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945
BUS Urban Standard 15 - 18 t	HD Euro VI	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945
BUS Urban Articulated >18 t	Conventional	131061	121778	67046	50258	32046	28959	18052	17430	29887	52148	59357	60336	50908
BUS Urban Articulated >18 t	HD Euro I - 91/542/EEC Stage I	167202	155358	85535	64117	40883	36945	23029	22237	38129	66528	75725	76974	64946
BUS Urban Articulated >18 t	HD Euro II - 91/542/EEC Stage II	188334	174993	96345	72220	46050	41614	25940	25047	42948	74936	85296	86702	73153
BUS Urban Articulated >18 t	HD Euro III - 2000 Standards	199885	185725	102254	76650	48874	44166	27531	26583	45582	79531	90527	92020	77640
BUS Urban Articulated >18 t	HD Euro IV - 2005 Standards	189775	176332	97082	72773	46403	41932	26138	25239	43276	75509	85948	87366	73713
BUS Urban Articulated >18 t	HD Euro V - 2008 Standards	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
BUS Urban Articulated >18 t	HD Euro VI	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945
BUS Coaches Standard <=18 t	Conventional	131829	122492	67439	50553	32234	29129	18157	17533	30063	52453	59705	60690	51206
BUS Coaches Standard <=18 t	HD Euro I - 91/542/EEC Stage I	154139	143220	78852	59108	37689	34058	21230	20500	35150	61330	69809	70960	59871
BUS Coaches Standard <=18 t	HD Euro II - 91/542/EEC Stage II	169932	157894	86931	65164	41551	37547	23405	22600	38751	67614	76961	78230	66005
BUS Coaches Standard <=18 t	HD Euro III - 2000 Standards	183945	170915	94099	70537	44977	40644	25335	24464	41947	73189	83308	84682	71449
BUS Coaches Standard <=18 t	HD Euro IV - 2005 Standards	192426	178795	98438	73789	47051	42518	26503	25592	43881	76564	87149	88586	74743
BUS Coaches Standard <=18 t	HD Euro V - 2008 Standards	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945
BUS Coaches Standard <=18 t	HD Euro VI	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945
BUS Coaches Articulated >18 t	Conventional	130469	121228	66743	50031	31902	28828	17970	17352	29752	51912	59089	60064	50678
BUS Coaches Articulated >18 t	HD Euro I - 91/542/EEC Stage I	157289	146147	80464	60316	38459	34754	21664	20919	35868	62584	71236	72410	61095
BUS Coaches Articulated >18 t	HD Euro II - 91/542/EEC Stage II	179666	166938	91910	68896	43931	39698	24746	23894	40971	71487	81370	82712	69786
BUS Coaches Articulated >18 t	HD Euro III - 2000 Standards	190436	176946	97420	73027	46564	42078	26229	25327	43427	75772	86248	87670	73970
BUS Coaches Articulated >18 t	HD Euro IV - 2005 Standards	190246	176769	97323	72953	46518	42036	26203	25302	43384	75696	86161	87582	73896
BUS Coaches Articulated >18 t	HD Euro V - 2008 Standards	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945
BUS Coaches Articulated >18 t	HD Euro VI	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945
BUS Urban CNG	HD Euro I - 91/542/EEC Stage I	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban CNG	HD Euro II - 91/542/EEC Stage II	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban CNG	HD Euro III - 2000 Standards	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban CNG	EEV	0	0	0	0	0	0	0	0	0	0	0	0	0
BUS Urban Biodiesel	Conventional	136807	127118	69986	52462	33451	30229	18843	18195	31198	54434	61960	62981	53140
BUS Urban Biodiesel	HD Euro I - 91/542/EEC Stage I	166272	154494	85059	63761	40656	36739	22901	22113	37917	66158	75304	76546	64584
BUS Urban Biodiesel	HD Euro II - 91/542/EEC Stage II	185331	172203	94808	71069	45316	40950	25526	24648	42263	73741	83936	85320	71987
BUS Urban Biodiesel	HD Euro III - 2000 Standards	197638	183638	101105	75788	48325	43669	27221	26285	45069	78638	89509	90985	76767
BUS Urban Biodiesel	HD Euro IV - 2005 Standards	191355	177799	97890	73379	46789	42281	26356	25449	43637	76137	86664	88093	74327
BUS Urban Biodiesel	HD Euro V - 2008 Standards	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945
BUS Urban Biodiesel	HD Euro VI	259883	241473	132947	99657	63545	57423	35794	34563	59264	103404	117700	119641	100945
MOP 2-stroke <50 cm³	Conventional	5624	6007	5257	2436	2865	3130	2985	3132	2562	1639	2051	1902	1478
MOP 2-stroke <50 cm³	Mop - Euro I	5929	6332	5542	2568	3020	3299	3147	3302	2701	1728	2162	2005	1558
MOP 2-stroke <50 cm³	Mop - Euro II	4399	4698	4112	1905	2241	2448	2335	2450	2004	1282	1604	1487	1156
MOP 2-stroke <50 cm³	Mop - Euro III	3680	3931	3440	1594	1875	2048	1953	2050	1677	1072	1342	1244	967
MOT 2-stroke >50 cm³	Conventional	8364	8933	7817	3623	4260	4654	4440	4658	3811	2437	3050	2828	2197
MOT 2-stroke >50 cm³	Mot - Euro I	8723	9317	8153	3778	4443	4854	4630	4858	3974	2542	3181	2949	2292

Subsector	Technology	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MOT 2-stroke >50 cm^3	Mot - Euro II	9882	10554	9236	4280	5034	5499	5245	5503	4502	2879	3604	3341	2596
MOT 2-stroke >50 cm^3	Mot - Euro III	10128	10817	9467	4387	5159	5636	5376	5640	4614	2951	3694	3424	2661
MOT 4-stroke <250 cm^3	Conventional	10835	11572	10127	4693	5519	6029	5751	6034	4936	3157	3951	3663	2847
MOT 4-stroke <250 cm^3	Mot - Euro I	12050	12870	11263	5219	6138	6705	6396	6711	5490	3511	4394	4074	3166
MOT 4-stroke <250 cm^3	Mot - Euro II	10673	11399	9976	4623	5437	5939	5665	5944	4863	3110	3892	3609	2804
MOT 4-stroke <250 cm^3	Mot - Euro III	11398	12173	10653	4937	5806	6343	6050	6348	5193	3321	4157	3854	2995
MOT 4-stroke 250 - 750 cm^3	Conventional	11150	11908	10421	4829	5679	6204	5918	6209	5080	3249	4066	3770	2929
MOT 4-stroke 250 - 750 cm^3	Mot - Euro I	12542	13396	11723	5432	6389	6979	6658	6985	5714	3655	4574	4241	3295
MOT 4-stroke 250 - 750 cm^3	Mot - Euro II	11238	12003	10504	4868	5725	6254	5965	6259	5120	3275	4099	3800	2953
MOT 4-stroke 250 - 750 cm^3	Mot - Euro III	11398	12173	10653	4937	5806	6343	6050	6348	5193	3321	4157	3854	2995
MOT 4-stroke >750 cm^3	Conventional	11317	12087	10578	4902	5765	6298	6007	6303	5156	3297	4127	3826	2973
MOT 4-stroke >750 cm^3	Mot - Euro I	12898	13775	12055	5586	6570	7177	6846	7183	5876	3758	4704	4361	3389
MOT 4-stroke >750 cm^3	Mot - Euro II	11533	12318	10780	4995	5875	6418	6122	6423	5255	3360	4206	3900	3030
MOT 4-stroke >750 cm^3	Mot - Euro III	11398	12173	10653	4937	5806	6343	6050	6348	5193	3321	4157	3854	2995

Table 296 Mileage data for Road transport (average km/year/vehicle) 2000-2014

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PC Gasoline 0,8 - 1,4 l	PRE ECE	2049	2092	1850	1683	1509	2948	2556	2289	2252	2058	1852	1735	1436	1656
PC Gasoline 0,8 - 1,4 l	ECE 15/00-01	2468	2520	2229	2028	1818	3552	3080	2758	2713	2479	2231	2091	1730	1995
PC Gasoline 0,8 - 1,4 l	ECE 15/02	2500	2552	2257	2053	1841	3597	3119	2793	2747	2510	2259	2117	1752	2020
PC Gasoline 0,8 - 1,4 l	ECE 15/03	2946	3007	2660	2420	2170	4238	3675	3291	3237	2958	2662	2495	2064	2381
PC Gasoline 0,8 - 1,4 l	ECE 15/04	3957	4040	3573	3251	2915	5694	4937	4421	4349	3973	3577	3351	2773	3198
PC Gasoline 0,8 - 1,4 l	Improved Conventional	3251	3318	2935	2670	2394	4677	4055	3632	3573	3264	2938	2753	2278	2627
PC Gasoline 0,8 - 1,4 l	Open Loop	3526	3600	3184	2897	2597	5074	4399	3940	3876	3541	3187	2986	2471	2850
PC Gasoline 0,8 - 1,4 l	PC Euro 1 - 91/441/EEC	4764	4863	4301	3913	3509	6854	5943	5322	5236	4783	4306	4034	3338	3850
PC Gasoline 0,8 - 1,4 l	PC Euro 2 - 94/12/EEC	5520	5635	4984	4534	4066	7942	6886	6167	6067	5542	4989	4675	3868	4461
PC Gasoline 0,8 - 1,4 l	PC Euro 3 - 98/69/EC Stage2000	6369	6502	5751	5232	4691	9164	7946	7116	7000	6395	5757	5394	4463	5148
PC Gasoline 0,8 - 1,4 l	PC Euro 4 - 98/69/EC Stage2005	6747	6887	6092	5543	4969	9708	8417	7538	7416	6775	6098	5714	4728	5453
PC Gasoline 0,8 - 1,4 l	PC Euro 5 - EC 715/2007	7550	7707	6817	6202	5561	10863	9419	8435	8298	7581	6824	6394	5290	6102
PC Gasoline 0,8 - 1,4 l	PC Euro 6 - EC 715/2007	7550	7707	6817	6202	5561	10863	9419	8435	8298	7581	6824	6394	5290	6102
PC Gasoline 1,4 - 2,0 l	PRE ECE	2196	2242	1983	1804	1618	3160	2740	2454	2414	2205	1985	1860	1539	1775

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PC Gasoline 1,4 - 2,0 l	ECE 15/00-01	2629	2684	2374	2160	1937	3783	3280	2938	2890	2640	2377	2227	1842	2125
PC Gasoline 1,4 - 2,0 l	ECE 15/02	2759	2816	2491	2266	2032	3969	3442	3082	3032	2770	2493	2336	1933	2230
PC Gasoline 1,4 - 2,0 l	ECE 15/03	3162	3228	2855	2598	2329	4550	3945	3533	3475	3175	2858	2678	2216	2556
PC Gasoline 1,4 - 2,0 l	ECE 15/04	4252	4341	3840	3493	3132	6118	5305	4751	4674	4270	3843	3601	2980	3437
PC Gasoline 1,4 - 2,0 l	Improved Conventional	3251	3318	2935	2670	2394	4677	4055	3632	3573	3264	2938	2753	2278	2627
PC Gasoline 1,4 - 2,0 l	Open Loop	4002	4086	3614	3288	2948	5759	4993	4472	4399	4019	3618	3390	2805	3235
PC Gasoline 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	5263	5372	4752	4323	3876	7572	6566	5880	5784	5284	4757	4457	3688	4253
PC Gasoline 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	5934	6058	5358	4875	4371	8539	7404	6630	6522	5959	5364	5026	4158	4796
PC Gasoline 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	6848	6990	6183	5625	5043	9852	8543	7650	7526	6876	6189	5799	4798	5534
PC Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	7600	7758	6862	6243	5598	10935	9482	8491	8353	7631	6869	6437	5326	6143
PC Gasoline 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	8393	8567	7578	6894	6181	12075	10470	9377	9224	8427	7586	7108	5881	6783
PC Gasoline 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	8393	8567	7578	6894	6181	12075	10470	9377	9224	8427	7586	7108	5881	6783
PC Gasoline >2,0 l	PRE ECE	2310	2358	2086	1897	1701	3323	2882	2581	2539	2319	2088	1956	1618	1867
PC Gasoline >2,0 l	ECE 15/00-01	2763	2821	2495	2270	2035	3976	3447	3087	3037	2775	2498	2340	1936	2233
PC Gasoline >2,0 l	ECE 15/02	2811	2870	2538	2309	2071	4045	3507	3141	3090	2823	2541	2381	1970	2272
PC Gasoline >2,0 l	ECE 15/03	3335	3404	3011	2739	2456	4798	4160	3726	3665	3348	3014	2824	2337	2695
PC Gasoline >2,0 l	ECE 15/04	4424	4516	3994	3634	3258	6365	5519	4943	4862	4442	3999	3747	3100	3576
PC Gasoline >2,0 l	PC Euro 1 - 91/441/EEC	5391	5504	4868	4429	3971	7757	6726	6024	5926	5414	4873	4566	3778	4357
PC Gasoline >2,0 l	PC Euro 2 - 94/12/EEC	6334	6466	5719	5203	4665	9114	7902	7077	6962	6360	5725	5364	4438	5119
PC Gasoline >2,0 l	PC Euro 3 - 98/69/EC Stage2000	7052	7198	6367	5793	5194	10146	8797	7879	7750	7081	6374	5972	4941	5699
PC Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	7927	8093	7158	6512	5839	11406	9890	8857	8713	7960	7165	6714	5555	6407
PC Gasoline >2,0 l	PC Euro 5 - EC 715/2007	8758	8940	7907	7194	6450	12601	10926	9785	9625	8794	7915	7417	6137	7078
PC Gasoline >2,0 l	PC Euro 6 - EC 715/2007	8758	8940	7907	7194	6450	12601	10926	9785	9625	8794	7915	7417	6137	7078
PC Diesel 1,4 - 2,0 l	Conventional	20051	19548	24131	31406	33160	22897	16510	14923	12892	11703	11343	11633	9422	9864
PC Diesel 1,4 - 2,0 l	PC Euro 1 - 91/441/EEC	22588	22021	27184	35380	37356	25794	18599	16811	14524	13184	12779	13105	10615	11113
PC Diesel 1,4 - 2,0 l	PC Euro 2 - 94/12/EEC	26606	25939	32020	41674	44001	30383	21907	19801	17107	15529	15052	15436	12503	13089
PC Diesel 1,4 - 2,0 l	PC Euro 3 - 98/69/EC Stage2000	30189	29432	36332	47286	49927	34474	24858	22468	19411	17621	17079	17515	14187	14852
PC Diesel 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	30456	29692	36653	47703	50367	34779	25077	22666	19582	17776	17229	17670	14312	14983
PC Diesel 1,4 - 2,0 l	PC Euro 5 - EC 715/2007	34255	33396	41225	53655	56651	39117	28205	25494	22025	19994	19379	19874	16097	16852
PC Diesel 1,4 - 2,0 l	PC Euro 6 - EC 715/2007	34255	33396	41225	53655	56651	39117	28205	25494	22025	19994	19379	19874	16097	16852
PC Diesel >2,0 l	Conventional	22142	21587	26648	34682	36619	25285	18232	16479	14237	12924	12526	12847	10405	10894
PC Diesel >2,0 l	PC Euro 1 - 91/441/EEC	25085	24456	30190	39292	41486	28646	20655	18670	16129	14642	14191	14554	11788	12341

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PC Diesel >2,0 l	PC Euro 2 - 94/12/EEC	28202	27494	33940	44173	46640	32205	23221	20989	18133	16461	15954	16362	13253	13874
PC Diesel >2,0 l	PC Euro 3 - 98/69/EC Stage2000	32967	32141	39676	51638	54521	37647	27145	24536	21197	19242	18651	19127	15492	16219
PC Diesel >2,0 l	PC Euro 4 - 98/69/EC Stage2005	34112	33256	41053	53430	56414	38954	28087	25387	21933	19910	19298	19791	16030	16781
PC Diesel >2,0 l	PC Euro 5 - EC 715/2007	38052	37098	45795	59602	62930	43454	31332	28320	24467	22210	21527	22077	17882	18720
PC Diesel >2,0 l	PC Euro 6 - EC 715/2007	38052	37098	45795	59602	62930	43454	31332	28320	24467	22210	21527	22077	17882	18720
PC LPG	Conventional	74369	71327	64883	58686	66656	68025	63339	58735	60825	57116	51681	47355	44864	38694
PC LPG	PC Euro 1 - 91/441/EEC	84414	80961	73646	66613	75659	77213	71894	66669	69040	64831	58661	53751	50924	43920
PC LPG	PC Euro 2 - 94/12/EEC	89622	85956	78190	70723	80327	81977	76330	70782	73300	68831	62281	57067	54066	46630
PC LPG	PC Euro 3 - 98/69/EC Stage2000	93946	90104	81963	74135	84203	85932	80013	74197	76837	72152	65286	59821	56675	48880
PC LPG	PC Euro 4 - 98/69/EC Stage2005	91839	88082	80125	72472	82314	84004	78218	72533	75114	70534	63821	58479	55403	47784
PC LPG	PC Euro 5 - EC 715/2007	96607	92655	84284	76235	86588	88366	82279	76299	79013	74195	67134	61515	58280	50264
PC LPG	PC Euro 6 - EC 715/2007	96607	92655	84284	76235	86588	88366	82279	76299	79013	74195	67134	61515	58280	50264
PC CNG	PC Euro 4 - 98/69/EC Stage2005	0	0	0	119549	194633	173988	188564	144169	167629	191946	115997	86643	81468	79152
PC CNG	PC Euro 5 - EC 715/2007	0	0	0	125755	204737	183021	198353	151653	176331	201910	122018	91141	85697	83262
PC CNG	PC Euro 6 - EC 715/2007	0	0	0	125755	204737	183021	198353	151653	176331	201910	122018	91141	85697	83262
PC 2-Stroke	Conventional	1712	1747	1545	1406	1261	2463	2135	1912	1881	1719	1547	1450	1199	1383
PC Hybrid Gasoline <1,4 l	PC Euro 4 - 98/69/EC Stage2005	8278	8450	7474	6800	6097	11910	10327	9248	9098	8311	7482	7010	5800	6690
PC Hybrid Gasoline 1,4 - 2,0 l	PC Euro 4 - 98/69/EC Stage2005	8427	8603	7609	6923	6207	12125	10514	9415	9262	8462	7617	7137	5905	6811
PC Hybrid Gasoline >2,0 l	PC Euro 4 - 98/69/EC Stage2005	9822	10027	8869	8069	7234	14132	12254	10974	10795	9863	8878	8318	6883	7939
LDV Gasoline <3,5t	Conventional	5622	5740	5077	4619	4141	8090	7014	6282	6180	5646	5082	4762	3940	4544
LDV Gasoline <3,5t	LD Euro 1 - 93/59/EEC	6471	6606	5843	5316	4766	9311	8074	7230	7113	6498	5849	5481	4535	5230
LDV Gasoline <3,5t	LD Euro 2 - 96/69/EEC	7239	7390	6536	5947	5332	10416	9031	8088	7956	7269	6543	6131	5073	5851
LDV Gasoline <3,5t	LD Euro 3 - 98/69/EC Stage2000	8212	8383	7415	6746	6048	11816	10245	9175	9026	8246	7422	6955	5754	6637
LDV Gasoline <3,5t	LD Euro 4 - 98/69/EC Stage2005	9286	9479	8384	7628	6839	13360	11585	10374	10206	9324	8393	7864	6507	7505
LDV Gasoline <3,5t	LD Euro 5 - 2008 Standards	10156	10367	9170	8343	7480	14613	12670	11347	11162	10198	9179	8601	7117	8208
LDV Gasoline <3,5t	LD Euro 6	10156	10367	9170	8343	7480	14613	12670	11347	11162	10198	9179	8601	7117	8208
LDV Diesel <3,5 t	Conventional	20649	20131	24851	32344	34150	23580	17002	15368	13277	12052	11682	11980	9704	10159
LDV Diesel <3,5 t	LD Euro 1 - 93/59/EEC	23955	23355	28830	37522	39617	27356	19725	17829	15403	13982	13552	13899	11257	11786
LDV Diesel <3,5 t	LD Euro 2 - 96/69/EEC	26352	25691	31714	41275	43580	30092	21698	19612	16943	15381	14908	15289	12383	12964
LDV Diesel <3,5 t	LD Euro 3 - 98/69/EC Stage2000	28751	28030	34601	45034	47548	32832	23673	21398	18486	16781	16265	16681	13511	14145
LDV Diesel <3,5 t	LD Euro 4 - 98/69/EC Stage2005	33151	32320	39897	51926	54825	37857	27297	24673	21316	19350	18755	19234	15579	16310
LDV Diesel <3,5 t	LD Euro 5 - 2008 Standards	35550	34658	42784	55683	58792	40596	29271	26458	22858	20750	20111	20626	16706	17489

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
LDV Diesel <3,5 t	LD Euro 6	35550	34658	42784	55683	58792	40596	29271	26458	22858	20750	20111	20626	16706	17489
HDV Gasoline >3,5 t	Conventional	7397	7551	6679	6077	5448	10643	9229	8265	8130	7428	6686	6265	5184	5979
HDV Rigid <=7,5 t	Conventional	29893	29143	35976	46822	49437	34136	24614	22247	19221	17448	16911	17344	14047	14706
HDV Rigid <=7,5 t	HD Euro I - 91/542/EEC Stage I	35049	34170	42181	54899	57964	40024	28859	26085	22536	20457	19828	20335	16470	17243
HDV Rigid <=7,5 t	HD Euro II - 91/542/EEC Stage II	41295	40259	49698	64681	68293	47157	34002	30733	26552	24103	23362	23959	19405	20316
HDV Rigid <=7,5 t	HD Euro III - 2000 Standards	48322	47110	58154	75688	79914	55181	39788	35963	31070	28204	27337	28036	22708	23773
HDV Rigid <=7,5 t	HD Euro IV - 2005 Standards	52253	50942	62885	81845	86415	59670	43024	38888	33597	30499	29561	30316	24555	25707
HDV Rigid <=7,5 t	HD Euro V - 2008 Standards	52253	50942	62885	81845	86415	59670	43024	38888	33597	30499	29561	30316	24555	25707
HDV Rigid <=7,5 t	HD Euro VI	52253	50942	62885	81845	86415	59670	43024	38888	33597	30499	29561	30316	24555	25707
HDV Rigid 7,5 - 12 t	Conventional	30752	29980	37009	48167	50857	35117	25321	22887	19773	17949	17397	17842	14451	15129
HDV Rigid 7,5 - 12 t	HD Euro I - 91/542/EEC Stage I	38617	37648	46475	60487	63865	44099	31797	28740	24830	22540	21847	22405	18147	18998
HDV Rigid 7,5 - 12 t	HD Euro II - 91/542/EEC Stage II	45355	44217	54584	71040	75007	51793	37345	33755	29162	26472	25658	26314	21313	22313
HDV Rigid 7,5 - 12 t	HD Euro III - 2000 Standards	53638	52293	64553	84015	88706	61252	44165	39920	34488	31307	30345	31120	25206	26388
HDV Rigid 7,5 - 12 t	HD Euro IV - 2005 Standards	58555	57086	70469	91715	96837	66866	48213	43578	37649	34177	33126	33973	27516	28807
HDV Rigid 7,5 - 12 t	HD Euro V - 2008 Standards	58555	57086	70469	91715	96837	66866	48213	43578	37649	34177	33126	33973	27516	28807
HDV Rigid 7,5 - 12 t	HD Euro VI	58555	57086	70469	91715	96837	66866	48213	43578	37649	34177	33126	33973	27516	28807
HDV Rigid 12 - 14 t	Conventional	26817	26145	32274	42005	44350	30624	22081	19958	17243	15653	15171	15559	12602	13193
HDV Rigid 12 - 14 t	HD Euro I - 91/542/EEC Stage I	35028	34149	42155	54865	57929	40000	28842	26069	22522	20445	19816	20323	16460	17232
HDV Rigid 12 - 14 t	HD Euro II - 91/542/EEC Stage II	41874	40824	50395	65589	69251	47818	34479	31164	26924	24441	23689	24295	19678	20601
HDV Rigid 12 - 14 t	HD Euro III - 2000 Standards	52243	50933	62874	81830	86399	59659	43017	38881	33591	30493	29555	30311	24550	25702
HDV Rigid 12 - 14 t	HD Euro IV - 2005 Standards	53878	52527	64842	84391	89103	61526	44363	40098	34643	31447	30480	31260	25319	26506
HDV Rigid 12 - 14 t	HD Euro V - 2008 Standards	53878	52527	64842	84391	89103	61526	44363	40098	34643	31447	30480	31260	25319	26506
HDV Rigid 12 - 14 t	HD Euro VI	53878	52527	64842	84391	89103	61526	44363	40098	34643	31447	30480	31260	25319	26506
HDV Rigid 14 - 20 t	Conventional	33751	32904	40619	52865	55817	38542	27790	25119	21701	19700	19094	19582	15860	16605
HDV Rigid 14 - 20 t	HD Euro I - 91/542/EEC Stage I	42322	41261	50934	66290	69992	48330	34848	31498	27212	24702	23943	24555	19888	20822
HDV Rigid 14 - 20 t	HD Euro II - 91/542/EEC Stage II	48772	47549	58696	76393	80659	55695	40159	36298	31359	28467	27592	28297	22919	23994
HDV Rigid 14 - 20 t	HD Euro III - 2000 Standards	56547	55128	68053	88570	93516	64573	46560	42084	36358	33005	31990	32808	26573	27819
HDV Rigid 14 - 20 t	HD Euro IV - 2005 Standards	57786	56337	69545	90512	95567	65989	47581	43007	37156	33728	32691	33527	27155	28429
HDV Rigid 14 - 20 t	HD Euro V - 2008 Standards	57786	56337	69545	90512	95567	65989	47581	43007	37156	33728	32691	33527	27155	28429
HDV Rigid 14 - 20 t	HD Euro VI	57786	56337	69545	90512	95567	65989	47581	43007	37156	33728	32691	33527	27155	28429
HDV Rigid 20 - 26 t	Conventional	33801	32953	40679	52944	55900	38599	27832	25156	21733	19729	19122	19611	15884	16629
HDV Rigid 20 - 26 t	HD Euro I - 91/542/EEC Stage I	42886	41810	51613	67173	70924	48974	35312	31917	27575	25031	24262	24882	20153	21099

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
HDV Rigid 20 - 26 t	HD Euro II - 91/542/EEC Stage II	49178	47945	59185	77029	81331	56159	40493	36600	31621	28704	27821	28533	23110	24194
HDV Rigid 20 - 26 t	HD Euro III - 2000 Standards	58406	56941	70291	91483	96592	66697	48091	43468	37554	34090	33042	33887	27447	28734
HDV Rigid 20 - 26 t	HD Euro IV - 2005 Standards	53212	51877	64039	83347	88001	60765	43814	39602	34214	31058	30103	30873	25005	26178
HDV Rigid 20 - 26 t	HD Euro V - 2008 Standards	53212	51877	64039	83347	88001	60765	43814	39602	34214	31058	30103	30873	25005	26178
HDV Rigid 20 - 26 t	HD Euro VI	53212	51877	64039	83347	88001	60765	43814	39602	34214	31058	30103	30873	25005	26178
HDV Rigid 26 - 28 t	Conventional	33666	32822	40517	52732	55677	38445	27720	25056	21647	19650	19046	19533	15821	16563
HDV Rigid 26 - 28 t	HD Euro I - 91/542/EEC Stage I	41438	40399	49870	64906	68530	47320	34120	30840	26644	24186	23443	24042	19473	20387
HDV Rigid 26 - 28 t	HD Euro II - 91/542/EEC Stage II	47637	46443	57331	74616	78782	54399	39224	35454	30630	27805	26950	27639	22386	23436
HDV Rigid 26 - 28 t	HD Euro III - 2000 Standards	55977	54573	67367	87678	92574	63923	46091	41660	35992	32672	31668	32477	26305	27539
HDV Rigid 26 - 28 t	HD Euro IV - 2005 Standards	57494	56052	69193	90054	95083	65655	47340	42789	36967	33558	32526	33357	27018	28285
HDV Rigid 26 - 28 t	HD Euro V - 2008 Standards	57494	56052	69193	90054	95083	65655	47340	42789	36967	33558	32526	33357	27018	28285
HDV Rigid 26 - 28 t	HD Euro VI	57494	56052	69193	90054	95083	65655	47340	42789	36967	33558	32526	33357	27018	28285
HDV Rigid 28 - 32 t	Conventional	33744	32897	40610	52854	55805	38534	27784	25113	21697	19695	19090	19578	15857	16601
HDV Rigid 28 - 32 t	HD Euro I - 91/542/EEC Stage I	41981	40928	50523	65755	69427	47940	34567	31244	26993	24503	23749	24357	19728	20653
HDV Rigid 28 - 32 t	HD Euro II - 91/542/EEC Stage II	48303	47091	58131	75658	79883	55159	39772	35949	31058	28193	27326	28025	22699	23763
HDV Rigid 28 - 32 t	HD Euro III - 2000 Standards	57355	55917	69026	89837	94854	65497	47226	42686	36878	33477	32447	33277	26953	28217
HDV Rigid 28 - 32 t	HD Euro IV - 2005 Standards	54063	52707	65064	84681	89410	61738	44515	40236	34762	31555	30585	31367	25406	26597
HDV Rigid 28 - 32 t	HD Euro V - 2008 Standards	54063	52707	65064	84681	89410	61738	44515	40236	34762	31555	30585	31367	25406	26597
HDV Rigid 28 - 32 t	HD Euro VI	54063	52707	65064	84681	89410	61738	44515	40236	34762	31555	30585	31367	25406	26597
HDV Rigid >32 t	Conventional	41575	40532	50034	65119	68756	47476	34232	30941	26732	24266	23520	24121	19537	20454
HDV Rigid >32 t	HD Euro I - 91/542/EEC Stage I	45873	44723	55208	71852	75865	52385	37772	34141	29496	26775	25952	26615	21557	22568
HDV Rigid >32 t	HD Euro II - 91/542/EEC Stage II	56290	54878	67744	88168	93092	64280	46349	41893	36193	32855	31845	32659	26452	27693
HDV Rigid >32 t	HD Euro III - 2000 Standards	64832	63206	78025	101549	107219	74035	53383	48251	41686	37841	36677	37615	30466	31895
HDV Rigid >32 t	HD Euro IV - 2005 Standards	59391	57901	71476	93025	98220	67821	48902	44201	38187	34665	33599	34458	27909	29218
HDV Rigid >32 t	HD Euro V - 2008 Standards	59391	57901	71476	93025	98220	67821	48902	44201	38187	34665	33599	34458	27909	29218
HDV Rigid >32 t	HD Euro VI	59391	57901	71476	93025	98220	67821	48902	44201	38187	34665	33599	34458	27909	29218
HDV Articulated 14 - 20 t	Conventional	43961	42858	52906	68857	72702	50201	36197	32717	28266	25659	24870	25506	20658	21627
HDV Articulated 14 - 20 t	HD Euro I - 91/542/EEC Stage I	53123	51791	63933	83209	87855	60664	43741	39536	34157	31007	30053	30822	24964	26135
HDV Articulated 14 - 20 t	HD Euro II - 91/542/EEC Stage II	63560	61966	76494	99556	105116	72583	52335	47304	40868	37099	35958	36877	29868	31269
HDV Articulated 14 - 20 t	HD Euro III - 2000 Standards	79248	77260	95374	124128	131060	90497	65252	58979	50955	46255	44833	45979	37240	38988
HDV Articulated 14 - 20 t	HD Euro IV - 2005 Standards	84121	82011	101238	131761	139119	96062	69265	62606	54088	49099	47590	48806	39531	41385
HDV Articulated 14 - 20 t	HD Euro V - 2008 Standards	84121	82011	101238	131761	139119	96062	69265	62606	54088	49099	47590	48806	39531	41385

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
HDV Articulated 14 - 20 t	HD Euro VI	84121	82011	101238	131761	139119	96062	69265	62606	54088	49099	47590	48806	39531	41385
HDV Articulated 20 - 28 t	Conventional	48745	47522	58663	76350	80613	55664	40136	36278	31342	28451	27576	28281	22906	23981
HDV Articulated 20 - 28 t	HD Euro I - 91/542/EEC Stage I	57907	56455	69690	90701	95766	66127	47680	43097	37233	33799	32760	33597	27212	28488
HDV Articulated 20 - 28 t	HD Euro II - 91/542/EEC Stage II	69339	67600	83448	108607	114672	79181	57093	51605	44584	40471	39227	40230	32584	34113
HDV Articulated 20 - 28 t	HD Euro III - 2000 Standards	84031	81923	101129	131619	138969	95958	69190	62539	54030	49046	47538	48754	39488	41340
HDV Articulated 20 - 28 t	HD Euro IV - 2005 Standards	84121	82011	101238	131761	139119	96062	69265	62606	54088	49099	47590	48806	39531	41385
HDV Articulated 20 - 28 t	HD Euro V - 2008 Standards	84121	82011	101238	131761	139119	96062	69265	62606	54088	49099	47590	48806	39531	41385
HDV Articulated 20 - 28 t	HD Euro VI	84121	82011	101238	131761	139119	96062	69265	62606	54088	49099	47590	48806	39531	41385
HDV Articulated 28 - 34 t	Conventional	52332	51019	62980	81968	86545	59760	43089	38947	33648	30545	29605	30362	24592	25746
HDV Articulated 28 - 34 t	HD Euro I - 91/542/EEC Stage I	61407	59867	73902	96183	101554	70123	50562	45701	39483	35842	34739	35628	28856	30211
HDV Articulated 28 - 34 t	HD Euro II - 91/542/EEC Stage II	73444	71602	88389	115038	121461	83869	60473	54660	47223	42868	41549	42611	34513	36132
HDV Articulated 28 - 34 t	HD Euro III - 2000 Standards	88575	86354	106599	138738	146485	101148	72932	65921	56952	51699	50109	51390	41624	43576
HDV Articulated 28 - 34 t	HD Euro IV - 2005 Standards	96437	94018	116060	151052	159487	110126	79405	71772	62007	56288	54557	55952	45318	47444
HDV Articulated 28 - 34 t	HD Euro V - 2008 Standards	96437	94018	116060	151052	159487	110126	79405	71772	62007	56288	54557	55952	45318	47444
HDV Articulated 28 - 34 t	HD Euro VI	96437	94018	116060	151052	159487	110126	79405	71772	62007	56288	54557	55952	45318	47444
HDV Articulated 34 - 40 t	Conventional	49904	48653	60059	78167	82532	56988	41091	37141	32088	29128	28232	28954	23451	24552
HDV Articulated 34 - 40 t	HD Euro I - 91/542/EEC Stage I	64156	62547	77211	100490	106101	73263	52826	47748	41251	37446	36295	37223	30149	31563
HDV Articulated 34 - 40 t	HD Euro II - 91/542/EEC Stage II	76095	74186	91579	119189	125845	86896	62656	56633	48927	44415	43049	44149	35759	37436
HDV Articulated 34 - 40 t	HD Euro III - 2000 Standards	91873	89569	110568	143903	151939	104914	75648	68375	59073	53624	51975	53304	43173	45198
HDV Articulated 34 - 40 t	HD Euro IV - 2005 Standards	97391	94949	117209	152547	161065	111216	80191	72482	62621	56845	55097	56505	45766	47913
HDV Articulated 34 - 40 t	HD Euro V - 2008 Standards	97391	94949	117209	152547	161065	111216	80191	72482	62621	56845	55097	56505	45766	47913
HDV Articulated 34 - 40 t	HD Euro VI	97391	94949	117209	152547	161065	111216	80191	72482	62621	56845	55097	56505	45766	47913
HDV Articulated 40 - 50 t	Conventional	57613	56168	69337	90241	95280	65791	47438	42878	37044	33627	32593	33427	27074	28344
HDV Articulated 40 - 50 t	HD Euro I - 91/542/EEC Stage I	70672	68899	85052	110695	116877	80704	58191	52597	45441	41249	39981	41003	33210	34769
HDV Articulated 40 - 50 t	HD Euro II - 91/542/EEC Stage II	86958	84777	104652	136205	143810	99301	71601	64717	55912	50755	49194	50452	40864	42781
HDV Articulated 40 - 50 t	HD Euro III - 2000 Standards	103846	101241	124977	162657	171740	118587	85506	77286	66771	60612	58748	60250	48800	51089
HDV Articulated 40 - 50 t	HD Euro IV - 2005 Standards	97391	94949	117209	152547	161065	111216	80191	72482	62621	56845	55097	56505	45766	47913
HDV Articulated 40 - 50 t	HD Euro V - 2008 Standards	97391	94949	117209	152547	161065	111216	80191	72482	62621	56845	55097	56505	45766	47913
HDV Articulated 40 - 50 t	HD Euro VI	97391	94949	117209	152547	161065	111216	80191	72482	62621	56845	55097	56505	45766	47913
HDV Articulated 50 - 60 t	Conventional	52984	51655	63765	82990	87624	60505	43626	39432	34067	30925	29974	30741	24898	26067
HDV Articulated 50 - 60 t	HD Euro I - 91/542/EEC Stage I	62927	61349	75732	98565	104069	71860	51814	46833	40461	36729	35600	36510	29571	30958
HDV Articulated 50 - 60 t	HD Euro II - 91/542/EEC Stage II	76193	74282	91696	119342	126007	87008	62736	56705	48990	44472	43104	44206	35805	37484

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
HDV Articulated 50 - 60 t	HD Euro III - 2000 Standards	92837	90508	111728	145413	153533	106015	76441	69093	59692	54187	52520	53863	43626	45672
HDV Articulated 50 - 60 t	HD Euro IV - 2005 Standards	97391	94949	117209	152547	161065	111216	80191	72482	62621	56845	55097	56505	45766	47913
HDV Articulated 50 - 60 t	HD Euro V - 2008 Standards	97391	94949	117209	152547	161065	111216	80191	72482	62621	56845	55097	56505	45766	47913
HDV Articulated 50 - 60 t	HD Euro VI	97391	94949	117209	152547	161065	111216	80191	72482	62621	56845	55097	56505	45766	47913
BUS Urban Midi <=15 t	Conventional	53444	52103	64318	83710	88384	61030	44005	39775	34363	31194	30234	31007	25114	26292
BUS Urban Midi <=15 t	HD Euro I - 91/542/EEC Stage I	65801	64151	79190	103066	108821	75141	54180	48972	42309	38406	37225	38177	30921	32372
BUS Urban Midi <=15 t	HD Euro II - 91/542/EEC Stage II	70232	68471	84523	110007	116150	80202	57829	52270	45158	40993	39732	40748	33004	34552
BUS Urban Midi <=15 t	HD Euro III - 2000 Standards	74918	73039	90163	117346	123899	85553	61687	55757	48171	43728	42383	43467	35206	36857
BUS Urban Midi <=15 t	HD Euro IV - 2005 Standards	70775	68999	85176	110856	117047	80821	58275	52673	45507	41309	40039	41063	33259	34819
BUS Urban Midi <=15 t	HD Euro V - 2008 Standards	71666	69868	86248	112252	118520	81839	59009	53336	46080	41829	40543	41580	33677	35258
BUS Urban Midi <=15 t	HD Euro VI	71666	69868	86248	112252	118520	81839	59009	53336	46080	41829	40543	41580	33677	35258
BUS Urban Standard 15 - 18 t	Conventional	56590	55170	68105	88638	93587	64622	46595	42116	36386	33030	32014	32833	26593	27840
BUS Urban Standard 15 - 18 t	HD Euro I - 91/542/EEC Stage I	68778	67052	82773	107728	113744	78540	56631	51187	44223	40144	38909	39904	32320	33836
BUS Urban Standard 15 - 18 t	HD Euro II - 91/542/EEC Stage II	76661	74738	92260	120076	126781	87543	63122	57054	49291	44745	43369	44478	36025	37715
BUS Urban Standard 15 - 18 t	HD Euro III - 2000 Standards	81752	79701	98386	128049	135200	93356	67314	60843	52565	47716	46249	47431	38417	40220
BUS Urban Standard 15 - 18 t	HD Euro IV - 2005 Standards	79152	77167	95259	123978	130902	90388	65173	58908	50893	46199	44779	45923	37196	38941
BUS Urban Standard 15 - 18 t	HD Euro V - 2008 Standards	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886
BUS Urban Standard 15 - 18 t	HD Euro VI	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886
BUS Urban Articulated >18 t	Conventional	54213	52853	65244	84915	89657	61908	44638	40347	34858	31643	30670	31454	25476	26671
BUS Urban Articulated >18 t	HD Euro I - 91/542/EEC Stage I	69162	67427	83235	108331	114380	78980	56948	51473	44470	40368	39127	40127	32501	34026
BUS Urban Articulated >18 t	HD Euro II - 91/542/EEC Stage II	77903	75949	93755	122022	128835	88961	64145	57978	50090	45470	44072	45198	36608	38326
BUS Urban Articulated >18 t	HD Euro III - 2000 Standards	82681	80607	99505	129505	136737	94417	68079	61534	53162	48259	46775	47970	38854	40676
BUS Urban Articulated >18 t	HD Euro IV - 2005 Standards	78499	76530	94472	122955	129821	89642	64636	58422	50473	45818	44409	45544	36889	38619
BUS Urban Articulated >18 t	HD Euro V - 2008 Standards	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886
BUS Urban Articulated >18 t	HD Euro VI	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886
BUS Coaches Standard <=18 t	Conventional	54530	53163	65626	85412	90182	62271	44900	40584	35062	31828	30849	31638	25625	26827
BUS Coaches Standard <=18 t	HD Euro I - 91/542/EEC Stage I	63759	62159	76732	99867	105443	72809	52498	47452	40996	37214	36070	36992	29962	31367
BUS Coaches Standard <=18 t	HD Euro II - 91/542/EEC Stage II	70291	68528	84594	110099	116247	80269	57877	52313	45196	41027	39765	40782	33031	34581
BUS Coaches Standard <=18 t	HD Euro III - 2000 Standards	76088	74179	91570	119178	125833	86888	62650	56627	48923	44410	43045	44145	35755	37432
BUS Coaches Standard <=18 t	HD Euro IV - 2005 Standards	79596	77599	95792	124673	131634	90894	65538	59238	51178	46458	45029	46180	37404	39159
BUS Coaches Standard <=18 t	HD Euro V - 2008 Standards	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886
BUS Coaches Standard <=18 t	HD Euro VI	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
BUS Coaches Articulated >18 t	Conventional	53968	52614	64949	84531	89252	61628	44437	40165	34700	31500	30531	31312	25361	26550
BUS Coaches Articulated >18 t	HD Euro I - 91/542/EEC Stage I	65062	63430	78301	101908	107599	74297	53571	48421	41833	37975	36807	37748	30574	32008
BUS Coaches Articulated >18 t	HD Euro II - 91/542/EEC Stage II	74317	72453	89440	116405	122905	84867	61192	55310	47785	43377	42043	43118	34923	36561
BUS Coaches Articulated >18 t	HD Euro III - 2000 Standards	78773	76797	94801	123384	130273	89954	64861	58626	50649	45978	44564	45703	37017	38754
BUS Coaches Articulated >18 t	HD Euro IV - 2005 Standards	78694	76720	94707	123260	130143	89864	64796	58567	50599	45932	44519	45657	36980	38715
BUS Coaches Articulated >18 t	HD Euro V - 2008 Standards	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886
BUS Coaches Articulated >18 t	HD Euro VI	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886
BUS Urban CNG	HD Euro I - 91/542/EEC Stage I	0	0	0	205151	333999	298572	323585	247400	287659	329388	199055	148684	139803	135829
BUS Urban CNG	HD Euro II - 91/542/EEC Stage II	0	0	0	228666	372282	332794	360674	275756	320631	367142	221870	165726	155827	151398
BUS Urban CNG	HD Euro III - 2000 Standards	0	0	0	243850	397003	354893	384624	294068	341922	391522	236604	176731	166175	161452
BUS Urban CNG	EEV	0	0	0	243850	397003	354893	384624	294068	341922	391522	236604	176731	166175	161452
BUS Urban Biodiesel	Conventional	56590	55170	68105	88638	93587	64622	46595	42116	36386	33030	32014	32833	26593	27840
BUS Urban Biodiesel	HD Euro I - 91/542/EEC Stage I	68778	67052	82773	107728	113744	78540	56631	51187	44223	40144	38909	39904	32320	33836
BUS Urban Biodiesel	HD Euro II - 91/542/EEC Stage II	76661	74738	92260	120076	126781	87543	63122	57054	49291	44745	43369	44478	36025	37715
BUS Urban Biodiesel	HD Euro III - 2000 Standards	81752	79701	98386	128049	135200	93356	67314	60843	52565	47716	46249	47431	38417	40220
BUS Urban Biodiesel	HD Euro IV - 2005 Standards	79152	77167	95259	123978	130902	90388	65173	58908	50893	46199	44779	45923	37196	38941
BUS Urban Biodiesel	HD Euro V - 2008 Standards	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886
BUS Urban Biodiesel	HD Euro VI	107499	104802	129373	168378	177780	122758	88514	80005	69119	62744	60815	62369	50516	52886
MOP 2-stroke <50 cm³	Conventional	1192	1217	1076	979	878	1715	1487	1332	1310	1197	1077	1010	835	963
MOP 2-stroke <50 cm³	Mop - Euro I	1257	1283	1135	1032	926	1808	1568	1404	1381	1262	1136	1064	881	1016
MOP 2-stroke <50 cm³	Mop - Euro II	932	952	842	766	687	1342	1163	1042	1025	936	843	790	653	754
MOP 2-stroke <50 cm³	Mop - Euro III	780	796	704	641	575	1122	973	872	857	783	705	661	547	630
MOT 2-stroke >50 cm³	Conventional	1773	1810	1601	1456	1306	2551	2212	1981	1948	1780	1602	1501	1242	1433
MOT 2-stroke >50 cm³	Mot - Euro I	1849	1887	1669	1519	1362	2660	2307	2066	2032	1856	1671	1566	1296	1494
MOT 2-stroke >50 cm³	Mot - Euro II	2095	2138	1891	1721	1543	3014	2613	2340	2302	2103	1893	1774	1468	1693
MOT 2-stroke >50 cm³	Mot - Euro III	2147	2191	1938	1764	1581	3089	2678	2398	2359	2156	1940	1818	1504	1735
MOT 4-stroke <250 cm³	Conventional	2296	2344	2074	1887	1691	3304	2865	2566	2524	2306	2076	1945	1609	1856
MOT 4-stroke <250 cm³	Mot - Euro I	2554	2607	2306	2098	1881	3675	3186	2854	2807	2565	2308	2163	1790	2064
MOT 4-stroke <250 cm³	Mot - Euro II	2262	2309	2043	1858	1666	3255	2822	2528	2486	2272	2045	1916	1585	1828
MOT 4-stroke <250 cm³	Mot - Euro III	2416	2466	2181	1985	1779	3476	3014	2699	2655	2426	2184	2046	1693	1953
MOT 4-stroke 250 - 750 cm³	Conventional	2363	2412	2134	1941	1741	3400	2948	2640	2597	2373	2136	2001	1656	1910
MOT 4-stroke 250 - 750 cm³	Mot - Euro I	2658	2714	2400	2184	1958	3825	3317	2970	2922	2669	2403	2251	1863	2149

Subsector	Technology	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MOT 4-stroke 250 - 750 cm^3	Mot - Euro II	2382	2432	2151	1957	1754	3427	2972	2661	2618	2392	2153	2017	1669	1925
MOT 4-stroke 250 - 750 cm^3	Mot - Euro III	2416	2466	2181	1985	1779	3476	3014	2699	2655	2426	2184	2046	1693	1953
MOT 4-stroke >750 cm^3	Conventional	2399	2449	2166	1971	1767	3451	2993	2680	2636	2409	2168	2031	1681	1939
MOT 4-stroke >750 cm^3	Mot - Euro I	2734	2791	2468	2246	2014	3933	3411	3054	3005	2745	2471	2315	1916	2210
MOT 4-stroke >750 cm^3	Mot - Euro II	2445	2495	2207	2008	1800	3517	3050	2731	2687	2455	2209	2070	1713	1976
MOT 4-stroke >750 cm^3	Mot - Euro III	2416	2466	2181	1985	1779	3476	3014	2699	2655	2426	2184	2046	1693	1953