# GREENHOUSE GAS EMISSIONS IN ESTONIA
# 1990–2005

**NATIONAL INVENTORY REPORT**
to the UNFCCC secretariat

Common Reporting Formats (CRF)
1990-2005

Tallinn 2007

# PREFACE

Estonian National Inventory Report under the UNFCCC (United Framework Convention on Climate Change) contains the following parts:

Part I. Description of the greenhouse gas emission inventory according to the UNFCCC reporting guidelines (FCCC/SBSTA/2004/8) containing description of the organisation of the national greenhouse gas inventory, IPCC and other methods applied in calculation of the year 2005 emissions and exemptions to the previous inventories. A summarising table of the emissions data for the years 1990-2005 is included as well as description of the current emission trends.

Part II. CRF (Common Reporting Format) data tables of Estonian updated greenhouse gas emission inventories for the years 1990-2005. The CFR tables are compiled for the first time with the UNFCCC CRF Reporter software (version 3.1).

Methodological improvements in accordance with the IPCC Guidelines for National Greenhouse Gas Inventories and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and changes since the inventory submission in 2005 are listed in Chapter 7

Department of Thermal Engineering and Department of Chemistry at Tallinn University of Technology (Inge Roos, Olga Gavrilova) have made the inventory calculations, the description of the methodologies and other information included in the National Inventory report. Climate and Ozone Bureau of Estonian Environment Information Centre (EEIC) co-ordinates the process of the inventory preparation.

The Ministry of the Environment is responsible for the finalisation of inventory reports and their submission to the UNFCCC Secretariat and the EC Commission.

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# EXECUTIVE SUMMARY

## ES.1. Background information on greenhouse gas inventories

Estonia signed the Framework Convention on Climate Change at the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992. In 1994 Estonia ratified the UN FCCC and in 2002, the Kyoto Protocol. Under the Protocol Estonia is obliged to reduce during the period 2008-1012 the emissions of air polluting greenhouse gases from its territory by 8% as compared with the 1990 level. A National Programme for the Reduction of Greenhouse Gas Emissions was compiled taking into consideration the Kyoto Protocol and the European Council Decision 93/389/EC from 24 June 1993 on the monitoring of greenhouse gas emissions in the EU (EÜT L 167, 09/07/1993 p 0031-0033). On 30 April 2004 the Estonian Government approved the National Programme for the Reduction of Greenhouse Gas Emissions for the years 2003-2012.

Estonia has prepared greenhouse gas inventories since the year 1994. Inventory reports are submitted to the UNFCCC Secretariat and the European Commission annually.

The Ministry of the Environment organises the practical providing of GHG inventories. Financial resources for this purpose are planned in the State Budget. Practical work is done on the basis of contracts. The Institute of Ecology at Tallinn University has been responsible for the inventories under contract to the Ministry of the Environment in Estonia until summer 2006. Since 2006 autumn 2 departments of Tallinn University of Technology (TTU) prepare the inventory (Department of Thermal Engineering and Department of Chemistry) and Climate and Ozone Bureau of Estonian Environment Information Centre (EEIC) co-ordinates the process of the inventory preparation.

This report presents the national inventory of greenhouse gas (GHG) emissions and removals from 1990 to 2004. The components covered are carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$). Data on F-gases – hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$) – are not provided. Thus emissions of this kind were not estimated, though a data collection system is currently under development. Estimates of the emission data for nitrogen oxides ($NO_x$), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide ($SO_2$) were also included in inventory data.

In this submission, which reports carbon stock changes and greenhouse gas emissions from LULUCF that occurred in 2005, Estonia has used the new UNFCCC reporting guidelines on annual inventories (FCCC/SBSTA/2004/8) and GPG LULUCF (IPCC 2003) for the second time. The earlier period (1990–2003) has been reported by using previous version of CRF tables (corresponding to 3/CP.5) and methods (IPCC 1997). The whole LULUCF-sector reporting is under ongoing development and will be more complete in forthcoming submissions.

The main sources of data were the Statistical Yearbooks and other publications issued by the Statistical Office of Estonia. Unfortunately the availability and reliability of data from different sectors differs, especially for the first years of independence regained in 1991. During the last 10 years Estonia has made great efforts in all directions, including in order increasing the reliability of statistical data.

The report and associated Common Reporting Format (CRF) tables were prepared in accordance with the UNFCCC reporting Guidelines on Annual Inventories. The CRF Tables are produced with the CRF Reporter software (version 3.1). The methodology used in calculations of emissions is harmonised with the Guidelines for National Greenhouse Gas Inventories and those of Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories published by the Intergovernmental Panel of Climate Change (IPCC). The methodology is described in detail in the *Estonia's Third National Communication* (2001) and *Estonia's Fourth National Communication* (2006).

The national inventory and reporting system is being constantly developed and improved.

## ES.2. Summary of trends in national emissions and removals

By 2004, Estonia reduced its emissions by 50.7% in comparison to the base year. This drastic decrease was mainly caused by the transition from planned economy to market economy and successful implementation of necessary reforms.

In 2005 the total emission of GHGs, measured as $CO_2$-equivalents, was 12 562.3 Gg, without $CO_2$ from LUCF 20 658.9 Gg. From 1990 to 2005 the emissions decreased by 52.6%. Table ES2_1 shows the trends in the total emissions during the period 1990–2005.

In 2005, the most important GHG in Estonia was carbon dioxide ($CO_2$), contributing 87.13 per cent to total national GHG emissions expressed in $CO_2$ equivalent, followed by methane ($CH_4$), 9.08 per cent, and nitrous oxide ($N_2O$), 3.73 per cent. Fluorocarbons (so-called "F gases") account for about 0.07 per cent of total emissions. The Energy sector accounted for 88.98 per cent of total GHG emissions, followed by Agriculture (5.75 per cent), Industrial Processes (2.71 per cent) and Waste (2.57 per cent).

**Table ES2_1. Greenhouse-gas emissions in Estonia – changes with regard to the base year**

| GHG EMISSIONS | Base year | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ equivalent (Gg) | | | | | | | | |
| $CO_2$ emissions including net $CO_2$ from LULUCF | 29 071,64 | 29 071,64 | 10 888,25 | 8 147,48 | 8 822,05 | 9 452,55 | 11 328,78 | 10 530,90 | 9 901,96 |
| $CO_2$ emissions excluding net $CO_2$ from LULUCF | 38 442,34 | 38 442,34 | 20 104,73 | 16 952,10 | 17 255,48 | 16 950,77 | 19 064,63 | 18 520,79 | 17 998,89 |
| $CH_4$ emissions including $CH_4$ from LULUCF | 3 294,54 | 3 294,54 | 2 171,48 | 2 049,09 | 1 850,03 | 1 745,46 | 1 743,42 | 1 849,36 | 1 875,99 |
| $CH_4$ emissions excluding $CH_4$ from LULUCF | 3 287,45 | 3 287,45 | 2 169,31 | 2 044,46 | 1 848,47 | 1 736,43 | 1 742,10 | 1 846,97 | 1 875,39 |
| $N_2O$ emissions including $N_2O$ from LULUCF | 1 865,32 | 1 865,32 | 889,40 | 735,85 | 709,25 | 658,71 | 757,69 | 771,54 | 770,33 |
| $N_2O$ emissions excluding $N_2O$ from LULUCF | 1 864,61 | 1 864,61 | 889,18 | 735,38 | 709,09 | 657,79 | 757,55 | 771,29 | 770,26 |
| HFCs | NA,NO | NA,NO | 0,13 | 4,19 | 4,89 | 5,68 | 6,59 | 7,21 | 7,88 |
| PFCs | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO | NA,NO |
| $SF_6$ | NA,NO | NA,NO | 0,25 | 1,43 | 2,24 | 3,68 | 4,75 | 5,28 | 5,87 |
| **Total (including LULUCF)** | **34 231,50** | **34 231,50** | **13 949,51** | **10 938,04** | **11 388,45** | **11 866,07** | **13 841,22** | **13 164,29** | **12 562,03** |
| **Total (excluding LULUCF)** | **43 594,40** | **43 594,40** | **23 163,60** | **19 737,57** | **19 820,17** | **19 354,35** | **21 575,62** | **21 151,54** | **20 658,29** |

| GHG SOURCE AND SINK CATEGORIES | Base year | 1990 | 1995 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|
| | $CO_2$ equivalent (Gg) | | | | | | | | |
| 1. Energy | 38 834,33 | 38 834,33 | 20 333,83 | 17 180,55 | 17 489,13 | 17 293,64 | 19 418,52 | 18 847,73 | 18 381,51 |
| 2. Industrial Processes | 945,59 | 945,59 | 568,92 | 587,80 | 612,21 | 423,35 | 467,64 | 579,95 | 559,19 |
| 3. Solvent and Other Product Use | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 4. Agriculture | 3 124,40 | 3 124,40 | 1 506,41 | 1 172,20 | 1 168,35 | 1 090,92 | 1 168,34 | 1 186,17 | 1 187,00 |
| 5. Land Use, Land-Use Change and Forestry[(5)] | -9 362,90 | -9 362,90 | -9 214,08 | -8 799,53 | -8 431,72 | -7 488,28 | -7 734,40 | -7 987,25 | -8 096,26 |
| 6. Waste | 690,08 | 690,08 | 754,44 | 797,02 | 550,49 | 546,44 | 521,12 | 537,69 | 530,58 |

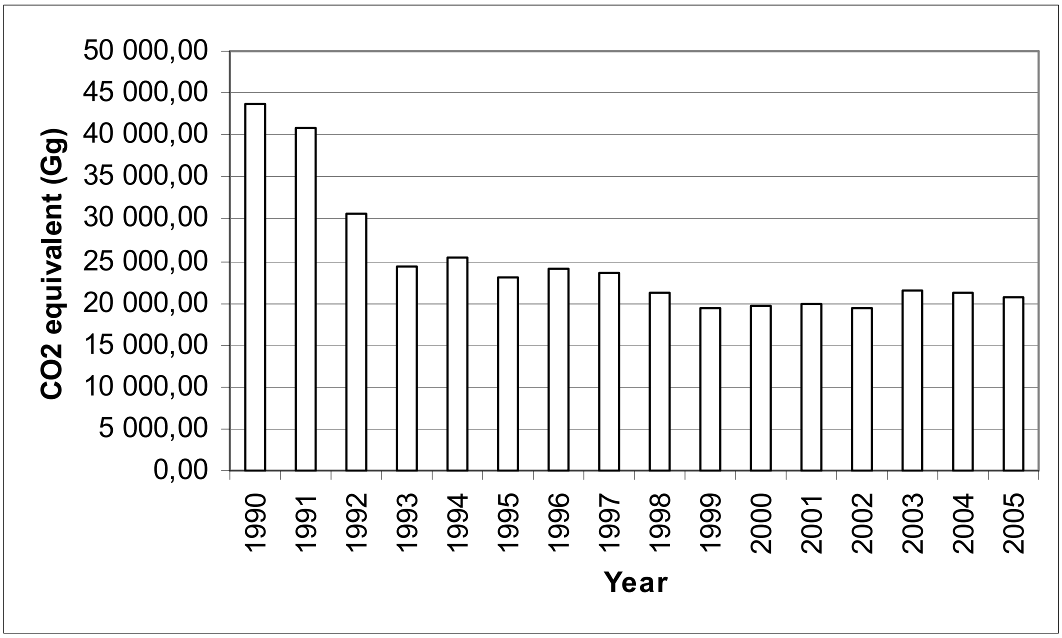



Figure ES2_1: Overall development of greenhouse gases in Estonia, in CO2 equivalents (without CO2 from LULUCF)

**Table ES2_2. Greenhouse-gas emissions in Estonia – annual contributions of the various greenhouse gases**

| GHG EMISSIONS [CO2 equivalent (Gg)] | Base year | | 1990 | | 1995 | | 2000 | | 2005 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | [Gg] | [%] | [Gg] | [%] | [Gg] | [%] | [Gg] | [%] | [Gg] | [%] |
| $CO_2$ emissions excluding net $CO_2$ from LULUCF | **38 442,34** | 88,18 | **38 442,34** | 88,18 | **20 104,73** | 86,79 | **16 952,10** | 85,89 | **17 998,89** | 87,13 |
| $CH_4$ emissions excluding $CH_4$ from LULUCF | **3 287,45** | 7,54 | **3 287,45** | 7,54 | **2 169,31** | 9,37 | **2 044,46** | 10,36 | **1 875,39** | 9,08 |
| $N_2O$ emissions excluding $N_2O$ from LULUCF | **1 864,61** | 4,28 | **1 864,61** | 4,28 | **889,18** | 3,84 | **735,38** | 3,73 | **770,26** | 3,73 |
| HFCs | **NA,NO** | | **NA,NO** | | **0,13** | 0,001 | **4,19** | 0,02 | **7,88** | 0,04 |
| PFCs | **NA,NO** | | **NA,NO** | | **NA,NO** | | **NA,NO** | | **NA,NO** | |
| $SF_6$ | **NA,NO** | | **NA,NO** | | **0,25** | 0,001 | **1,43** | 0,01 | **5,87** | 0,03 |
| **Total (excluding LULUCF)** | **43 594,40** | | **43 594,40** | | **23 163,60** | | **19 737,57** | | **20 658,29** | |

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

The greenhouse gas emissions and removals are divided into the following sectors according to the UNFCCC reporting guidelines on annual inventories (FCCC/SBSTA/2004/8): Energy (CRF 1), Industrial processes (CRF 2), Solvent and other product use (CRF 3), Agriculture (CRF 4), Land use, Land use change and Forestry (LULUCF) (CRF 5) and Waste (CRF 6).

Figure ES3_1 shows the contributions of individual source and sink categories to total greenhouse-gas emissions.

Over the period 1990–2005, emissions from the Energy sector decreased by 52.7 per cent, emissions from the Industrial Processes and Waste sectors decreased by 40.9 per cent and 23.1 per cent, respectively, and reductions of 62 per cent occurred in emissions from the Agriculture sector. Reported net $CO_2$ removals in the Land-use Change and Forestry (LUCF) sector decreased by 13.5 per cent between 1990 and 2005.

In comparison to the previous year, 2004, total emissions decreased by 2.33 per cent.

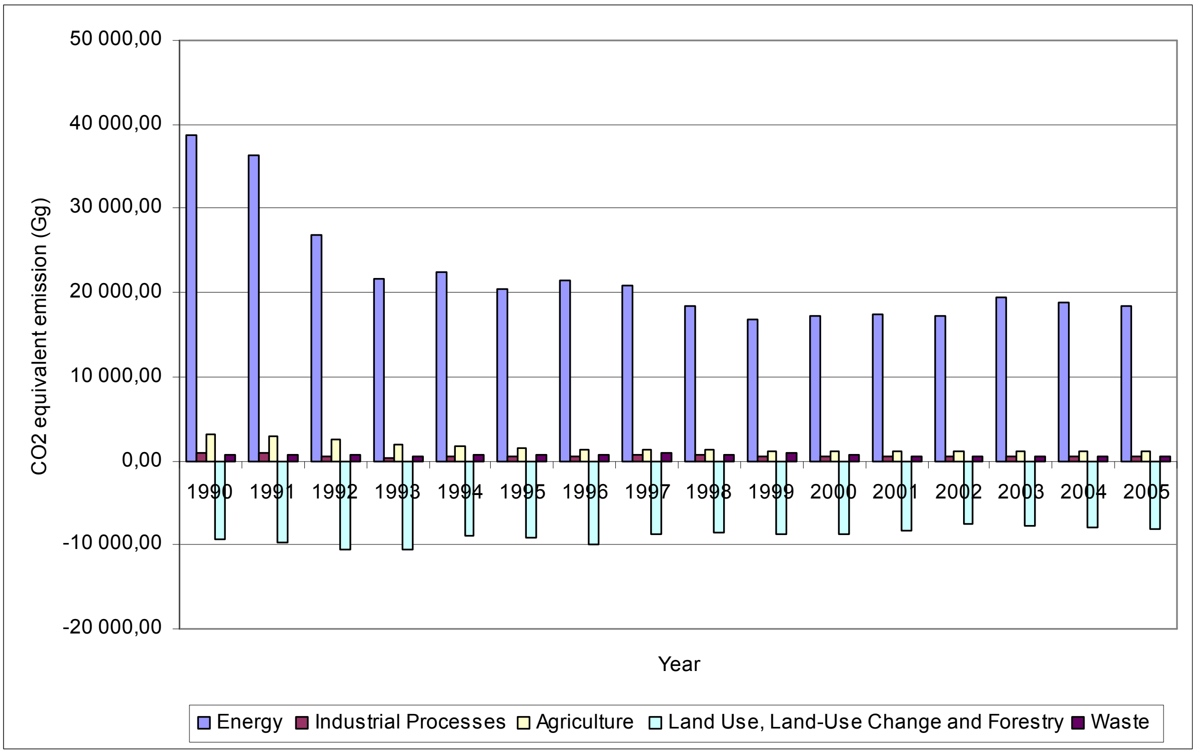



Figure ES3_1: Greenhouse-gas emissions trends, by source groups, in CO2 equivalents

On 30th of April 2004 Estonian Government approved the National Program for reduction of Greenhouse Gas Emissions for years 2003-2012.

# CHAPTER 1. INTRODUCTION

## 1.1. Background and institutional arrangement

Estonia signed the Framework Convention on Climate Change at the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992. In 1994 Estonia ratified the UN FCCC and in 2002, the Kyoto Protocol. In response to UNFCCC requirements Estonia has prepared the present emission National Inventory Report.

In 1994 an Interministerial Committee of Climate Change was created at the Estonian Government. The Chairman of this Committee is the Minister of the Environment and members are from key ministries, scientists as well as representatives of NGOs. This Committee deals with the problems connected with the implementation of UN FCCC, organises monitoring of emissions of GHG, national communications etc.

The Ministry of the Environment organises the practical providing of GHG inventories. Financial resources for this purpose are planned in the State Budget. Practical work has been done on the basis of contracts. Department of Thermal Engineering and Department of Chemistry at Tallinn Technical University is responsible for the inventories and National Communications under contract to the Ministry of the Environment in Estonia.

This report presents the national inventory of greenhouse gas (GHG) emissions and removals from 1990 to 2005. The components covered are carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$). Also reported are four indirect greenhouse gases: nitrogen oxides ($NO_x$), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide ($SO_2$).

Emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$) have not been estimated. Unfortunately Estonia does not have such a data collection system which is necessary to calculate the emissions of these gases.

The Twinning project “Enhancing the capacity to reduce the emissions of fluorinated greenhouse gases in Estonia” financed by the EU should start in the year 2007 and end in 2008. To which extent the Ozone Depleting Substances (ODS) database can be used in the content of fluorinated greenhouse gases will be estimated and what kind of additional measures have to be implemented will be estimated during this project. In addition to that the missing inventories will be compiled and necessary strategies, programs, guidelines, standards and legal documents will be worked out. Public and industry awareness campaigns on how to stabilize the emissions of fluorinated greenhouse gases and how to minimize these emissions in the future will be planned. The Twinning project aims at preparing Estonia for better implementation of the UN Framework Convention on Climate Change and its Kyoto Protocol as well as preparing Estonia for implementation the new EC Regulation No 842/2006 on certain fluorinated greenhouse gases (of 17 May 2006) (replaces Commission document 2003/0189) ) complemented by the new EC Directive 2006/40/EC.

The structure of this report corresponds to the UNFCCC reporting guidelines on annual inventories 2004 (FCCC/SBSTA/2004/8). Chapter 1 gives an introduction to the background of greenhouse gas inventories and the arrangement for inventory preparation. Chapters 2-6 give information of GHG emission trends from the base year 1990 to year 2005 for the following sectors: energy; industrial processes; agriculture; land use, land-use change and forestry; waste. A number of (methodological) changes have been implemented in the NIR 2007 relative to the NIR of the preceding year. A detailed overview of these changes is provided in Chapter 7. Annex 1 includes emission factors of non- $CO_2$ gases from fuel combustion, Annex 2 contains the QC checklists. In Annex 3 the assessment of completeness is described and Annex 4 includes reasoning and impact of the recalculations for the sectors Energy and Industrial Processes.

## 1.2. Brief description of the process of inventory preparation

Estonian national GHG inventory system is designed and operated according to the guidelines for national system under article 5, paragraph 1, of the Kyoto Protocol (Decision 20/CP7) to ensure the transparency, consistency, comparability, completeness and accuracy of inventories. Inventory activities include planning, preparation and management of the inventories.

The inventory phases are:

- collecting activity data;
- selecting methods and emission factors appropriately;
- estimating anthropogenic GHG emissions by sources and removals by sinks;
- implementing uncertainty assessment;
- implementing QA/QC activities;
- verification of the inventory data at the national level.

The Ministry of the Environment organises the practical providing of GHG inventories. Financial resources for this purpose are planned in the State Budget. Practical work is done on the basis of contracts. The Institute of Ecology at Tallinn University has been responsible for the inventories under contract to the Ministry of the Environment in Estonia until summer 2006. Since 2006 autumn 2 departments of Tallinn University of Technology (TTU) prepare the inventory (Department of Thermal Engineering and Department of Chemistry) and Climate and Ozone Bureau of Estonian Environment Information Centre (EEIC) co-ordinates the process of the inventory preparation.

Three specialists are involved in the preparation of the 2005 year inventory: 2 specialists from TTU and 1 specialist from EEIC. Department of Thermal Engineering of TTU is responsible for the preparation of energy and industrial processes inventory sectors including Common Reporting Format (CRF) tables and relevant chapters of the national inventory report. The expert on energy and industrial processes sectors has a long experience in the inventory preparation since 1993. TTU Department of Chemistry is responsible for the preparation of agriculture, waste and LULUCF sectors including CRF tables and relevant chapters of the report. These 3 sectors are prepared by new experts. Inventory compilation takes place in Climate and Ozone Bureau of EEIC. The Ministry of the Environment submits them to the UNFCCC Secretariat and to the European Commission.

Methodological improvements in accordance with the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories", "Revised 2000 IPCC Guidelines for National Greenhouse Gas Inventories" and the Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, and according to the recommendations by the Expert Review Teams, have been implemented in the present inventory as far as possible and will be implemented in their entirety as soon as possible.

The estimation of GHG emissions in Estonia is based on Intergovernmental Panel on Climate Change (IPCC 1996, 2000) tier 1 and tier 2 methods, default emission factors (EFs) and available Estonian data.

In deriving emissions/removals estimates for LULUCF IPCC *Good Practice Guidance for Land Use, Land-use Change and Forestry* (LULUCF) (hereinafter referred to as the IPCC good practice guidance for LULUCF) and the requirements of decision 14/CP.11 were accounted.

## 1.3. Database information and methodologies

More detailed description of the methodologies and activity data sources is presented in the "Estonia's fourth National Communication" which is also available in the UNFCCC website.

Main data sources used in current inventory are given in Table 1.3_1.

**Table 1.3_1. Methodology, activity data and emission factor sources used**

| IPCC category | Methodology (1) | Emission factor (1) | Activity data |
|---|---|---|---|
| **1. Energy** | Revised 1996 IPCC methodology; IPCC good practice guidance | Revised 1996 IPCC methodology | Energy balances provided by the Statistical Office of Estonia |
| A. Fuel Combustion | $T_1$ | D, CS | Energy balances |
| B. Transport | $T_1$ | D | Energy balances |
| C. Fugitive Emissions | | D; CS | Energy balances |
| **2. Industrial Processes** | Revised 1996 IPCC methodology | | Plant specific data |
| A. Mineral Industry | $T_1$ | D, CS | Statistical Yearbooks; Plant specific data |
| B. Chemical industry | $T_1$, CS | CS | Plant specific data |
| B. Other consumption | | D | Statistical Yearbooks |
| C. Consumption of halocarbons and $SF_6$ | $T_1$a | D | Statistical database |
| D. Feedstock and non-energy use of fuels | $T_1$ | D | Statistical Yearbooks |
| **4. Agriculture** | Revised 1996 IPCC methodology, Revised 2000 IPCC methodology | Revised 1996 IPCC methodology, Revised 2000 IPCC methodology | Estonian statistics; IPCC default parameters |
| A. Enteric Fermentation | $T_1$; $T_2$; L | IPCC; CS | Estonian statistics; IPCC default parameters |
| B. Manure Management | $T_1$ | IPCC; CS | Estonian statistics; IPCC default parameters |
| D. Agricultural Soils | $T_1$ | IPCC | Estonian statistics; IPCC default parameters |
| **5. LUCF** | Revised 1996 IPCC methodology IPCC good practice guidance for LULUCF | Revised 1996 IPCC methodology | |
| A. Forest land | $T_1$, NE | IPCC, CS, NE | Statistical Office of Estonia, Estonia forest 2005; Forest Resources Assessment 2005 |
| B. Croplands | NE | NE | |
| C. Grassland | NE | NE | |
| D. Wetlands | NE | NE | |
| E. Settlements | NE | NE | |
| **6. Waste** | Revised 1996 IPCC methodology | Revised 1996 IPCC methodology | |
| A. Solid Waste Disposal on Land | $T_1$ | IPCC, CS | Estonian Evironment Information Center; Estonian Office of Statistics. |

| | | | |
|---|---|---|---|
| B. Wastewater Handling | $T_1$ | IPCC; CS | Estonian Evironment Information Center; Estonian Office of Statistics. |
| C. Waste Incineration | NE | NE | |

$T_1$ –IPCC Tier 1; $T_2$ –IPCC Tier 2; L – Literature; IPCC – IPCC default factors; CS – Country specific; NE – not estimated

The main sources of data are from official Estonian statistics (the Statistical Office of Estonia, Estonian Animal Recording Center) and from company's annual emission reports. This data is often too general and inadequate. The availability and reliability of data from different sectors differs, especially for the first years of regained independence from 1991 onward. It is practically not possible to revise estimates for 1990 because at that time absolutely different system of the statistic was practizised. Emissions for the base year are not overestimated but are most probably underestimated. In 1990 in Estonia were a huge amount of Soviet troops and in the inventory were not included emissions from military sources.

General (Tier 1) Quality Control (QC) procedures were applied to all categories as following:

- Activity data were compiled and gross-checked.
- The default factors were used.
- All units were checked

For estimating the emissions of GHG and sinks, as well as the uncertainties associated with them, the IPCC top-down method according to the IPCC Guidelines (IPCC Greenhouse Gas Inventory Reporting Instructions: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Volumes I, II and III, 1997) was used.

The Estonian inventory also includes carbon monoxide (CO), nitrogen oxides ($NO_x$), non-methane volatile organic compounds (NMVOCs) and sulphur oxides ($SO_2$). Sulphur gases – primarily $SO_2$ – are believed to contribute negatively to the greenhouse effect.

Estonia has prepared already four climate reports. The Fourth National Communication covers the GHG inventories of the years 1990 to 2004 including also the years for which inventories have been reported earlier and have been recalculated in 2002. The purpose of all recalculations was to improve the accuracy and completeness. Now, the inventory of all years up to 2005 is estimated using the same methodology, adjusted statistical data and emission factors.

Due to the sparse population and specificity of land-use structure (ca 50% of the territory is covered by forest, 21% by wetlands, there are more than 1500 small lakes, the proportion of abandoned lands is growing) the sink of GHG by Estonian nature is great. Presently we can consider only the $CO_2$ sink by forest, which compensates for about 30% of the emissions. In reality the sink is much greater being roughly comparable with total emission. Research demonstrates that during the second half of the 20th century Estonian peatlands were strongly influenced by drainage for agricultural, forestry and peat industry purposes. The ongoing restoration projects are directed toward increasing peat increment and thus also the accumulation of GHG, which may be about 3.37 t $ha^{-1}$ $yr^{-1}$. Large areas previously used for agricultural purposes are now abandoned and covered by bushes and forest. Soil and vegetative cover provide a potential sink for carbon emissions. Today we have not enough trustful data to calculate the changes in the accumulation of GHG for those areas. However, Estonia will report GHG flows in the further submissions.

## 1.4. Brief description of key source categories

Key categories are the categories of emissions/removals, which have a significant influence on the total inventory in terms of the absolute level of emissions (1990 or 2005), the trend of emissions (change between 1990 and 2005) or both. There are two alternative methods for identifying key categories: Tier 1 and Tier 2. In this report Tier 1 method has been used – the emission categories are sorted according to their contribution to emission level or trend. The key categories are those that represent together 95% of inventory level or trend.

**Table 1.4_1. Key categories in 1990 by level without LULUCF (Tier 1)**

| IPCC code | IPCC source category | Fuel | Gas | 1990 Base year $CO_{2\ eq}$ | Level Assessment | Cumulative Total |
|---|---|---|---|---|---|---|
| 1.A.1.a | Public Electricity and Heat Production | Solid Fuels | $CO_2$ | 21970.56 | 50.40% | 50.40% |
| 1.A.1.a | Public Electricity and Heat Production | Liquid Fuels | $CO_2$ | 4825.04 | 11.07% | 61.47% |
| 1.A.1.a | Public Electricity and Heat Production | Gaseous Fuels | $CO_2$ | 2033.48 | 4.66% | 66.13% |
| 1.A.1.b | Petroleum refining | Solid Fuels | $CO_2$ | 1528.99 | 3.51% | 69.64% |
| 1.A.3.b | Road Transportation | Gasoline | $CO_2$ | 1462.15 | 3.35% | 72.99% |
| 4.A | Enteric Fermentation: Cattle (CH4) | | $CH_4$ | 1060.01 | 2.43% | 75.42% |
| 1.A.2.f | Other | Solid Fuels | $CO_2$ | 819.87 | 1.88% | 77.30% |
| 1.B.2.b | Natural Gas | Gaseous Fuels | $CH_4$ | 787.22 | 1.81% | 79.11% |
| 1.A.4.b | Residential | Solid Fuels | $CO_2$ | 699.69 | 1.61% | 80.71% |
| 1.A.3.b | Road Transportation | Diesel oil | $CO_2$ | 674.97 | 1.55% | 82.26% |
| 1.A.4.b | Residential | Liquid Fuels | $CO_2$ | 547.06 | 1.25% | 83.52% |
| 6.A.1 | Managed Waste Disposal on Land | | $CH_4$ | 515.79 | 1.18% | 84.70% |
| 2.A.1 | Cement Production | | $CO_2$ | 483.08 | 1.11% | 85.81% |
| 4.D.3.2 | Nitrogen Leaching and Run-off | | $N_2O$ | 480.77 | 1.10% | 86.91% |
| 1.A.3.d | Navigation | Residual Oil | $CO_2$ | 472.73 | 1.08% | 88.00% |
| 1.A.2.e | Food Processing, Beverages and Tobacco | Liquid Fuels | $CO_2$ | 438.64 | 1.01% | 89.00% |
| 1.A.4.c | Agriculture/Forestry/Fisheries | Other Fuels | $CO_2$ | 426.50 | 0.98% | 89.98% |
| 1.B.1.a | Solid Fuels /Coal Mining | Solid Fuels | $CH_4$ | 407.69 | 0.94% | 90.92% |
| 4.D.1.1 | Synthetic Fertilizers | | $N_2O$ | 392.94 | 0.90% | 91.82% |
| 1.A.1.c | Manufacture of Solid Fuels and Other Energy Industries | Solid Fuels | $CO_2$ | 383.71 | 0.88% | 92.70% |
| 1.A.2.f | Other | Liquid Fuels | $CO_2$ | 324.01 | 0.74% | 93.44% |
| 4.D.1.2 | Animal Manure Applied to Soils | | $N_2O$ | 318.51 | 0.73% | 94.17% |
| 2.B.1 | Ammonia Production | | $CO_2$ | 317.16 | 0.73% | 94.90% |
| 4.B | Manure Management ($N_2O$) | | $N_2O$ | 286.99 | 0.66% | 95.56% |

**Table 1.4_2. Key Categories in 2005 by trend and level without LULUCF (Tier 1)**

| IPCC code | IPCC source category | Fuel | Gas | 1990 Base year $CO_{2\ eq}$ | 2005 $CO_{2\ eq}$ | Level Assess-ment | Trend Assess ment | Contri-bution to Trend | Cumula-tive Total |
|---|---|---|---|---|---|---|---|---|---|
| 1.A.1.a | Public Electricity and Heat Production | Solid Fuels | $CO_2$ | 21970.56 | 9730.62 | 47.10% | 0.07 | 8% | 8% |
| 1.A.1.b | Petroleum refining | Solid Fuels | $CO_2$ | 1528.99 | 2751.90 | 13.32% | 0.21 | 24% | 33% |
| 1.A.1.a | Public Electricity and Heat Production | Gaseous Fuels | $CO_2$ | 2033.48 | 1254.49 | 6.07% | 0.03 | 3% | 36% |
| 1.A.3.b | Road Transportation | Diesel Oil | $CO_2$ | 674.97 | 1084.35 | 5.25% | 0.08 | 9% | 45% |
| 1.A.3.b | Road Transportation | Gasoline | $CO_2$ | 1462.15 | 850.38 | 4.12% | 0.02 | 2% | 47% |
| 1.B.2.b | Natural Gas | Gaseous Fuels | $CH_4$ | 787.22 | 513.04 | 2.48% | 0.01 | 2% | 49% |
| 6.A.1 | Managed Waste Disposal on Land | | $CH_4$ | 515.79 | 489.49 | 2.37% | 0.03 | 3% | 52% |
| 1.A.1.a | Public Electricity and Heat | Liquid | $CO_2$ | 4825.04 | 466.86 | 2.26% | 0.19 | 22% | 74% |

| IPCC code | IPCC source category | Fuel | Gas | 1990 Base year $CO_{2\ eq}$ | 2005 $CO_{2\ eq}$ | Level Assess-ment | Trend Assess ment | Contri-bution to Trend | Cumula-tive Total |
|---|---|---|---|---|---|---|---|---|---|
| | Production | Fuels | | | | | | | |
| 4.A | Enteric Fermentation | Cattle | $CH_4$ | 1060.01 | 427.31 | 2.07% | 0.01 | 1% | 75% |
| 2.A.1 | Cement Production | | $CO_2$ | 483.08 | 372.83 | 1.80% | 0.01 | 2% | 76% |
| 1.A.2.f | Other | Solid Fuels | $CO_2$ | 819.87 | 258.54 | 1.25% | 0.01 | 2% | 78% |
| 1.B.1.a | Solid Fuels /Coal Mining | Solid Fuels | $CH_4$ | 407.69 | 258.09 | 1.25% | 0.01 | 1% | 79% |
| 4.D.3.2 | Nitrogen Leaching and Run-off | | $N_2O$ | 480.77 | 182.95 | 0.89% | 0.00 | 1% | 79% |
| 4.D.1.2 | Animal Manure Applied to Soils | | $N_2O$ | 318.51 | 175.33 | 0.85% | 0.00 | 0% | 79% |
| 1.A.2.f | Other | Liquid Fuels | $CO_2$ | 324.01 | 151.74 | 0.73% | 0.00 | 0% | 79% |
| 2.B.1 | Ammonia Production | | $CO_2$ | 317.16 | 143.54 | 0.69% | 0.00 | 0% | 80% |
| 1.A.4.c | Agriculture/Forestry/Fisheries | Other Fuels | $CO_2$ | 426.50 | 130.37 | 0.63% | 0.01 | 1% | 80% |
| 1.A.3.c | Railways | Liquid Fuels | $CO_2$ | 143.06 | 123.85 | 0.60% | 0.01 | 1% | 81% |
| 4.D.1.1 | Synthetic Fertilizers | | $N_2O$ | 392.94 | 122.29 | 0.59% | 0.01 | 1% | 82% |
| 1.A.1.c | Manufacture of Solid Fuels and Other Energy Industries | Solid Fuels | $CO_2$ | 383.71 | 111.63 | 0.54% | 0.01 | 1% | 83% |
| 1.A.4.b | Residential | Gaseous Fuels | $CO_2$ | 118.06 | 104.44 | 0.51% | 0.00 | 1% | 83% |
| 1.A.4.b | Residential | Solid Fuels | $CO_2$ | 699.69 | 95.01 | 0.46% | 0.02 | 3% | 86% |
| 1.A.2.f | Other | Gaseous Fuels | $CO_2$ | 101.20 | 90.09 | 0.44% | 0.00 | 1% | 87% |
| 1.A.4.b | Residential | Biomass | $CH_4$ | 33.67 | 77.75 | 0.38% | 0.01 | 1% | 87% |
| 1.A.4.c | Agriculture/Forestry/Fisheries | Liquid Fuels | $CO_2$ | 46.85 | 70.87 | 0.34% | 0.00 | 1% | 88% |
| 4.D.1.4 | Crop Residue | | $N_2O$ | 104.29 | 66.52 | 0.32% | 0.00 | 0% | 88% |
| 1.A.4.a | Commercial/Institutional | Liquid Fuels | $CO_2$ | 62.03 | 60.17 | 0.29% | 0.00 | 0% | 89% |
| 4.B | Manure Management | | $N_2O$ | 286.99 | 53.50 | 0.26% | 0.01 | 1% | 90% |
| 4.D.2 | Pasture, Range and Paddock Manure | | $N_2O$ | 88.44 | 49.96 | 0.24% | 0.00 | 0% | 90% |
| 4.D.3.1 | Atmospheric Deposition | | $N_2O$ | 96.77 | 39.00 | 0.19% | 0.00 | 0% | 90% |
| 6.B.2.2 | Wastewater handing | Human Sewage | $N_2O$ | 45.14 | 35.91 | 0.17% | 0.00 | 0% | 90% |
| 4.B | Manure Management | Cattle | $CH_4$ | 132.77 | 32.35 | 0.16% | 0.00 | 0% | 90% |
| 1.A.4.a | Commercial/Institutional | Gaseous Fuels | $CO_2$ | 18.76 | 30.25 | 0.15% | 0.00 | 0% | 91% |
| 2.A.2 | Lime Production | | $CO_2$ | 145.36 | 29.07 | 0.14% | 0.00 | 0% | 91% |
| 1.A.4.b | Residential | Liquid Fuels | $CO_2$ | 547.06 | 25.79 | 0.12% | 0.02 | 3% | 94% |
| 1.A.3.d | Navigation | Gas/Diesel Oil | $CO_2$ | 105.74 | 25.00 | 0.12% | 0.00 | 0% | 94% |
| 4.B | Manure Management | Swine | $CH_4$ | 99.26 | 16.56 | 0.08% | 0.00 | 0% | 94% |
| 1.A.4.b | Residential | Biomass | $N_2O$ | 6.63 | 15.30 | 0.07% | 0.00 | 0% | 95% |
| 1.B.2.a | Oil | Liquid Fuels | $CH_4$ | 5.59 | 12.65 | 0.06% | 0.00 | 0% | 95% |
| 1.A.1.a | Public Electricity and Heat Production | Biomass | $N_2O$ | 2.70 | 12.27 | 0.06% | 0.00 | 0% | 95% |
| 4.A | Enteric Fermentation | Sheep | $CH_4$ | 23.49 | 8.33 | 0.04% | 0.00 | 0% | 95% |
| 2.F.1 | Refrigeration and Air Conditioning Equipment | | HFC | 0.00 | 7.88 | 0.04% | 0.00 | 0% | 95% |
| 1.A.2.e | Food Processing, Beverages and Tobacco | Gaseous Fuels | $CO_2$ | 15.02 | 6.98 | 0.03% | 0.00 | 0% | 95% |

| IPCC code | IPCC source category | Fuel | Gas | 1990 Base year $CO_{2\ eq}$ | 2005 $CO_{2\ eq}$ | Level Assess-ment | Trend Assess ment | Contri-bution to Trend | Cumula-tive Total |
|---|---|---|---|---|---|---|---|---|---|
| 1.A.4.a | Commercial/Institutional | Solid Fuels | $CO_2$ | 6.37 | 6.88 | 0.03% | 0.00 | 0% | 95% |
| 1.A.1.a | Public Electricity and Heat Production | Biomass | $CH_4$ | 1.37 | 6.24 | 0.03% | 0.00 | 0% | 95% |
| 2.F.8 | Electrical Equipment | | $SF_6$ | 0.00 | 5.86 | 0.03% | 0.00 | 0% | 95% |
| 4.A | Enteric Fermentation | Swine | $CH_4$ | 25.24 | 5.80 | 0.03% | 0.00 | 0% | 95% |

## 1.5 Information about the QA/QC plan including verification and treatment of confidentiality issues

### 1.5.1 Quality Assurance and Quality Control (QA/QC)

This section presents the general QA/QC programme including the quality objectives and the QA/QC plan for the Estonian greenhouse gas inventory at the national inventory level. Source-specific QA/QC details are discussed in the relevant sections of this NIR.

During preparation of the Estonian 2005 national greenhouse gases (GHG) inventory, "Estonia's National Greenhouse Gas Inventory Quality Control Plan" was implemented. Specific checks were completed.

Quality assurance/quality control plan is under development. General (Tier 1) Quality Control (QC) procedures are applied to all categories as following:

- activity data are compiled and gross-checked;
- mostly default factors are used;
- all units are checked.

The Ministry of the Environment bears the responsibility of archiving the quality manual and the submissions of annual inventories (CRF tables and NIR). Expert organisations contributing to the sectoral calculation archive the primary data used, internal documentation of calculations and sectoral CRF tables.

Accordingly to the UNFCCC Guidelines the National greenhouse gas inventories have to be transparent, consistent, comparable, complete and accurate. In addition, the principle of continuous improvement is included.

### 1.5.2 QA procedures implemented

To meet the inventory QA system a specialist was hired in 2006 to Estonian Environment Information Centre in the Climate and Ozone Bureau. This specialist is hired to put together and review the National Inventory report. Tallinn Technical University produces the national GHG inventories under contract to the Ministry of the Environment in Estonia. Inventory capacity is severely limited as inventory experts are engaged only on a part-time basis and there is little direct involvement of other, external experts. At this moment Estonia doesn't have external experts, who are independent from the inventory preparation, to review the inventory report. The expert organisation contributing to the production of emission or removal estimates are responsible for the quality of their own inventory calculations. Also to verify the completeness of the CRF tables, the completeness checks are carried out in the CRF Reporter.

### 1.5.3 QC procedures implemented

Tier 1 QC checks for key sources of Energy, Industrial Processes, Waste, Agriculture and LULUC sectors were carried out. The checks incorporated in the CRF reporter were undertaken for the period 1990 – 2005 (checklists of QC are presented in Annex 2).

QC was carried out for the following categories of Inventory:

- **ENERGY:**
  - **Fuel Combustion Activities (1.A)**
  - $CO_2$, $N_2O$ and $CH_4$ emissions from fuel combustion in Energy Industries (1.A.1)
  - $CO_2$, $N_2O$ and $CH_4$ emissions from fuel combustion in Manufacturing Industries and Constructions (1.A.2)
  - $CO_2$, $N_2O$ and $CH_4$ emissions from fuel combustion in Transport (1.A.3)
  - $CO_2$, $N_2O$ and $CH_4$ emissions from fuel combustion in Other Sectors (1.A.4)
  - **Fugitive Emissions from Fuels (1.B.)**
  - $CH_4$ emissions from mining, handling and transport of Solid Fuel (1.B.1)
  - $CH_4$ emissions from production and transport of Oil (1.B.2.A.) $CH_4$ emissions from transmission and distribution of Natural Gas (1.B.2.A) and Venting and Flaring (1.B.2.C)

- **INDUSTRIAL PROCESSES:**
  - $CO_2$, and $CH_4$ emissions from cement and lime production (2.A.1 and 2.A.2)
  - $CO_2$ emissions from ammonia production (2.B.1)

- **AGRICULTURE:**
  - $CH_4$ emission from Enteric Fermentation (Dairy Cattle, Non-Dairy Cattle, Sheep, Goats, Horses, Swine, Poultry) (4.A);
  - $CH_4$ emissions from Manure Management (Dairy Cattle, Non-Dairy Cattle, Sheep, Goats, Horses, Swine, Poultry);
  - $N_2O$ emissions from Manure Management (Anaerobic Lagoon, Liquid system, Daily spread, Solid storage and dry lot, Pasture range and paddock, Other AWMS) (4.B);
  - $N_2O$ emissions from Synthetic Fertilizers applied to agricultural soils (4.D.1.1);
  - $N_2O$ emissions from growing of N-fixing Crops (4.D.1.3) and Crop Residue (4.D.1.4);
  - Indirect $N_2O$ emissions: Atmospheric Deposition (4.D.3.1) and Nitrogen Leaching and Run-off (4.D.3.2)

- **LULUC:**
  - Forest land and biomass burning

- **WASTE:**
  - Solid Waste Disposal on Land (Managed Waste Disposal on Land) (6.A.1);
  - Industrial Wastewater: Wastewater (6.B.1);
  - Domestic and Commercial Wastewater: Wastewater (6.B.2.1);
  - Human Sewage (6.B.2.2)

### 1.5.4 Future development of QA/QC systems and planned improvements

The submission of 2007 was the first for which QC was done. Estonia will continue to improve the quality management in forthcoming years. This will include:

- Reporting of QA/QC for all key categories;
- Reporting of QA/QC according to suggested Tier 2 method (IPCC 2006);

- QA/QC of activity data, and complete description with estimation of possible uncertainties.

## 1.6 Summary of the uncertainty analysis

Uncertainty analysis will be submitted separately in April 2007.

## 1.7 General assessment of the completeness

Assessment of completeness is given in Annex 3.

# CHAPTER 2. ENERGY (CRF 1)

## 2.1 Overview of sector (CRF 1)

The predominating part of primary energy utilised in Estonia is of domestic origin. Imported fuels (natural gas, fuel oils, coal, motor fuels and liquid gas) made up in fuels utilised in 2005 only 28.3%. The share of renewable energy sources reached 10.5%, wood fuels formed the main part of it, the part of other sources remained on the level of 0.7%. From the energy of primary fuels (216 PJ) 44% was used for electricity production, 21% for heat production, 15% for the production of secondary fuels, about 3% as raw material in industry and 17% for immediate final consumption (the rest of the energy used for final consumption was converted energy)[1].

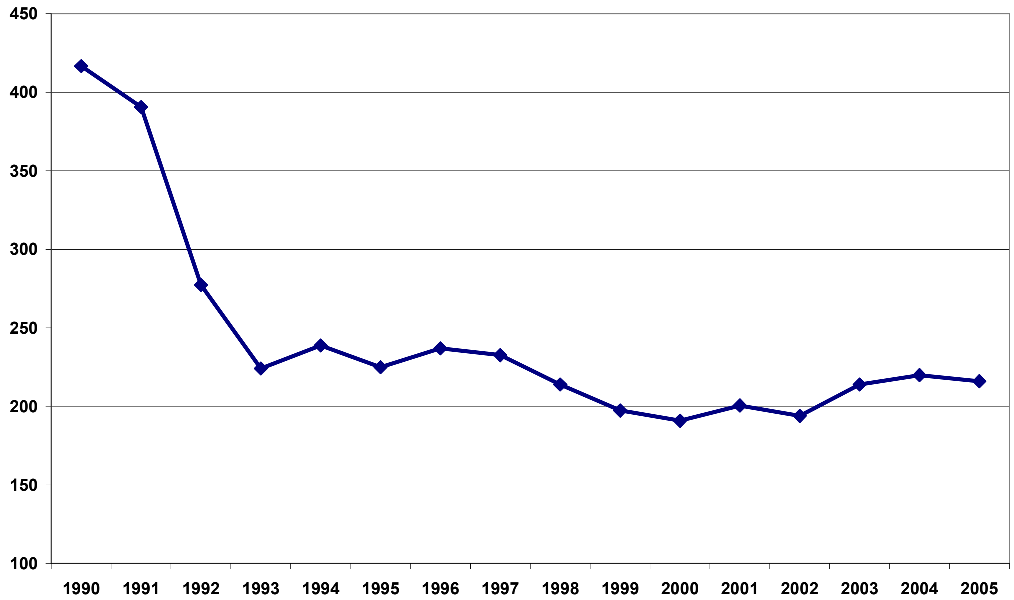



Figure 2.1_1: Development of Total Primary Energy Supply in Estonia, 1990 – 2005.

The development of primary energy supply in Estonia is presented in Figure 2.1_1. The structure of primary energy supply in 1990 and 2005 accordingly is presented in Figure 2.1_2.

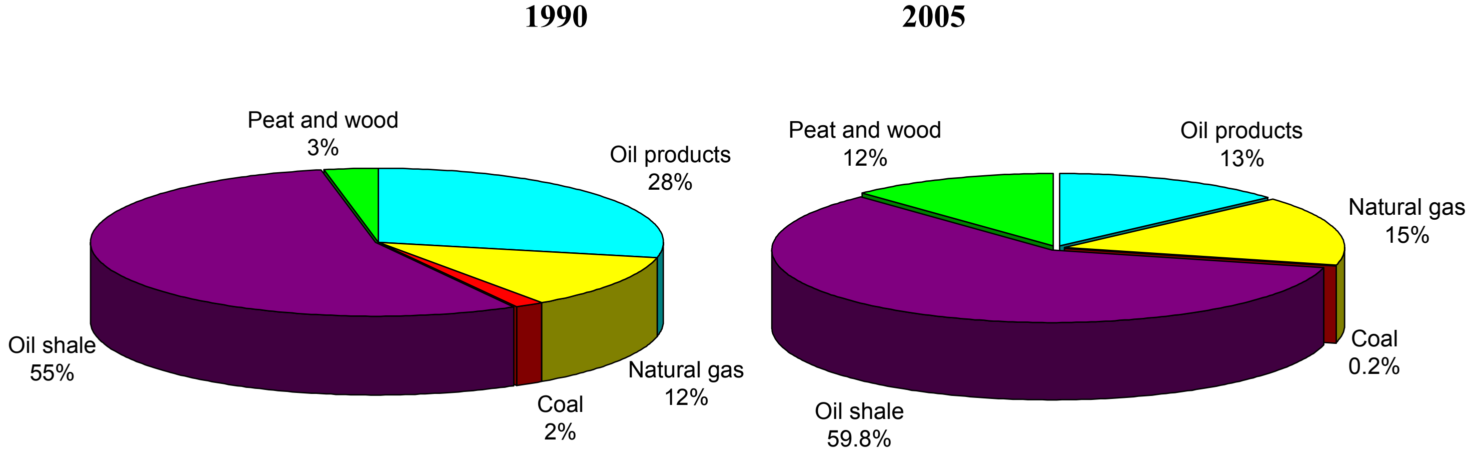



Figure 2.1_2: Structure of primary energy supply in Estonia in 1990 and 2005.

[1] Energy Balance 2005. Statistics Estonian. Yearbook. Tallinn, pp 39.

Analysing the structure of primary energy supply in 2005 we can see that the share of oil shale has risen from 55% in 1990 up to about 60% in 2005. The shares of other local fuels – wood and peat – have significantly increased, accounting for 3% and 12% respectively. Local energy resources therefore covered together 71.7% of the primary energy consumption. From among imported fuels, the share of coal has continued to decline (to 0.2%). The share of oil products has fallen drastically, from 28% up to 13%. That of natural gas has risen slightly, from 12% to 15%.

The efficiency of primary energy utilisation (the ratio of final energy consumption to the primary energy used) is relatively low in Estonia, making 53% in 2005. This index is lower than in neighbouring countries mainly because Estonia does not have large hydro power plants and over 90% power energy is produced by condensing steam power stations, whose efficiency is approximately 36%. The efficiency index of the energy sector is reduced also by losses in electricity and district heating networks and by the export of converted energy (electricity, shale oil and shale coke, peat briquette, wood chips).

The national goal in this field is continuous rise of the efficiency of the energy sector and as efficient as possible use of energy.

**Renovation of oil shale power plants**

The development of oil shale based power production using environmentally sound technologies is an issue of high priority in Estonia. For complying with the requirements of the Directive 2001/80/EC the owner of the largest power plants, Eesti Energia AS, has to reconstruct several units in the power plants of Narva Elektrijaamad AS (Narva Power Plants, including Eesti and Balti plants). Up to 2004, only the pulverised combustion technology of oil shale had been used in these power plants. The conventional pulverised combustion technique for burning oil shale is characterised by a low net average efficiency: 27–29%. This, together with the peculiarities of oil shale as a fuel, results in an extremely high specific emission of carbon dioxide per generated electricity: 1.3–1.4 t $CO_2/MWh_e$. The use of the pulverised combustion method causes also high emissions of $SO_2$ and solid particles. All these factors have made it not acceptable to continue using this technology in medium- and long-term future.

The options for more efficient combustion measures for firing oil shale in large power plants have been under investigation for many years. The circulating fluidised bed combustion technology (CFBC) has been the most attractive option, also in the environmental aspect. As a result of relevant research, it was decided to start the gradual replacing of oil shale boilers of pulverised combustion with the ones utilising the circulating fluidised bed combustion (CFBC) method. The CFBC is a variant of atmospheric circulating fluidised bed combustion, which has been in use for particularly low-grade fuels. In CFBC boilers the sulphur dioxide is better bound with the ash and therefore the $SO_2$ emission can be reduced significantly. The higher combustion efficiency reduces fuel consumption up to 25%, which in turn means substantially lower $CO_2$ emission as well (to 1.05–1.10 $CO_2/MWh_e$).

The first two new blocks (both 215 MW), in Narva Elektrijaamad AS, one at the Eesti and the other at the Balti Plant, adopting new CFBC boilers, were commissioned in 2004. This is Estonia's largest environment-related investment (245 MEUR) in the protection of the atmosphere. The scope of further reconstruction of other blocks will be determined on the basis of the experience gained with the operation of the first two blocks (Punning, J.-M., 2005).

The energy sector is the biggest source of anthropogenic greenhouse gas emissions in Estonia. In 2005 emissions from the energy sector totalled 18.38 Tg $CO_2$ eqv. That was 89% (icl 85% from fuel combustion and 4% from fugitive emissions from fuel) of the total greenhouse gas emissions in 2005 (Figure 2.1_1). Compared to base year 1990 emissions from energy sector have increased ~52.67%. Most of the emissions come from fuel combustion (Figure 2.1_3).

The energy sector releases three greenhouse gases, mainly $CO_2$, and small amounts of $CH_4$ and $N_2O$. Indirect greenhouse gases from the energy sector are nitrogen oxides ($NO_x$), carbon monoxide (CO), non-methane volatile organic compounds (NMVOC) and sulphur dioxide ($SO_2$).

Emissions in the energy sector are divided into emissions from fossil fuel combustion (CRF 1.A) and fugitive emissions from fuels (CRF 1.B). Emissions from the energy sector come from a variety of sources. Emissions from fuel combustion include direct and indirect greenhouse gas emissions from domestic fuel combustion including point sources, transport and other fuel combustion. Fugitive emissions from fuels in Estonia arise mainly from shale oil production and transmission and distribution of imported oil products and natural gas. In addition, fugitive emissions from venting and flaring from shale oil refineries are calculated (Table 2.1_1).

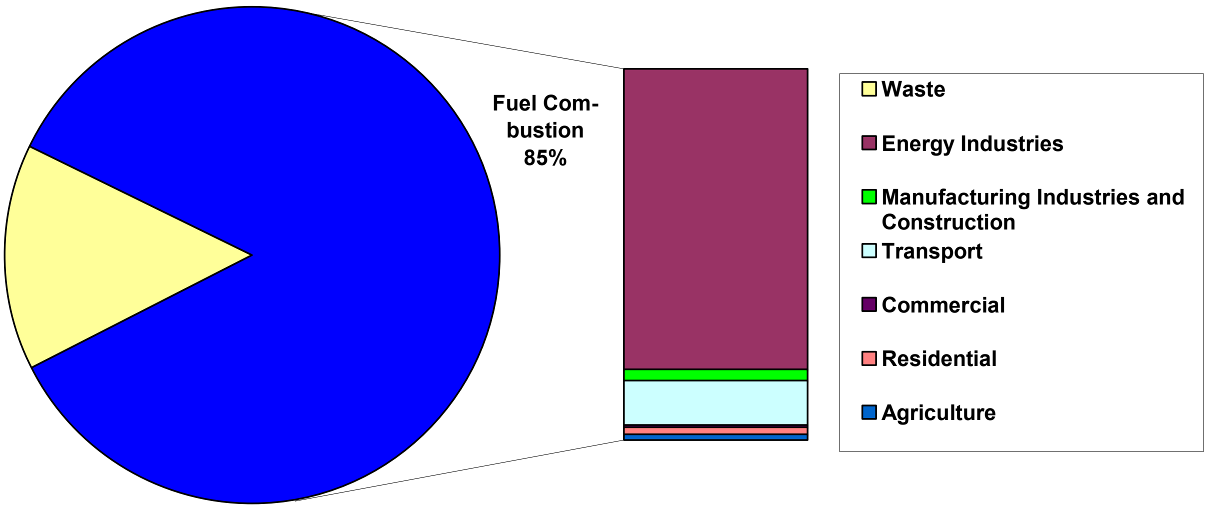



Figure 2.1_3: Emissions from the fuel combustion compared to the total GHG emissions in 2005.

Emissions from fuel combustion include direct and indirect greenhouse gas emissions from domestic fuel combustion including point sources, transport and other fuel combustion.

**Table 2.1_1. Emissions from energy sector in 1990-2005 by subcategories and gases.**

| | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Energy | **38.83** | **36.32** | **26.89** | **21.57** | **22.43** | **20.33** | **21.41** | **20.82** | **18.37** | **16.87** | **17.18** | **17.49** | **17.29** | **19.42** | **18.85** | **18.38** |
| A. Fuel com-bustion | 37.63 | 35.16 | 26.09 | 21.06 | 21.83 | 19.70 | 20.71 | 20.14 | 17.76 | 16.29 | 16.52 | 16.80 | 16.69 | 18.76 | 18.11 | 17.60 |
| $CO_2$ | 37.50 | 35.03 | 25.99 | 20.97 | 21.72 | 19.54 | 20.52 | 19.95 | 17.61 | 16.15 | 16.37 | 16.65 | 16.54 | 18.61 | 17.95 | 17.45 |
| $CH_4$ | 0.09 | 0.08 | 0.07 | 0.06 | 0.07 | 0.12 | 0.14 | 0.14 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.10 |
| $N_2O$ | 0.05 | 0.05 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 |
| B. Fugitive emissions from fuel ($CH_4$) | 1.20 | 1.16 | 0.80 | 0.51 | 0.60 | 0.63 | 0.70 | 0.68 | 0.61 | 0.58 | 0.66 | 0.69 | 0.61 | 0.65 | 0.74 | 0.78 |

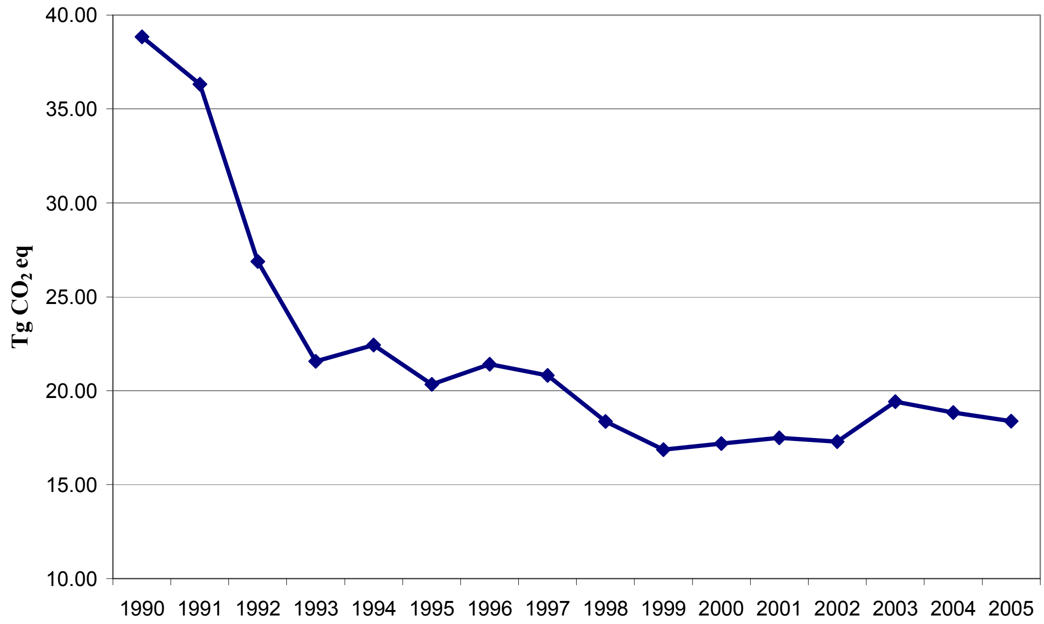



Figure 2.1_4: Emissions from the energy sector in 1990-2005 (Tg $CO_2$ eqv.)

## 2.2 Emissions from fuel combustion (CRF 1.A)

### 2.2.1 Description

Emissions from fuel combustion comprise all domestic fuel combustion, including point sources, transport and other fuel combustion. Direct ($CO_2$, $CH_4$, $N_2O$) and indirect GHGs ($NO_x$ CO, NMVOC) and $SO_2$, are reported. As suggested in the UNFCCC guidelines, emissions from fuel combustion in the energy sector are divided into five subcategories as follows:

CRF 1.A 1 – Energy Industries
CRF 1.A 2 – Manufacturing industries and construction
CRF 1.A 3 – Transport
CRF 1.A 4 – Other sectors
CRF 1.A 5 – Other (including Commercial, Residential and Agriculture/Forest/Fishery sectors).

### 2.2.2 Quantitative overview

$CO_2$ emissions from fossil fuel combustion (17.6 Tg) accounted for 95.8% of the energy sector's total emissions and 85% of total greenhouse gas emissions in 2005.

The portion of $N_2O$ emissions from fuel combustion in 2005 was about 0.5%. $N_2O$ emissions come mainly from energy industries and transport sectors. $CH_4$ emissions from fuel combustion are relatively small (0.3%) and are mainly due to the incomplete combustion of wood fuels (small combustion).

**Table 2.2_1. Emissions from fuel combustion in Estonia in 1990-2005 (Tg $CO_2$).**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Energy | **38.83** | **36.32** | **26.89** | **21.57** | **22.43** | **20.33** | **21.41** | **20.82** | **18.37** | **16.87** | **17.18** | **17.49** | **17.29** | **19.42** | **18.85** | **18.38** |
| A. Fuel combustion total | 37.63 | 35.16 | 26.09 | 21.06 | 21.83 | 19.70 | 20.71 | 20.14 | 17.76 | 16.29 | 16.52 | 16.80 | 16.69 | 18.76 | 18.11 | 17.60 |
| $CO_2$ 1. Energy industries | 30.77 | 28.56 | 22.34 | 17.74 | 18.40 | 16.91 | 17.66 | 17.21 | 14.81 | 13.78 | 13.91 | 13.84 | 13.59 | 15.65 | 14.96 | 14.34 |
| $CO_2$ 2. Manufacturing Industries | 1.79 | 1.75 | 1.14 | 0.54 | 0.85 | 0.56 | 0.69 | 0.61 | 0.64 | 0.37 | 0.48 | 0.59 | 0.42 | 0.48 | 0.47 | 1.79 |
| $CO_2$ 3. Transport | 3.02 | 2.92 | 1.54 | 1.89 | 1.99 | 1.56 | 1.62 | 1.68 | 1.74 | 1.62 | 1.60 | 1.90 | 1.99 | 1.95 | 2.00 | 3.02 |
| $CO_2$ 4. Other Sectors | 1.95 | 1.83 | 0.99 | 0.81 | 0.51 | 0.53 | 0.58 | 0.48 | 0.44 | 0.39 | 0.39 | 0.34 | 0.56 | 0.56 | 0.55 | 1.95 |
| $CH_4$ | 0.09 | 0.08 | 0.07 | 0.06 | 0.07 | 0.12 | 0.14 | 0.14 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.09 |
| $N_2O$ | 0.05 | 0.05 | 0.03 | 0.03 | 0.04 | 0.04 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 |

***Methods***

Emissions from fuel combustion (CRF 1.A 1-1.A 5) are in general calculated by multiplying fuel consumption with either a fuel type-specific emission factor or technology-specific emission factor. When calculating $CO_2$ emissions, adjustment the fraction of carbon (un)oxidised is included.

Calculations of all emissions from fuel combustion are done with the Excel Work Tables calculation system developed by IPCC.

At the moment the data sources are the same as in the previous system, but other data sources will be included in the system to reduce uncertainties in the allocation of fuels to different subcategories.

### 2.2.3 Key categories

Several emission sources in the energy combustion sector are key categories. The key categories in 2005 by level and trend and without LULUCF are listed in the Table 2.2_2.

**Table 2.2_2. Key categories in Energy combustion (CRF 1.A) in 2005 (L=Level, T=Trend without LULUCF) (quantitative method used: Tier 2).**

| IPCC code | IPCC source category | Fuel | Gas | Identification criteria |
|---|---|---|---|---|
| 1.A.1.a | Public Electricity and Heat Production | Solid Fuels | $CO_2$ | L,T |
| 1.A.1.b | Petroleum refining | Solid Fuels | $CO_2$ | L,T |
| 1.A.1.a | Public Electricity and Heat Production | Gaseous Fuels | $CO_2$ | L,T |
| 1.A.3.b | Road Transportation | Diesel Oil | $CO_2$ | L,T |
| 1.A.3.b | Road Transportation | Gasoline | $CO_2$ | L,T |
| 1.B.2.b | Natural Gas | Gaseous Fuels | $CH_4$ | L,T |
| 1.A.1.a | Public Electricity and Heat Production | Liquid Fuels | $CO_2$ | L,T |
| 1.A.2.f | Other | Solid Fuels | $CO_2$ | L,T |
| 1.B.1.a | Solid Fuels /Coal Mining | Solid Fuels | $CH_4$ | L,T |
| 1.A.2.f | Other | Liquid Fuels | $CO_2$ | L,T |
| 1.A.4.c | Agriculture/Forestry/Fisheries | Other Fuels | $CO_2$ | L,T |
| 1.A.3.c | Railways | Liquid Fuels | $CO_2$ | L,T |
| 1.A.1.c | Manufacture of Solid Fuels and Other Energy Industries | Solid Fuels | $CO_2$ | L,T |
| 1.A.4.b | Residential | Gaseous Fuels | $CO_2$ | L,T |
| 1.A.4.b | Residential | Solid Fuels | $CO_2$ | L,T |
| 1.A.2.f | Other | Gaseous Fuels | $CO_2$ | L,T |
| 1.A.4.b | Residential | Biomass | $CH_4$ | L,T |
| 1.A.4.c | Agriculture/Forestry/Fisheries | Liquid Fuels | $CO_2$ | L,T |

| IPCC code | IPCC source category | Fuel | Gas | Identification criteria |
|---|---|---|---|---|
| 1.A.4.a | Commercial/Institutional | Liquid Fuels | $CO_2$ | L,T |
| 1.A.4.a | Commercial/Institutional | Gaseous Fuels | $CO_2$ | L,T |
| 1.A.4.b | Residential | Liquid Fuels | $CO_2$ | L,T |
| 1.A.3.d | Navigation | Gas/Diesel Oil | $CO_2$ | L,T |
| 1.A.4.b | Residential | Biomass | $N_2O$ | L,T |
| 1.B.2.a | Oil | Liquid Fuels | $CH_4$ | L,T |
| 1.A.1.a | Public Electricity and Heat Production | Biomass | $N_2O$ | L,T |
| 1.A.2.e | Food Processing, Beverages and Tobacco | Gaseous Fuels | $CO_2$ | L,T |
| 1.A.4.a | Commercial/Institutional | Solid Fuels | $CO_2$ | L,T |
| 1.A.1.a | Public Electricity and Heat Production | Biomass | $CH_4$ | L,T |

### 2.2.4 Energy industries and Manufacturing industries and construction (CRF 1.A 1, CRF 1.A 2)

#### *2.2.4.1 Source category description*

Energy industries (CRF 1.A 1) and Manufacturing industries include emissions from fuel combustion in point sources in energy production and industrial sectors (power plants, boilers and industrial plants with boilers and/or other combustion). The emissions from energy industries by relevant subcategories and gases in 1990-2005 are presented in Table 2.2_3.

**Table 2.2_3. The emissions from Energy Industries by relevant subcategories and gases in 1990-2005.**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$CO_2$** | | | | | | | | | | | | | | | | |
| 1. Energy industries | **30.74** | **28.53** | **22.31** | **17.72** | **18.38** | **16.88** | **17.63** | **17.18** | **14.79** | **13.76** | **13.89** | **13.82** | **13.56** | **15.63** | **14.94** | **14.32** |
| 1.a. Public Electricity and Heat Production | 28.83 | 26.50 | 19.89 | 15.42 | 15.67 | 14.10 | 14.59 | 14.15 | 12.85 | 12.28 | 11.63 | 11.36 | 11.04 | 12.81 | 12.27 | 11.45 |
| 1.b. Petroleum Refining | 1.53 | 1.66 | 2.13 | 2.07 | 2.47 | 2.47 | 2.74 | 2.80 | 1.76 | 1.30 | 2.11 | 2.26 | 2.30 | 2.61 | 2.56 | 2.75 |
| 1.c. Manufacture of Solid Fuels | 0.38 | 0.38 | 0.30 | 0.23 | 0.23 | 0.31 | 0.30 | 0.23 | 0.18 | 0.18 | 0.15 | 0.20 | 0.22 | 0.20 | 0.11 | 0.11 |
| **$CH_4$** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** | **0.01** |
| **$N_2O$** | **0.02** | **0.02** | **0.02** | **0.01** | **0.02** | **0.02** | **0.02** | **0.02** | **0.02** | **0.02** | **0.02** | **0.02** | **0.02** | **0.02** | **0.02** | **0.02** |
| Aggregate GHGs $CO_{2\ eq}$ | **30.74** | **28.53** | **22.31** | **17.72** | **18.38** | **16.88** | **17.63** | **17.18** | **14.79** | **13.76** | **13.89** | **13.82** | **13.56** | **15.63** | **14.94** | **14.32** |

In Estonia's case, under sub-category *1.A.1.b Petroleum Refining* – Shale Oil production is reported. Estonia has no any oil refinery.

The emissions from manufacturing industries and construction by relevant subcategories and gases in 1990-2005 are presented in Table 2.2_4 below.

**Table 2.2_4. The emissions from manufacturing industries and construction by relevant subcategories and gases in 1990-2005.**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$CO_2$** | | | | | | | | | | | | | | | | |
| 2. Manufacturing Industries and Construction | **1.79** | **1.75** | **1.14** | **0.54** | **0.85** | **0.56** | **0.69** | **0.61** | **0.64** | **0.37** | **0.48** | **0.59** | **0.42** | **0.48** | **0.47** | **0.53** |
| a. Iron and Steel | 0.003 | 0.000 | 0.000 | 0.000 | 0.004 | 0.003 | 0.002 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.003 |
| b. Non-Ferrous Metals | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.002 | 0.001 |
| c. Chemicals | 0.079 | 0.085 | 0.033 | 0.011 | 0.041 | 0.048 | 0.155 | 0.140 | 0.032 | 0.000 | 0.004 | 0.002 | 0.004 | 0.006 | 0.006 | 0.006 |
| d. Pulp, Paper and Print | 0.000 | 0.000 | 0.055 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.001 | 0.001 | 0.002 | 0.003 | 0.037 | 0.003 | 0.004 |
| e. Food Processing, Beverages and Tobacco | 0.458 | 0.476 | 0.241 | 0.220 | 0.350 | 0.021 | 0.106 | 0.094 | 0.051 | 0.017 | 0.017 | 0.013 | 0.016 | 0.016 | 0.013 | 0.013 |

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| f. Other | 1.245 | 1.186 | 0.812 | 0.308 | 0.453 | 0.483 | 0.431 | 0.370 | 0.553 | 0.355 | 0.459 | 0.571 | 0.398 | 0.414 | 0.446 | 0.500 |
| **$CH_4$** | | | | | | | | | | | | | | | | |
| 2. Manufacturing Industries and Construction | **0.002** | **0.001** | **0.001** | **0.000** | **0.001** | **0.000** | **0.001** | **0.000** | **0.001** | **0.000** | **0.001** | **0.001** | **0.001** | **0.002** | **0.002** | **0.002** |
| **$N_2O$** | | | | | | | | | | | | | | | | |
| 2. Manufacturing Industries and Construction | **0.003** | **0.003** | **0.002** | **0.001** | **0.001** | **0.001** | **0.001** | **0.001** | **0.001** | **0.001** | **0.001** | **0.001** | **0.001** | **0.003** | **0.003** | **0.003** |
| Aggregate GHGs $CO_{2\ eq}$ | **1.790** | **1.751** | **1.143** | **0.540** | **0.850** | **0.558** | **0.694** | **0.607** | **0.638** | **0.374** | **0.486** | **0.592** | **0.426** | **0.480** | **0.476** | **0.531** |

In Estonia, sub-category *1.A.2.f Other* includes following sub-sectors: “production of other non-metallic minerals”; “production of transport equipment”; “machinery”; “mining and quarrying”; “production of wood and wood products construction”; “textile, leather and clothing industry” and “other industry”

### *2.2.4.2 Methodological issues*

***Methods***

Emissions from fuel combustion are in general calculated by using the methodology of IPCC Guidelines 1996.

The basic formula for estimating total carbon content is the following:

*Total Carbon Content (GgC) = Σ Apparent Energy Consumption (by fuel type in TJ) x Carbon Emission Factor (by fuel type in tC/TJ) x $10^{-3}$*

$CO_2$ Emissions by Source Categories

*Carbon Emissions = Σ Fuel Consumption Expressed in Energy Units (TJ) for each sector x Carbon Emission Factor - Carbon Stored x Fraction Oxidised*

**Oil Shale**

As oil shale is the main indigenous fuel of Estonia, its short description is given below. Estonian oil shale as fuel is characterised by a high ash content (45-50%), a moderate content of moisture (11-13%) and sulphur (1.4-1.8%), a low net calorific value (8-9 MJ/kg) and a high content of volatile matter in the combustible part (up to 90%). The dry matter of Estonian oil shale is considered to consist of three main parts: organic, sandy-clay and carbonate.

Oil shale is produced in two qualities: with the grain size of 0÷25 mm and 25÷125 mm. The enriched lumpy oil shale (25÷125 mm) with higher calorific value is used in oil shale industry to produce oil shale oil and as fuel in cement kilns. About 77% of the mined oil shale (grain size 0÷25 mm) with lower calorific value is used as boiler fuel in large power plants. Net calorific value of oil shale is decreasing, because oil shale layers of the best quality have mostly been exhausted already.

From the point of view of greenhouse gas emissions it is important that during combustion of powdered oil shale $CO_2$ is formed not only as a burning product of organic carbon, but also as a decomposition product of the ash carbonate part. Therefore the total quantity of carbon dioxide increases up to 25% in flue gases of oil shale.

Two different combustion technologies, the old pulverised combustion of oil shale (PC) and the new circulated fluidised bed combustion (CFBC) technology are used presently in the Estonian Power Plants.

The first CFBC power unit (215 MWel) started at the Eesti Power Plant at the end of 2003. The conducted tests showed that the transition at an oil shale power plant from pulverised combustion boilers to circulating fluidised bed boilers is accompanied by several changes: the CFBC boiler $CO_2$ discharge is merely 82-84% of that figure for pulverised combustion boilers, the carbonate decomposition rate was about 0.75 (sometimes even less), the $SO_2$ atmospheric discharges stopped almost completely (kS=0.999), the boiler efficiency increased from 81-82% to ~90-95%, thus also the fuel consumption decreased, power production efficiency at nominal load was in the range 35-36%, versus 29-30% at oil shale fluidised bed combustion.

The second CFBC power unit (215 MWel) started at Narva PP in 2004. The successful operation of new CFBC units allows continuing the construction of additional units.

A formula compiled by A. Martins for the calculation of Estonian (pulverised combustion) oil shale carbon emission factor, taking into consideration the decomposition of its ash carbonate part, is as follows:

$$CEF_{oil\,shale} = 10 \cdot \left[C_t^r + k \cdot (CO_2)_M^r \cdot 12/44\right] / Q_{i,}^r \left[tC/TJ\right] \qquad (1)$$

where:

$Q_i^r$ – lower heating value oil shale, MJ/kg;

$C_t^r$ – carbon content of oil shale, %;

$(CO_2)_M^r$ – mineral carbon dioxide content of oil shale, %;

$k$ decomposition rate of ash carbon part ($k$ = 0.95÷1.0 for pulverised combustion of oil shale).

Formula (1) gives:

$$CEF_{oilshale} = 10 \cdot (20.6 + 0.95 \cdot 17.0 \cdot 12/44)/8.6 = 29.1 \; tC/TJ$$

The emission factor for oil shale with the value of 29.1 tC/TJ is also included into the revised 1996 IPCC Guidelines for National Greenhouse Case Inventories Guidelines (Greenhouse Gas…, 1996).

This carbon emission factor value – 29.1 tC/TJ was used for estimation of carbon dioxide emissions from oil shale pulverised combustion in the Estonian annual National Inventories of GHG from 1990 up to 2003.

In 2004, a new regulation of the Minister of the Environment for calculation the amount of carbon dioxide discharged into the atmosphere at oil shale power plants was issued (Method…, 2006).

With this regulation, carbon emission factor for oil shale is recalculated using the new value of factor k in formula (1), which takes into account the extent of carbonate decomposition and $CO_2$ binding at ash fields.

The new value of k was established on the basis of the research made at the Laboratory of Inorganic Materials of the Tallinn University of Technology. The general value of k based on the results of this research is 0.64 (Emissions of…, 2006).

Formula (1) gives:

$$CEF_{oil\,shale\,PC} = 10 \cdot (20.7 + 0.64 \cdot 17.7 \cdot 12/44)/8.4 = 27.85 \; tC/TJ$$

where:

average heating value $Q_i^r$ = 8.40 MJ/kg;

mineral carbon dioxide content of oil shale

$(CO_2)_M^r$ = 17.7%;

carbon content of oil shale $C_t^r$ = 20.7%;

In case the new value (0.64) for *k* is used the carbon emission factor for oil shale pulverised combustion is 27.85 tC/TJ.

With the introduction in 2004 of new power units with circulating fluidised bed (CFB) boilers at Eesti and Balti power plants, the situation concerning carbon emission factor has changed. Firing temperatures in CFB boilers are lower (780 – 820 °C) than those in pulverised combustion (PC) boilers (>1400 °C). This circumstance exerts a considerable influence on the intensity of carbonate decomposition.

Researchers of Department of Thermal Engineering (DTE) of TUT recommend use the new value of *k* for CFB boilers 0.40 instead of the previously used 0.64 (Emissions of…, 2006).

$$CEF_{oil\,shale\,CFB} = 10 \cdot (20.7 + 0.4 \cdot 17.7 \cdot 12/44)/8.4 = 26.94\ tC/TJ$$

Therefore, the value of carbon emission factor for oil shale CFB combustion is lower than that for pulverised combustion.

It means that for National GHG Inventories emissions of $CO_2$ from pulverised combustion and circulating fluidised bed combustion boilers must be calculated separately.

### *Emission factors and other parameters*

Both IPCC default emission factors and national (plant level/activity level) emission factors are used in calculations. $CO_2$ emission factors, oxidation factors and net caloric values for different fuels are presented in Table 2.2_5 below.

**Table 2.2_5. $CO_2$ emission factors, oxidation factors and net caloric values by fuel.**

| | EF (t C/TJ) | Source*** | Fraction of Carbon Oxidised | NCV average | Unit |
|---|---|---|---|---|---|
| Natural Gas Liquids | 17.2 | D | 0.99 | 45.94 | GJ/t |
| Gasoline | 18.9 | D | 0.99 | 43.01 | GJ/t |
| Jet Gerosene | 19.5 | D | 0.99 | 43.50 | GJ/t |
| Other Kerosene | 20.2 | D | 0.99 | 35.54 | GJ/t |
| Shale Oil | 21.1 | CS | 0.98 | 39.56 | GJ/t |
| Diesel Oil | 20.2 | D | 0.99 | 42.4 | GJ/t |
| Residuel Fuel Oil | 21.1 | D | 0.98 | 37.08 | GJ/t |
| Antracite | 26.8 | D | 0.98 | 27.09 | GJ/t |
| Oil Shale $_{PC}$* | 27.85 | CS | 0.98 | 8.86 | GJ/t |
| Oil Shale $_{FBC}$** | 26.94 | CS | 0.98 | 8.86 | GJ/t |
| Peat | 28.9 | D | 0.97 | 9.27 | GJ/t |
| Peat Briquette | 28.9 | D | 0.97 | 16.07 | GJ/t |
| Coke | 29.5 | D | 0.97 | 28.08 | GJ/t |

| | EF (t C/TJ) | Source*** | Fraction of Carbon Oxidised | NCV average | Unit |
|---|---|---|---|---|---|
| Natural Gas | 15.3 | D | 0.995 | 33.62 | GJ/1000 $m^3$ |
| Solid Biomass | 29.9 | D | 0.98 | 6.79 | GJ/$m^3$ s |

* *Oil Shale $_{PC}$ – pulverised combustion of oil shale*
** *Oil Shale $_{FBC}$ – fluidised bed combustion of oil shale*
*** *D - IPCC default value; CS – country specific*

Calorific values of used fuels were found from the annual proceeding of the Statistics Estonia *"Energy Balance 2005*" (Energy…, 2006). CEFs of used fuels were taken from IPCC Guidelines (Greenhouse ... Workbook, Vol. 2, 1996) and CEF for shale oil and oil shale (for pulverised combustion and also for fluidized combustion) were taken from the new Regulation of the Minister of Environment *Methods for Determination of the Carbon Dioxide Emission into Ambient Air*[2]. The most changeable are the calorific values of oil shale and of solid biomass (wood waste). From 1990 up to the year 2003 the old carbon emission factor CEF'=29.1 tC/TJ was used (Greenhouse ... Workbook, Vol. 2, 1996).

#### 2.2.4.3 Emission Factors of non- $CO_2$ Gases from Fuel Combustion

The $CH_4$, $N_2O$, CO and NMVOC emission factors used in the Estonian inventory are mainly taken from the Revised 1996 IPCC Guidelines, but some emission factors and new data from national research were used (Annex 1).

### Activity data

**Table 2.2_6. Fuel consumption in Energy industries (CRF 1.A 1) and Manufacturing industries and construction (CRF 1.A 2) in 1990-2005 (PJ).**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.A 1** | | | | | | | | | | | | | | | | |
| Liquid Fuels | 63.1 | 56.6 | 32.3 | 33.2 | 28.1 | 21.2 | 20.9 | 18.1 | 18.6 | 16.7 | 9.2 | 9.2 | 8.2 | 7.0 | 6.5 | 6.2 |
| Solid Fuels | 232.8 | 215.9 | 183.4 | 144.6 | 153.2 | 142.3 | 148.1 | 146.0 | 124.0 | 115.7 | 120.1 | 118.7 | 117.1 | 137.8 | 136.6 | 130.9 |
| Gaseous Fuels | 36.4 | 37.3 | 20.1 | 9.1 | 11.7 | 14.9 | 17.9 | 17.5 | 15.0 | 14.8 | 19.1 | 20.5 | 20.2 | 20.0 | 22.2 | 22.5 |
| Biomass | 2.2 | 2.3 | 2.2 | 2.0 | 3.7 | 4.6 | 5.2 | 5.6 | 6.2 | 6.4 | 6.9 | 7.8 | 7.8 | 7.6 | 8.7 | 9.9 |
| **1.A 2** | | | | | | | | | | | | | | | | |
| Liquid Fuels | 10.5 | 10.5 | 6.6 | 3.6 | 5.7 | 2.0 | 3.9 | 3.8 | 2.0 | 1.1 | 1.3 | 1.4 | 1.8 | 2.7 | 2.5 | 2.2 |
| Solid Fuels | 8.1 | 7.7 | 5.4 | 2.2 | 3.5 | 3.2 | 3.1 | 2.4 | 3.8 | 2.3 | 3.2 | 4.0 | 2.2 | 1.8 | 2.0 | 2.6 |
| Gaseous Fuels | 2.8 | 2.9 | 1.4 | 0.6 | 0.9 | 1.2 | 1.3 | 1.2 | 1.5 | 0.9 | 1.1 | 1.5 | 1.1 | 1.8 | 1.6 | 1.8 |
| Other Fuels | 0.2 | 0.3 | 0.2 | 0.0 | 0.2 | 0.2 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 1.7 | 1.7 | 1.8 |

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

There are numerous automatic and manual QC procedures, which are used. The documentation of these procedures is going on and will be reported in the following submission.

Each year the latest inventory calculations (activity data and $CO_2$ emissions) are crosschecked against national energy balance. There is a reference calculation based on energy balance, showing activity data (in natural units and TJ).

#### 2.2.4.5 Source-specific recalculations

$CO_2$ emissions from combustion of other kerosene have been recalculated for whole period 1990-2004. The reason of recalculations is the changed value of carbon emission factor for other kerosene. CEF of other kerosene like CEF for diesel oil is equal to 20.2 tC/TJ (instead of 19.6 tC/TJ in former NIR submissions) because there are similar oil products only the sphere of application is different.

[2] RTL, 22.11.2006, 85, 1546

Some improvements in activity data have in previous years been applied because Statistical Office has the practice to improve previous years Energy Balances.

## 2.3 Transport (CRF 1.A 3)

### 2.3.1 Source category description

Emissions from Transport (CRF 1.A 3) include all domestic transport sectors: road transport, civil aviation, domestic navigation, railways and mobile sources (which are not included in other sectors) (Table 2.3_1). Road transport includes all transportation on roads in Estonia. Types of vehicles with combustion engines are: cars, vans, buses, lorries, motorcycles and mopeds. The source category does not cover farm and forest tractors driving occasionally on the roads because they are included in other sectors (agriculture) or military vehicles.

Railway transport in Estonia includes railway transport operated by diesel locomotives. Domestic navigation includes the most important domestic waterway transport in Estonia: sea going ships, icebreakers, working boats and leisure boats.

Emissions from civil aviation include all domestic civil aviation transport within Estonian flight information regions (mostly islands). Helicopters are not included in the calculations due to the small number of flights and the lack of emission factors.

Greenhouse gas emissions from the transport sector have increased since 1990. In 1990, emissions from the transport sector were 7% of the total greenhouse gas emissions in Estonia. In 2005, the corresponding figure was about 10%.

**Table 2.3_1. Emissions from the Transport sector in 1990-2005 by subcategories.**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2002 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ (Tg) | | | | | | | | | | | | | | | | |
| 3. Transport | 3.02 | 2.92 | 1.54 | 1.89 | 1.99 | 1.56 | 1.62 | 1.68 | 1.74 | 1.62 | 1.60 | 1.90 | 1.99 | 1.95 | 2.00 | 2.09 |
| a. Civil Aviation | 3.02 | 2.92 | 1.54 | 1.89 | 1.99 | 1.56 | 1.62 | 1.68 | 1.74 | 1.62 | 1.60 | 1.90 | 1.99 | 1.95 | 2.00 | 2.09 |
| b. Road transport | 0.11 | 0.11 | 0.04 | 0.06 | 0.05 | 0.05 | 0.05 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| c. Railways | 2.15 | 1.94 | 0.97 | 1.10 | 1.39 | 1.39 | 1.43 | 1.55 | 1.58 | 1.45 | 1.44 | 1.76 | 1.79 | 1.78 | 1.85 | 1.94 |
| d. Navigation | 0.16 | 0.15 | 0.11 | 0.11 | 0.11 | 0.11 | 0.12 | 0.11 | 0.13 | 0.14 | 0.14 | 0.13 | 0.16 | 0.14 | 0.12 | 0.12 |
| e. Other trans. | 0.58 | 0.68 | 0.40 | 0.63 | 0.41 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 |
| $CH_4$ (Gg) | | | | | | | | | | | | | | | | |
| 3. Transport | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| $N_2O$ (Gg) | | | | | | | | | | | | | | | | |
| 3. Transport | 0.009 | 0.008 | 0.004 | 0.005 | 0.005 | 0.004 | 0.005 | 0.005 | 0.005 | 0.004 | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Aggregate GHGs ($CO_{2\ eq}$) | **3.044** | **2.938** | **1.549** | **1.905** | **2.000** | **1.575** | **1.632** | **1.693** | **1.748** | **1.633** | **1.615** | **1.916** | **2.001** | **1.958** | **2.010** | **2.098** |

#### *2.3.1.1 Methodological issues*

The fundamental methodologies for estimating greenhouse gas emissions from road vehicles, which are have not changed since the publication of the 1996 IPCC Guidelines.

### *Methods*

Emissions can be estimated from either the fuel consumed (represented by fuel sold) or the distance travelled by the vehicles. In general, the first approach (fuel sold) is appropriate for $CO_2$ and the second (distance travelled by vehicle type and road type) is appropriate for $CH_4$ and $N_2O$.

In current inventory report emissions of $CO_2$, are calculated on bases of the amounts and type of fuel combusted and its carbon content.

The *Tier 1* approach calculates $CO_2$, $N_2O$ and $CH_4$ emissions by multiplying estimated fuel sold with a default emission factor. This approach can be expressed as:

Emissions = Σ [$Fuel_a$ x $EF_a$
where: Emissions '= Emissions of $CO_2$ (Gg)
$Fuel_a$ = Fuel sold (TJ)
$EF_a$ - emission factor
A = type of fuel (e.g. petrol, diesel, natural gas, LPG etc)

## *Activity data*

**Table 2.3_2. Fuel Consumption of the Transport sector in 1990 – 2005 by sub -sectors, TJ**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.A 3.a Civil aviation** | | | | | | | | | | | | | | | | |
| Jet Kerosene (TJ) | 1.61 | 0.53 | 0.79 | 0.64 | 0.73 | 0.68 | 0.09 | 0.12 | 0.21 | 0.09 | 0.01 | 0.04 | 0.01 | 0.03 | 0.02 | 1.61 |
| **1.A.3.b Road Transportation** | | | | | | | | | | | | | | | | |
| Liquid Fuels | 30.66 | 27.62 | 13.83 | 15.58 | 19.80 | 19.65 | 20.20 | 21.95 | 22.32 | 20.50 | 20.40 | 24.87 | 25.26 | 25.07 | 25.95 | 27.19 |
| incl Gasoline | 21.31 | 19.17 | 8.98 | 9.57 | 12.40 | 10.61 | 11.68 | 12.98 | 12.46 | 11.92 | 12.01 | 14.33 | 13.15 | 12.61 | 12.15 | 12.40 |
| Diesel | 9.21 | 8.36 | 4.76 | 5.98 | 7.24 | 9.02 | 8.50 | 8.95 | 9.86 | 8.57 | 8.37 | 10.54 | 12.10 | 12.45 | 13.80 | 14.79 |
| Natural Gas Liquids | 0.14 | 0.09 | 0.09 | 0.03 | 0.17 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Gaseous Fuels | 0.03 | 0.03 | 0.03 | 0.05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **1.A.3.c Railways** | | | | | | | | | | | | | | | | |
| Liquid Fuels | 1.95 | 1.84 | 1.36 | 1.41 | 1.45 | 1.43 | 1.54 | 1.41 | 1.78 | 1.96 | 1.84 | 1.70 | 2.20 | 1.91 | 1.69 | 1.69 |
| Solid Fuels | 0.12 | 0.14 | 0.05 | 0.05 | 0.06 | 0.04 | 0.06 | 0.04 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Other Fuels | 0.11 | 0.09 | 0.05 | 0.00 | 0.02 | 0.02 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **1.A.3.d National Navigation** | | | | | | | | | | | | | | | | |
| Liquid Fuels | | | | | | | | | | | | | | | | |
| Residual Fuel Oil | 6.17 | 7.24 | 3.32 | 3.68 | 2.62 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Diesel Oil | 1.44 | 1.72 | 2.04 | 4.64 | 2.88 | 0.17 | 0.30 | 0.26 | 0.25 | 0.23 | 0.32 | 0.30 | 0.45 | 0.35 | 0.36 | 0.34 |
| **1.A.3.e Other Transportation** | | | | | | | | | | | | | | | | |
| Liquid Fuels | 0.34 | 0.47 | 0.26 | 0.00 | 0.35 | 0.00 | 0.08 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Biomass | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Activity data for calculation of $CO_2$ emissions from Transport sector are taken from the annual proceeding Energy Balances of the Statistics of Estonia (www.stat.ee).

## *Emission factors and other parameters*

$CO_2$ emission factors used in Transport sector are the same as for fossil fuel combustion and given in the Table 2.2_5, and non-$CO_2$ emission factors are presented in Annex 1.

### *2.3.1.2 Source-specific recalculations*

The main improvements in this source category where connected with gasoline and diesel oil used by passenger cars. In previous inventories (1990 – 1999) $CO_2$, $N_2O$ and $CH_4$ emissions from use of gasoline and diesel oil by private cares were included into Residential sector. After improvements all emissions from consumption of motor fuels are allocated to the Transport sector sub-category – 1.A.3.2. Road transportation.

## 2.4. Fugitive emissions from fuels (CRF 1.B)

### 2.4.1 Overview of the sector

#### *Description*

Under fugitive emissions from fuels, Estonia reports $CH_4$ emissions from: solid fuels (oil shale mining and handling) and oil and natural gas including following activities:

- shale oil production and transport and storage of oil products
- transmission and distribution of natural gas and oil products
- consumption of natural gas and
- $CH_4$ emissions from flaring and venting from oil and gas production.

In 2005, fugitive emissions from natural gas and oil were 25.09 Gg$CH_4$ (528.82 Gg $CO_{2\ eqv}$) and from oil shale mining and handling were 12.29 Gg$CH_4$ (258.09 Gg $CO_{2\ eqv}$). In previous NIR submissions $CH_4$ emission from landfill gas (biogas) production were accidentally also included into the fugitive emissions. In 2007 submission (emission data of the year 2005) $CH_4$ emission from landfill gas (biogas) production was excluded from key sources of Fugitive emissions. All previous years (1990-2003) have been recalculated.

#### *Quantitative overview*

Fugitive emissions from fuels comprise about 3.8% of total greenhouse gas emissions in Estonia. Emissions from natural gas transmission and distribution dominate this category comprising about 41% of the fugitive emissions reported in the Estonia's Inventory. Emissions from oil shale mining are the second big source of $CH_4$ emission (33%) and natural gas consumption contributes about 24% of the total $CH_4$ emissions of this sector (Table 2.4_1).

**Table 2.4_1. Fugitive emissions from solid fuels, oil and natural gas (Gg $CH_4$)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Solid fuels** | | | | | | | | | | | | | | | | |
| 1.B.1.a Oil Shale mining and handling | 19.41 | 17.55 | 16.25 | 13.40 | 13.17 | 12.13 | 13.47 | 13.02 | 10.76 | 9.74 | 11.25 | 11.02 | 10.63 | 10.92 | 11.26 | 12.29 |
| **Oil** | | | | | | | | | | | | | | | | |
| Shale Oil production (1.B 2 a.2) | 0.02 | 0.02 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.06 | 0.03 | 0.02 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.54 |
| Oil transport (1.B 2 a.3) | 0.20 | 0.10 | 0.06 | 0.06 | 0.07 | 0.07 | 0.07 | 0.09 | 0.09 | 0.09 | 0.04 | 0.04 | 0.05 | 0.04 | 0.05 | 0.05 |
| Oil storage (1.B 2 a.4) | 0.05 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 |
| **Natural Gas** | | | | | | | | | | | | | | | | |
| Natural gas transmission and distribution (1.B 2 b.3) | 23.47 | 23.53 | 13.75 | 6.82 | 9.79 | 11.17 | 12.32 | 11.97 | 11.36 | 11.06 | 12.71 | 13.65 | 11.43 | 12.60 | 14.87 | 15.33 |
| Other leakage (1.B 2 b.5) | 14.02 | 13.98 | 8.06 | 3.80 | 5.58 | 6.54 | 7.30 | 7.09 | 6.68 | 6.51 | 7.51 | 8.09 | 6.76 | 7.48 | 8.85 | 9.10 |
| **Venting and Flaring (1.B.2.e)** | 0.02 | 0.02 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.06 | 0.03 | 0.02 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 |
| **Total $CO_2$ eqv** | **1200.9** | **1159.7** | **802.7** | **507.8** | **603.4** | **630.5** | **698.8** | **678.7** | **608.5** | **576.9** | **663.4** | **690.7** | **608.3** | **654.2** | **738.0** | **784.9** |

### 2.4.2 Solid Fuels (CRF 1.B.1)

#### *2.4.2.1 Source category description*

This section covers fugitive emissions of $CH_4$ from production, processing, handling and utilisation of coal. In Estonia only oil shale is mined and burned for energy generation and shale oil production. For approximate estimations of fugitive emissions from oil shale mining and handling were used methods suggested in IPCC Guidelines for coal.

#### *2.4.2.2 Methodological issues*

*Methods*

The emissions are calculated by multiplying amounts of produced oil shale with national emission factors. Annual activity data is received from the AS Eesti Energia who ovens the oil shale mining company AS Eesti Põlevkivi.

*$CH_4$ emissions (Gg) = $CH_4$ Emission Factor (m3 $CH_4$/ton of oil shale mined) x Oil Shale Production (Mt) x Conversion Factor (Gg/*106 $m^3$)

The structure of the $CH_4$ emissions from mining (underground and surface mining) and post mining activities (underground and surface mining) is given in the Greenhouse Gas Workbook, Vol. 3, 1996:

*Emission factors and other parameters*

The emission factors used for calculation of fugitive emissions from oil shale mining are estimated by Estonian experts.

**Table 2.4_2 $CH_4$ emission factors for fugitive emissions from solid fuel mining and handling**

| SOLID FUEL | Emission Factor | Unit | Source |
|---|---|---|---|
| Oil Shale mining and handling | | | |
| Underground mining | 2 | $m^3$ $CH_4$/t | CS |
| Underground post-mining | 0.2 | $m^3$ $CH_4$/t | CS |
| Surface mining | 0.3 | $m^3$ $CH_4$/t | CS |
| Surface post-mining | 0.1 | $m^3$ $CH_4$/t | CS |

### 2.4.3 Oil and Natural Gas (CRF 1.B.2)

#### *2.4.3.1 Source category description*

Sources of fugitive emissions within oil and gas systems include releases during normal operation, such as emissions associated with venting and flaring, chronic leaks or discharge from process vents, emissions during maintenance, and emissions during system upsets and accidents. In Estonia liquid fossil fuels and natural gas are mainly imported. Only shale oil is produced in Estonia.

#### *2.4.3.2 Methodological issues*

### *Methods*

The equation for calculating $CH_4$ emissions from oil and gas activities is following:

$$CH_4\ Emissions\ (Gg\ CH_4) = \{Activity\ (PJ)\ x\ Emission\ Factor\ (kg\ CH_4/PJ)\}/10^6$$

### *Emission factors and other parameters*

Emission factors of oil and gas activities are estimated on bases of dates in Table 2.4_3 IPCC Guidelines and on bases of expert meaning of specialists from Oil Shale Institute in Kohtla-Järve.

**Table 2.4_3. $CH_4$ emission factors for fugitive emissions from oil and gas activities**

| | Emission Factor | Unit | Source |
|---|---|---|---|
| **OIL** | | | |
| Production of Shale Oil | 4 000 | kg $CH_4$/PJ | D |
| Transport of oil products | 745 | kg $CH_4$/PJ | D |
| Storage of oil products | 200 | kg $CH_4$/PJ | D |
| **GAS** | | | |
| Transmission and distribution of natural gas | 458 000 | kg $CH_4$/PJ | D |
| Other Leakage | | | |
| Non-residential gas consumed | 279 500 | kg $CH_4$/PJ | D |
| Residential gas consumed | 139 500 | kg $CH_4$/PJ | D |
| **Venting and flaring from oil/gas production** | | | |
| Oil (Shale Oil) | 4000 | kg $CH_4$/PJ | D |
| Gas | 18 000 | kg $CH_4$/PJ | D |

## 2.5 Reference approach

Reference approach (RA) is carried out using import, export, production and stock change data from the Energy Balance (EB) annual proceeding published by Statistics of Estonia. However, the RA table requires liquid fuels reported to a more disaggregated level than in the EB sheet. This data was taken from the background data of the EB. In the 2005 inventory, the difference of $CO_2$ emissions between RA and Sectoral Approach (SA) was -3.91%, which is acceptable.

## 2.6 International bunkers

International bunkers cover international aviation and navigation according to the IPCC Guidelines.

In 2005, GHG emissions from marine bunkers were 378.46 $GgCO_{2eqv}$ and aviation bunkers 148.89 $GgCO_{2\ eqv}$.

The emissions were calculated using the IPCC metrology and default emission factors. Fuel consumption data for marine bunkering and aviation bunkering was obtained from the Energy Balance. The emissions of aviation bunkering for the years 1997 to 2003 were calculated first time in this inventory, since the Energy Balance background data (disaggregated Jet Kerosene) was used. In former inventories, all emissions from the use of Jet Kerosene were included into domestic aviation. Jet Kerosene for the years 1990 – 1996 is still included into inland consumption only.

No uncertainty estimation for international bunkers has been carried out.

# CHAPTER 3. INDUSTRIAL PROCESSES (CRF 2)

## 3.1 Overview of sector

### 3.1.1 Description

Estonia's emissions from Industrial Processes sector are divided to Mineral products (CRF 2.A), Chemical industry (CRF 2.B), and Consumption of halocarbons and $SF_6$ (CRF 2.F) and Other production (CRF 2.D). Under Mineral products Estonia reports emissions from cement production and lime production. Under Chemical industry emissions from ammonia production are reported.

The CRF category 2.F covers emissions (potential and actual) of F-gases from refrigeration and air conditioning, as well as some smaller sources.

Under Other production (CRF 2.D) Estonia reports NMVOC emissions from the pulp and paper and food industries.

#### *3.1.1.1 Quantitative overview*

Industrial greenhouse gas emissions contribute about 3% to the total anthropogenic greenhouse gas emissions in Estonia (Figure 3.1_1). The most important greenhouse gas emissions from industrial processes in Estonia's inventory in 2005 are the $CO_2$ emissions from the cement, ammonia and lime production with the 1.64%, 0.60% and 0.58% shares of the total greenhouse gas emissions, respectively.

F-gases emissions comprised together about 0.06% of the total greenhouse gas emissions in Estonia.

Industrial $CO_2$ emissions have decreased considerably since 1990 having the lowest value in 1993 and after small increase in 1994 the trend of $CO_2$ emissions have stabilized (except small fall in 2002). In 2005, GHG emissions from Industrial Processes sector formed about 41% of 1990's level (see Table 3.1_1and Figure 3.1_2Figure ).

**Table 3.1_1. Trend in greenhouse gas emissions from industrial processes (Gg $CO_2$ eqv.)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | | | | | | | | | | | | | | | | |
| A. Mineral Products | 628 | 634 | 388 | 245 | 344 | 361 | 375 | 411 | 429 | 386 | 394 | 402 | 386 | 363 | 396 | 402 |
| B Chemical Industry | 317 | 292 | 150 | 60 | 202 | 207 | 211 | 222 | 242 | 217 | 188 | 203 | 28 | 93 | 171 | 144 |
| HFCs | 0 | 0 | 0 | 0 | 0 | 0.13 | 0.73 | 1.39 | 2.44 | 3.33 | 4.19 | 4.89 | 5.68 | 6.59 | 7.21 | 7.88 |
| $SF_6$ | 0 | 0 | 0 | 0 | | 0.25 | 0.31 | 0.58 | 0.81 | 1.05 | 1.43 | 2.24 | 3.68 | 4.75 | 5.28 | 5.87 |

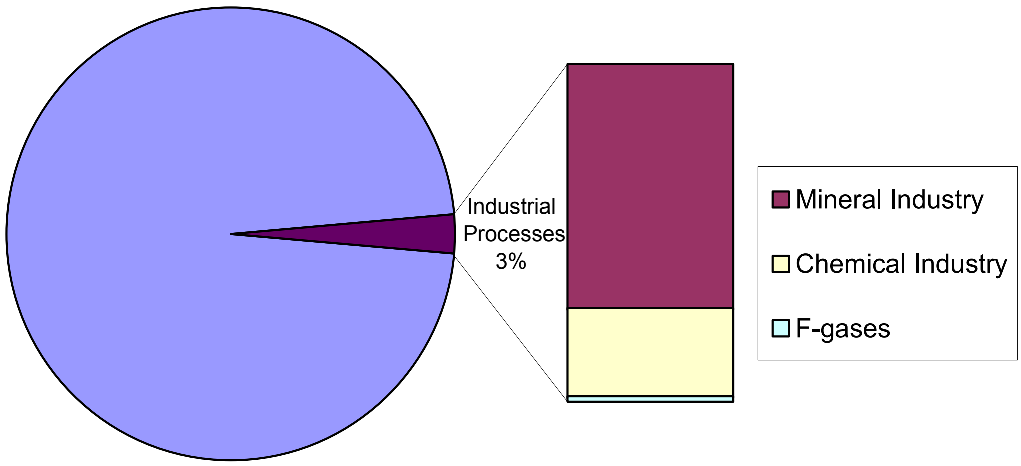



Figure 3.1_1: Emissions from industrial processes in Estonia in 2005.

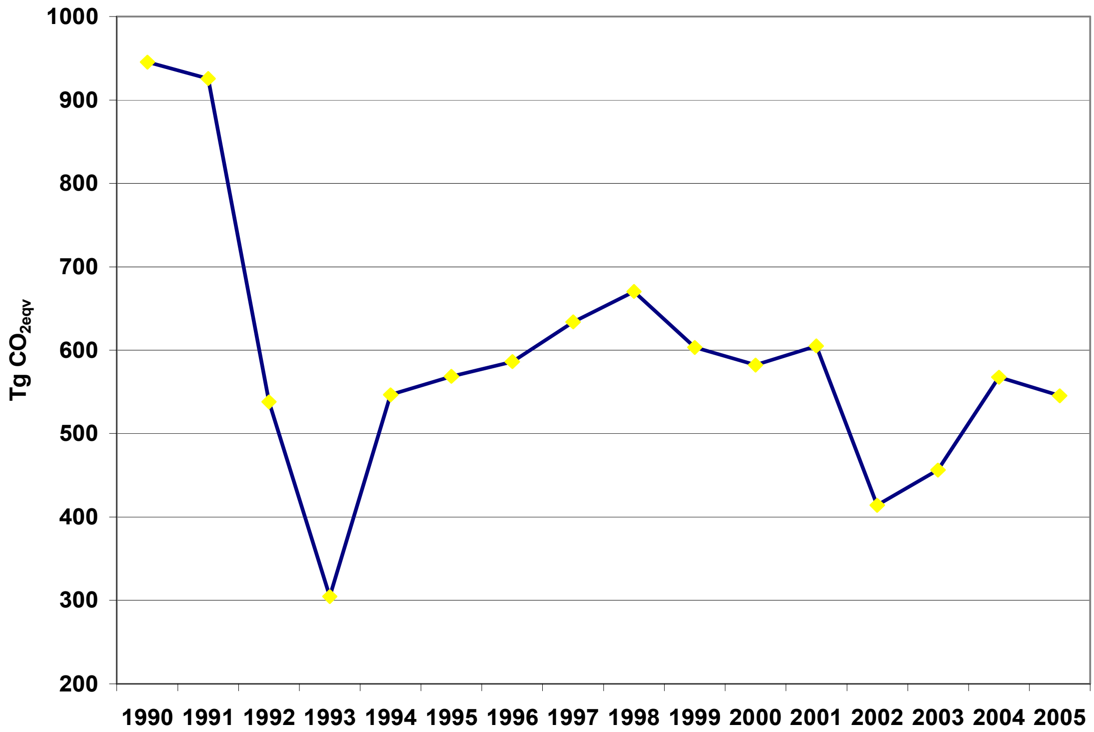



Figure 3.1_2: Emission from industrial processes in 1990-2005 in Estonia (Tg $CO_2$ eqv.)

### *3.1.1.2 Key categories*

Key categories under industrial processes in 2005 calculated with IPCC Tier 1 method were $CO_2$ from cement, lime and ammonia production by level and trend method without LULUCF.

## 3.1.2 Source category description

In this category the non-fuel emissions from cement and lime production are reported (Table 3.1_2). In production of cement $CO_2$ is emitted when an intermediate product, clinker, is produced. In that process limestone is heated to high temperature, which results in emissions, as the main component of limestone, calcium carbonate, breaks down, calcinates, into calcium oxide and carbon dioxide. Limestone contains also small amounts of magnesium carbonate ($MgCO_3$), which will also calcinate in the process causing $CO_2$ emissions. Also $CO_2$ emissions from lime production and limestone and dolomite use are due to calcination of calcium and magnesium carbonates at high temperatures.

The activity data and emission factors used in calculations are from AS Kunda Nordic Cement and AS Nordkalk.

**Table 3.1_2. $CO_2$ emissions from mineral products (Gg)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.A 1 Cement production | 483 | 471 | 315 | 228 | 330 | 348 | 361 | 396 | 404 | 361 | 379 | 387 | 364 | 339 | 369 | 373 |
| 2.A 2 Lime Production | 145 | 163 | 72 | 17 | 14 | 13 | 14 | 15 | 25 | 25 | 16 | 16 | 22 | 24 | 27 | 29 |
| **Total** | **628** | **634** | **388** | **245** | **344** | **361** | **375** | **411** | **429** | **386** | **394** | **402** | **386** | **363** | **396** | **402** |

### 3.1.3 Methodological issues

#### *Methods*

Emissions from cement and lime production are calculated by multiplying emission factor with activity data. Activity data is collected mainly directly from the industry. Emission factors are calculated by the industry (cement production and lime production) or are based on IPCC's default factors (lime production). The methods for calculating emissions from cement production and lime production are consistent with IPCC Tier 1 and Tier 2 level method. (For lime production tier 1 and for cement production tier 2 methods).

#### *Emission factors*

Cement and lime production

Emission factors used in calculation of emissions from cement and lime production are national provided by the industry (i.e. production plants). Previously emission factors have not been directly collected from the industry on as detailed a level as in the present inventory. Annual emission factors vary slightly, since the parameters affecting them vary slightly from year to year (Table 3.1_3).

Emission factor of cement production is based on the CaO and MgO contents of clinker. Cement kiln dust and by pass dust as well as the amounts of CaO and MgO that are calcined already before the process (and therefore do not cause emissions) are taken into account.

Emission factor for lime production is taken from the IPCC's 1996 Revised Guidelines and based on the estimate CaO and MgO contents of lime derived.

#### *Activity data*

Activity data (Table 3.1_3) for cement and lime production is collected mainly directly from the industry and taken partly from industrial statistics.

**Table 3.1_3. Activity data and emission factor for mineral products (Gg)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2. A.1. Clinker production, kt | 790 | 773 | 517 | 378 | 540 | 571 | 591 | 651 | 659 | 590 | 620 | 629 | 591 | 560 | 623 | 635 |
| $EF_{clinker}$ (t/t) | 0.549 | 0.547 | 0.548 | 0.542 | 0.549 | 0.547 | 0.546 | 0.543 | 0.546 | 0.546 | 0.545 | 0.548 | 0.549 | 0.545 | 0.544 | 0.547 |
| Cement kiln dust, kt | 120 | 117 | 78.5 | 57.4 | 82 | 86.7 | 95.8 | 105.5 | 107 | 95.7 | 100.5 | 102.5 | 96.1 | 84.8 | 74.9 | 61.9 |
| $EF_{owen\ dust}$ (t/t) | 0.410 | 0.415 | 0.409 | 0.405 | 0.410 | 0.408 | 0.408 | 0.406 | 0.408 | 0.408 | 0.408 | 0.409 | 0.410 | 0.407 | 0.406 | 0.408 |
| 2. A.2. Lime production, kt | 294.0 | 270.2 | 140.0 | 55.0 | 180.0 | 201.3 | 203.0 | 205.9 | 210.7 | 199.3 | 176.8 | 183.2 | 47.1 | 98.3 | 201.7 | 212.6 |
| $EF_{lime}$ (t/t) | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 | 0.7857 |

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

General (Tier 1) Quality Control (QC) procedures applied to category Mineral products (CRF 2.A)

- Assumptions and criteria for the selection of activity data and emission factors are documented.
- For subcategories CRF 2.A 1 and 2.A 2 the whole time series of emissions, correctness of the calculation formulas, use of appropriate units have been checked.
- The consistency of input data and methods over the time series has been checked.

### 3.1.5 Source-specific recalculations including changes made in response to the review process

Cement and lime production

Emissions from cement production have been recalculated. Activity data and emissions factors have been updated.

Emissions from lime production have been recalculated using improved emission factors.

## 3.2 Chemical Industry (CRF 2.B)

### 3.2.1 Source category description

In Estonia's inventory this category includes the non-fuel emissions from ammonia production (Table 3.2_1). In previous inventory reports $CO_2$ emission from chemical industry was not calculated because lack of activity data. In current inventory submission all years since 1990 are calculated and included into national total GHG emissions.

All ammonia currently produced in Estonia is produced in one company – AS Nitrofert.

**Table 3.2_1. Emissions of $CO_2$ from ammonia production (Gg)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.B.1 Ammonia production | 317 | 292 | 150 | 60 | 202 | 207 | 211 | 222 | 242 | 217 | 188 | 203 | 28 | 93 | 171 | 144 |

### 3.2.2 Methodological issues

Emissions of $CO_2$ will depend on the amount and composition of gas used in the technological process. It is assumed that all carbon will be emitted to air. In the Estonia's ammonia production factory Nitrofert a different ammonia production technology is in use. Not all $CO_2$ emissions are emitted into air, part of them are used as raw material for carbamide production and an other part of is sold to other companies.

### *Methods*

There are two different methods in the IPCC 1996 Guideline for calculation of CO2 emissions from ammonia production: Tier 1a and Tier 1b method.

According to the Tier 1a method:
*Emissions (Gg) '= Consumption of gas (kt) x carbon content x 44/12*
Tier 1b: An alternative is to calculate the emissions from the ammonia production:

*Emissions (Gg) Production of ammonia (kt) x Emission factor*

In the current inventory calculations the tier 1b method has been used.

## *Emission factors*

The emission factor for calculation of $CO_2$ emissions from ammonia production is country specific and based on technology used in the factory.

In the IPCC 1996 Guideline, Vol.3, p. 1.16 same example for used emission factor is given for Canada and Norway. These emission factories are equal to 1.5 – 1.6 $tCO_2$/tonne $NH_3$ produced. In Estonia, ammonia production emission factors are, depending of the year, between 1.407 – 1.572 6 $tCO_2$/tonne $NH_3$ produced.

## *Activity data*

The annual ammonia production figures 1990-2005 have been obtained from the production plants and presented in Table 3.2_2.

**Table 3.2_2. Production ammonia (1000 tonnes)**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ammonia production, kt | 294 | 270 | 140 | 55 | 180 | 201 | 203 | 206 | 211 | 199 | 177 | 183 | 47 | 98 | 202 | 213 |
| Emission factor | 1.564 | 1.572 | 1.572 | 1.572 | 1.580 | 1.485 | 1.458 | 1.417 | 1.396 | 1.428 | 1.431 | 1.487 | 1.469 | 1.529 | 1.366 | 1.407 |
| CO, kt | 460 | 425 | 220 | 86 | 284 | 299 | 296 | 292 | 294 | 285 | 253 | 272 | 69 | 150 | 276 | 299 |
| $CO_2$ for carbamide production | 143 | 133 | 70 | 27 | 82 | 91 | 85 | 69 | 53 | 68 | 65 | 70 | 41 | 57 | 104 | 156 |
| **Total $CO_2$ emissions, Gg** | **317** | **292** | **150** | **60** | **202** | **207** | **211** | **222** | **242** | **217** | **188** | **203** | **28** | **93** | **171** | **144** |

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

General (Tier 1) Quality Control (QC) procedures applied to category Chemical industry (CRF 2.B)

- Assumptions and criteria for the selection of activity data and emission factors are documented.
- For whole time series the emission calculation formulas have been checked.
- For whole time series the use of appropriate units throughout the calculations has been checked.
- Several interviews to describe and explain production technology with factory technologist have been carried out.
- The consistency of input data and methods over the time series has been assessed.

### 3.2.4 Source-specific recalculations including changes made in response to the review process

Previously, due to lack of activity data, emissions from ammonia production have not been estimated.

In the current inventory submission emission calculations from this source category have been made for whole time series 1990-2005 and added to the national total emissions.

## 3.3 Other Consumption (CRF 2.D)

### 3.3.1 Source category description

This source category includes the NMVOC emissions from the pulp and paper (2.D.1) and food (2.D.2) industries.

The non-fuel based $CO_2$ emissions the from pulp and paper industry are estimated to be negligible in Estonia. All $N_2O$ emissions from the pulp and paper and food industry are reported as fuel based emissions under CRF 1.

### 3.3.2 Methodological issues

NMVOC emissions from the pulp and paper and food industry are calculated at the Department of Thermal Engineering of the Tallinn University of Technology. Activity data of the years 1990 – 2002 is obtained from the annual proceeding of the Statistics Estonia “Industry” and of the years 2003-2005 from the electronic database on the web site of statistical office. Emission factors are taken from the IPCC 1996 Guideline.

All $SO_2$ emissions of different sulphur compounds are calculated as $SO_2$ equivalents.

### 3.3.3 Source-specific recalculations including changes made in response to the review process

No recalculations have been made since the previous inventory.

### 3.3.4 Source-specific planned improvements

No source specific improvements are under active consideration at the moment.

## 3.4 Consumption of Halocarbons and $SF_6$ (CRF 2.F)

### 3.4.1 Source category description

HFCs, PFCs and $SF_6$ are not produced in Estonia. However, such gases are brought to Estonia in bulk or in some imported equipment (mainly household and industrial refrigerators, ice machines, drinking water coolers, etc.) where the gases are accumulated.

Unfortunately, Estonia does not have today such a data collection system needed for the emission calculations of those gases, but the Ozone and Climate Bureau of the Information and Technology Centre at the Ministry of Environment has in the course of building up a special data bases including the collected data on fluorinated gases.

In 2005 a project proposal for the EU Transition Facility programme was prepared by the Ozone and Climate Unit at the Estonian Environmental Research Centre (EERC) entitled: *“Enhancing the capacity to reduce the emissions of fluorinated greenhouse gases in Estonia”*. The project will start in second half of 2007 and end in 2008. The project will assess to what extent the current system for ozone depleting substances can be used in the context of fluorinated gases and what additional activities need to be taken. In addition all missing inventories, strategies, programmes, guidelines, standards, legislative provisions etc. will be prepared and also public and industry awareness events and training sessions will be conducted with an aim to first stabilise the emissions of fluorinated gases and eventually reduce the emissions.

The project aims at preparing Estonia for better implementation of the Kyoto Protocol which was approved on behalf of the Community by decision 2002/358/EC (Council Decision of 25 April 2002 concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments there under) and by the Estonian Government on 30 September 2004 as well as the forthcoming Regulation 2003/0189 (COD) on fluorinated greenhouse gases and the Proposal for a Directive relating to emissions from air conditioning systems in motor vehicles and amending Council Directive 70/156/EEC, which are planned to be passed before project start and which establish a detailed framework for the system to be set up in all member states for the reduction of emissions of fluorinated gases.

Due to lack of activity data there was not possible to calculate actual emissions of F-gases in Estonia. In Table 3.4_1 the estimated emissions of HFC-de, PFC-de and $SF_6$ are presented in accordance to the Decision 280/2004/EC Article 4(1) and Decision 2005/166/EC Article 13 and 14 of European Commission. The estimated emissions are calculated together with European Commission using linear extrapolation method. Analysing the amounts of estimated emissions of HFC-de, PFC-de and $SF_6$ we can draw a conclusion that the share of emissions of F-gases in the total GHG emissions is very small (approximately 0.02 – 0.06 %) and the value is in bounds of accepted uncertainties.

**Table 3.4_1. Estimated emissions of HFC-de, PFC-de and $SF_6$ in 1990-2005, Gg $CO_{2\ eqv}$**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **HFCs** | NO | NO | NO | NO | NO | 0.13 | 0.73 | 1.39 | 2.44 | 3.33 | 4.19 | 4.89 | 5.68 | 6.59 | 7.21 | 7.88 |
| **PFCs** | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NO | NE | NE | NE | NE | NE |
| **$SF_6$** | NO | NO | NO | NO | NO | 0.25 | 0.31 | 0.58 | 0.81 | 1.05 | 1.43 | 2.24 | 3.68 | 4.75 | 5.28 | 5.87 |
| **Total** | **NO** | **NO** | **NO** | **NO** | **NO** | **0.38** | **1.04** | **1.97** | **3.25** | **4.38** | **5.62** | **7.130** | **9.36** | **11.34** | **12.49** | **13.75** |

## 3.5 Feedstock and Non-energy Use of Fuels (CRF 7)

### 3.5.1 Source category description

This source covers the $CO_2$ emissions from non-energy use of natural gas. The amount of natural gas is used as feedstock in the Chemical Industry sector for ammonia production and corresponding $CO_2$ emission is taken into account in the Industrial Processes sector.

# CHAPTER 4. AGRICULTURE (CRF 4)

## 4.1. Overview of source category description and methodology

$CH_4$ and $N_2O$ are two gases emitted from agriculture:

- $CH_4$ emission from enteric fermentation and manure management;
- $N_2O$ emission from manure management;
- Direct $N_2O$ emissions from agricultural soils;
- Indirect $N_2O$ emissions from agricultural soils;

Emissions from rice cultivation and savanna burning were not estimated due to the absence of such activities (processes) in Estonia.

Methodologies (*Tier 1* and *Tier 2*) were used in the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" and in "Revised 2000 IPCC Guidelines for National Greenhouse Gas Inventories" (Table 4.1_1).

Activity data were used from official Estonian statistics (the Statistical Office of Estonia [ESO], Estonian Animal Recording Center (EARC) and IPCC default parameters were used (when Estonian data were not available) in the process of the estimation of emissions.

**Table 4.1_1. Methods and emissions factors used for estimations of emission from agriculture**

| | $CH_4$ | | $N_2O$ | |
|---|---|---|---|---|
| | Method Applied | Emission Factor | Method Applied | Emission Factor |
| 1 | 2 | 3 | 4 | 5 |
| **I. Enteric Fermentation** | | | | |
| 1. Cattle | | | | |
| a. Cows, bulls and heifers (2 years and over) | | | | |
| Dairy cattle | T2 | IPCC, CS | | |
| Non-Dairy cattle | | | | |
| …Mature Females | T2 | IPCC, CS | | |
| …Mature Males | T2 | IPCC, CS | | |
| b. Bovine animals (ages between 1 and 2 years) | T2 | IPCC, CS | | |
| c. Calves (less than 1 year old) | T2 | IPCC, CS | | |
| 2. Swine | | | | |
| a. Piglets, live weight less than 20 kg | T1, L | IPCC, CS | | |
| b. Young pigs, live weight 20 - <50 kg | T1, L | IPCC, CS | | |
| c. Fattening pigs, live weight | | | | |
| 50 - <80 kg | T1, L | IPCC, CS | | |
| 80 - <110 kg | T1, L | IPCC, CS | | |
| 110 kg or more | T1, L | IPCC, CS | | |
| d. Breeding pigs, live weight 50 kg and more | T1, L | IPCC, CS | | |
| 3. Sheep | T1 | IPCC, CS | | |
| 4. Goats | T1 | IPCC | | |
| 5. Horses | T1 | IPCC | | |
| 6. Poultry | T1 | IPCC | | |
| **II. Manure Management** | | | | |
| 1. Cattle | | | | |
| a. Cows, bulls and heifers (2 years and over) | | | | |
| Dairy cattle | T1 | IPCC, CS | T1 | IPCC, CS |
| 1 | 2 | 3 | 4 | 5 |
| Non-Dairy Cattle | | | | |
| Mature Females | T1 | IPCC | T1 | IPCC, CS |
| Mature Males | T1 | IPCC | T1 | IPCC, CS |
| b. Bovine animals (ages between 1 and 2 years) | T1 | IPCC | T1 | IPCC, CS |

| | | | | |
|---|---|---|---|---|
| c. Calves (less than 1 year old) | T1 | IPCC | T1 | IPCC, CS |
| 2. Swine | | | | |
| a. Piglets, live weight less than 20 kg | T1 | IPCC, CS | T1 | IPCC, CS |
| b. Young pigs, live weight 20 - <50 kg | T1 | IPCC, CS | T1 | IPCC, CS |
| c. Fattening pigs, live weight | | | | |
| 50 - <80 kg | T1 | IPCC, CS | T1 | IPCC, CS |
| 80 - <110 kg | T1 | IPCC, CS | T1 | IPCC, CS |
| 110 kg or more | T1 | IPCC, CS | T1 | IPCC, CS |
| d. Breeding pigs, live weight 50 kg and more | T1 | IPCC, CS | T1 | IPCC, CS |
| 3. Sheep | T1 | IPCC | T1 | IPCC |
| 4. Goats | T1 | IPCC | T1 | IPCC |
| 5. Horses | T1 | IPCC | T1 | IPCC |
| 6. Poultry | T1 | IPCC | T1 | IPCC |
| **III. Rice Cultivation** | | | | |
| **IV. Agricultural soil** | | | | |
| 1. Direct Soil Emissions | | | | |
| a. Synthetic Fertilizers | | | T1 | IPCC |
| b. Animal Waste Applied to Soils | | | T1 | IPCC |
| c. N-fixing crops | | | T1 | IPCC |
| d. Crop Residues | | | T1 | IPCC |
| e. Cultivation of Histosols | | | NE | NE |
| 2. Animal Production | | | T1 | IPCC |
| 3. Indirect Emissions | | | | |
| a. Atmospheric Deposition | | | T1 | IPCC |
| b. Leaching and Run-off | | | T1 | IPCC |
| **V. Prescribed Burning of Savannas** | | | | |
| **VI. Field Burning of Agricultural Residues** | | | NE | NE |

T1 –Tier 1; T – Tier 2; L – literature; IPCC – IPCC default factors; CS – Country specific

## 4.2. $CH_4$ and $N_2O$ emissions from enteric fermentation and manure management

Emissions of $CH_4$ and $N_2O$ from livestock are reported under enteric fermentation and livestock manure management.

### 4.2.1. Livestock

The livestock population decreased in comparison with 1990; the total number of swine decreased 2.5 fold, horses – 1.8 fold and poultry – 3.5 fold. The number of dairy cattle decreased from 477 thousand heads to 119.1 thousand heads from 1990 to 2005 and the number of non-dairy cattle from 281 thousand heads to 136.7 thousand heads during the same period (Figure 4.2_1, Figure 4.2_2).

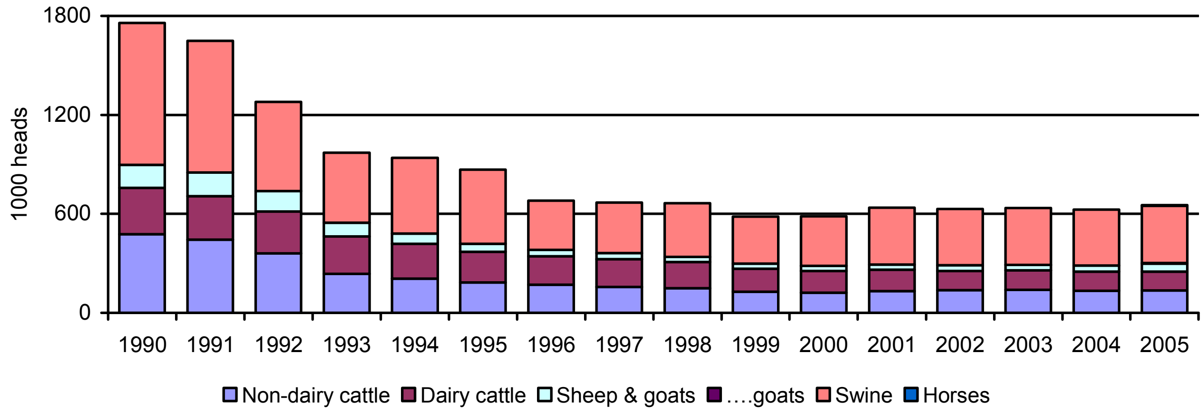


Figure 4.2_1: Population of livestock in Estonia from 1990 to 2005, 1000 heads[3]

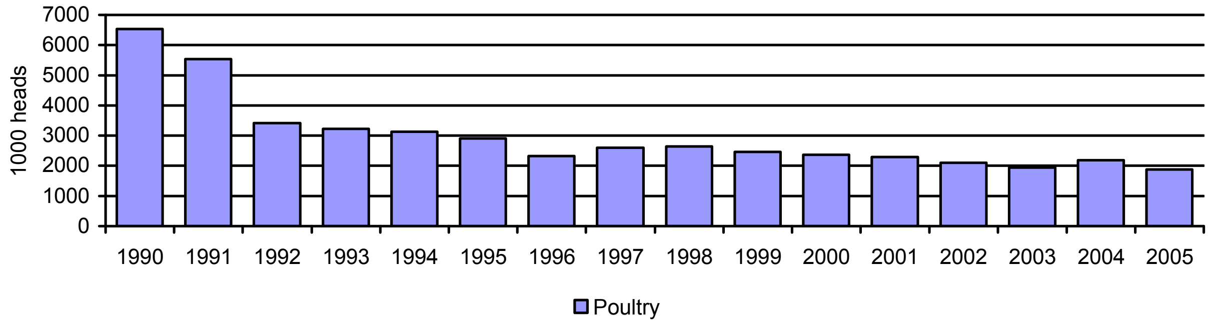



Figure 4.2_2: Population of poultry in Estonia from 1990 to 2005, 1000 heads[1]

### 4.2.2. Methane from enteric fermentation (CRF 4.A)

#### *4.2.2.1. Source category description*

Methane is emitted as a by-product of the normal livestock digestive process, in which microbes resident in the animal's digestive system ferment the feed consumed by the animal. This fermentation process is also known as enteric fermentation. The $CH_4$ is then eructated or exhaled by the animal. Within livestock, ruminant livestock (cattle, buffalo, sheep, and goats) are the primary source of emissions [Gibbs *et al.*, 2000]. Pigs are non-ruminant animals and convert a smaller proportion of feed intake into methane than ruminants.

#### *4.2.2.2. Methodology*

The key category for the estimation of $CH_4$ emission from enteric fermentation was *Tier 1* and *Tier 2* method (IPCC 1996, 2000).

#### *4.2.2.2.1. Cattle*

The *Tier 2* method (IPCC 1996) was used to estimate $CH_4$ emission from enteric fermentation of the main cattle livestock sub-categories (presented by ESO). A disaggregation on county level of Estonia was used (Table 4.2_1).

**Table 4.2_1. Symbols used in the algorithm for cattle**

| County | Cattle classes |
|---|---|
| i1- Harju county | j1- Dairy Cattle |
| i2- Hiiu county | j2- Mature Females |
| i3- Ida-Viru county | j3- Mature Males |
| i4- Jõgeva county | j4- Bovine cattle |
| i5- Järva county | j5- Calves (less than 1 year old) |
| i6- Lääne county | |
| i7- Lääne-Viru country | |
| i8- Põlva county | |
| i9- Pärnu county | |
| i10- Rapla county | |
| i11- Saare county | |
| i12- Tartu county | |
| i13- Valga county | |
| i14- Viljandi county | |

[3] The data were obtained from [Greenhouse gas emissions in Estonia 1990–2004] and [Agriculture 2005]

| i15- Võru county | |
|---|---|

**Net energy for maintenance** – Net energy required by the animal to keep the animals in energy equilibrium

$$NE_{mji}\,(MJ/day) = C_{f\,ji} \times (weight\_in\_kg_{ij})^{0.75} \qquad (4.1)^{4}$$

Where:
$NE_{mji}$ - Net energy for maintenance by *j* category of cattle in *i* county, MJ/head/day;
Weight – Live weight of *j* category of cattle in *i* county, kg;
Cf – Table 4.2_2;

**Table 4.2_2. $C_f$ coefficient**[5]

| Animal Category | $C_{fi}$ |
|---|---|
| Cattle (non-lactating) | 0.322 |
| Cattle (lactating) | 0.335 |

**Net energy for activity** for animals

$$NE_{aji} = C_a \times NE_{mji}\ \_for\_cattle \qquad (4.2)^{6}$$

Where:
$NE_{aji}$ - Net energy intake by *j* category of cattle in *i* county, MJ/head/day;
$C_a$ - Coefficient corresponding to animal's feeding situation;
$NE_m$ – Net energy required for maintenance by *j* category of cattle in *i* county (4.1);

[4] IPCC 2000, Agriculture, Equation 4.1, pp 4.13
[5] IPCC 2000, Agriculture, Table 4-4 – Coefficient for calculating NEm, pp. 4.15
[6] IPCC 2000, Agriculture, Equation 4.2a – pp 4.12

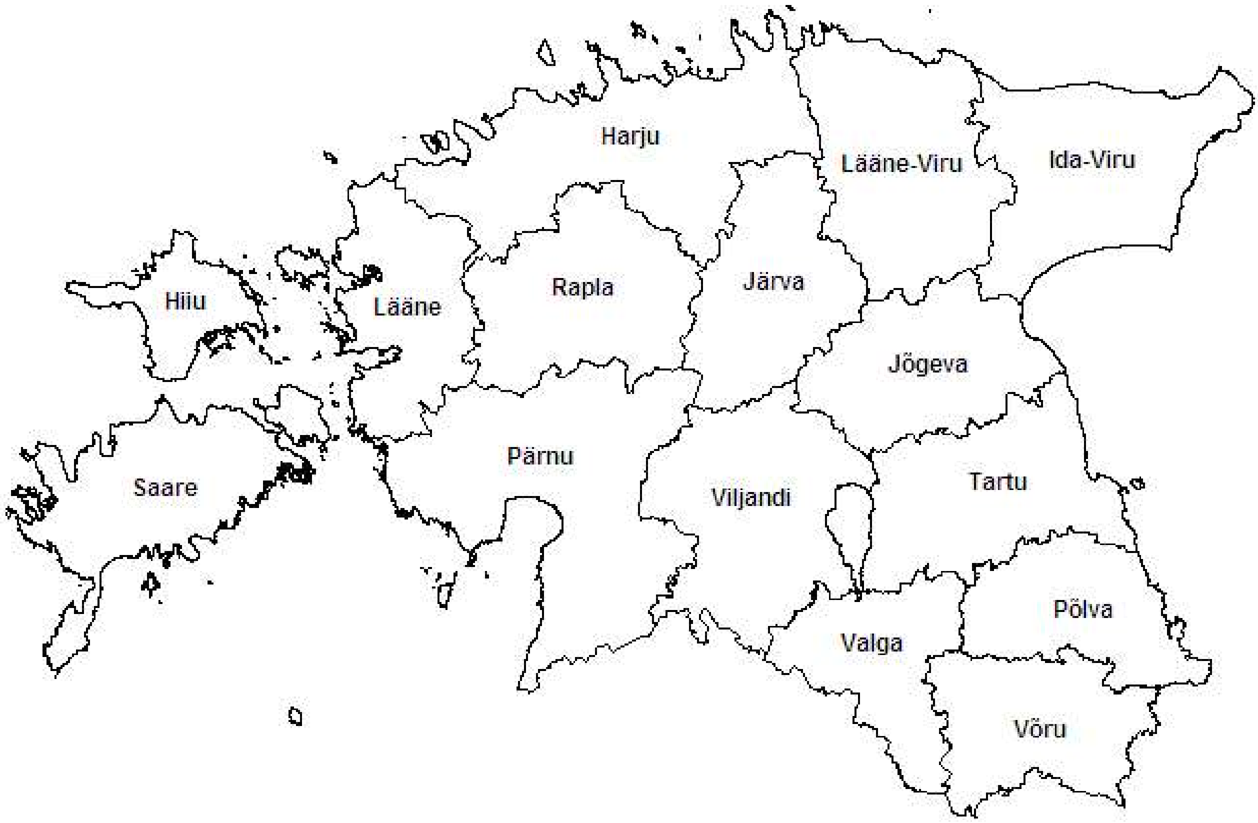



Figure 4.2_3: Administrative boundaries of Estonia's counties [map from the Estonian Land Board]

**Table 4.2_3. Activity coefficients corresponding to animal's feeding situation**[7]

| Situation | Definition | $C_a$ |
|---|---|---|
| Stall | Animals are confined to a small area with the result that they expend very little or no energy to acquire feed. | 0 |
| Pasture | Animals are confined in areas with sufficient means to forage, requiring a modest energy expense to acquire feed. | 0.17 |

**Net energy for growing** – net energy needed for growth live weight gain

$$NE_{gji}(MJ/day) = 4.18 \times \{(0.035 W_{ji}^{0.75} \times WG_{ji}^{1.119}) + WG_{ji}\} \qquad (4.3)^{8}$$

Where:
$NE_{gji}$ – Net energy for growing by *j* category of cattle in *i* county, MJ/head/day;
W – Weight, kg;
WG – Weight gain by *j* category of cattle in *i* county, kg per day;

**Net energy for lactation** – energy for lactation

$$NE_{l_i}(MJ/day) = kg\_of\_milk/day_i \times (1.47 + 0.40 \times Fat_i) \qquad (4.4)^{9}$$

Where:
$NE_{li}$ – Net energy for lactation by dairy cattle in *i* county, MJ/head/day;
Fat – Fat content of milk in *i* county, %;

[7] IPCC 2000, Table 4.5 – Activity coefficients corresponding to animal's feeding situation, pp. 4.15
[8] IPCC 1996, Agriculture, Reference Manual, Equation 3, pp. 4.18
[9] IPCC 2000, Agriculture, Equation 4.5a, pp. 4.17

**Net energy for pregnancy**

$$NE_{pregnancy}(MJ/281-day\_period) = 28 \times calf\_birth\_weight\_in\_kg \qquad (4.5)^{10}$$

$$Calf\_birth\_weight\_(kg) = 0.266 \times (cow\_weight\_in\_kg)^{0.79} \qquad (4.6)$$

**Ratio of net energy available in a diet for maintenance to digestible energy consumed**

$$NE/DE_{ji} = 1.123 - (4.092 \times 10^{-3} \times DE_{ji}\%) + (1.126 \times 10^{-5} \times (DE_{ji}\%)^2) - 25.4/DE_{ji}\% \qquad (4.7)^{11}$$

Where:
$NE_{ma}/DE_{ji}$ – Ratio of net energy available in a diet for maintenance to digestible energy consumed for *j* category of cattle in *i* county;
$DE_{ji}$ – Digestible energy expressed as a percentage of gross energy for *j* category of cattle in *i* county;

**Ratio of net energy available for growth in a diet to digestible energy consumed**

$$NE_g/DE_{ji} = 1.164 - (5.160 \times 10^{-3} \times DE_{ji}\%) + (1.308 \times 10^{-5} \times (DE_{ji}\%)^2) - 37.4/DE_{ji}\% \qquad (4.8)^{12}$$

Where:
$NE_{gaji}$ – Ratio of net energy available for growth in a diet to digestible energy consumed for *j* category of cattle in *i* county;

**Gross energy for cattle**

$$GE = \frac{(NE_{m\,ji} + NE_{feedji} + NE_{lji} + NE_{workji} + NE_{pregnancyji}) \times \left(\frac{100}{DE_{ji}\%}\right)}{(NE/DE)_{ji} + (NE_{gji}/\{NE_g/DE\}_{ji})} \qquad (4.9)^{13}$$

Where:
GE – Gross energy by *j* category of cattle in *i* county, MJ/head/day
$NE_m$ – Net energy required by the animal for maintenance by *j* category of cattle in *i* county, MJ/head/day;
$NE_a$ or $N_{feed}$ – Net energy for animal activity by *j* category of cattle in *i* county, MJ/day
$NE_l$ – Net energy for lactation by dairy cattle in *i* county, MJ/head/day;
$NE_w$ – Net energy for work by *j* category of cattle in *i* county[14], MJ/head/day;
$NE_p$ or $NE_{pregnancy}$ – Net energy required for pregnancy by dairy cattle in *i* county, MJ/head/day;
$NE_g$ – Net energy needed for growth by *j* category of cattle in *i* county, MJ/head/day;
DE – Digestible energy as percentage of gross energy of *j* category of cattle in *i* county, %;

[10] IPCC 1996, Agriculture, Reference Manual, Equation 6, pp. 4.19
[11] IPCC 2000, Agriculture, Equation 4.9, pp. 4.19
[12] IPCC 1996, Agriculture, Reference Manual, Equation 10, pp 4.19
[13] IPCC 1996, Reference Manual, Equation 16, pp. 4.21
[14] Net energy for work was not calculated

**Methane emission factor from livestock category**

$$E = [GE \times Y_m \times (365 days/yr)] / [55.65 MJ / CH_4\ kg] \qquad (4.10)^{15}$$

Where:
E – Methane emission from enteric fermentation of *j* category of cattle in *i* county, kg $CH_4$/year;
GE – Gross Energy Intake by *j* category of cattle in *i* county, MJ/head/day;
$Y_m$ – Methane conversion rate, which is the factor of gross energy in feed converted to methane;

### 4.2.2.2.1.1 Data availability and sources

The main sources of data used in the algorithm to estimate the methane emission factor from enteric fermentation by sub-categories of cattle:
*Weight, kg* – data on weight of cattle were obtained from IPCC reported tables[16].
*Average Weight gain per day* – a source on average weight gain for young and growing animals was Kaasik's work [Kaasik et al., 2002].
*Feeding situation* – data were obtained from databases (tables) reported by IPCC[14]
*Milk production per day, kg/day* – a source of data was [Agriculture 2005] (Table 4.2_4).
*Fat content of milk, %* - data were obtained from a database of the EARC (Table 4.2_5).
*Percentage of cows that give birth in a year, %* – data used from a database of the EARC (Table 4.2_5).
*Feed digestibility, %* - data were used from databases (tables) presented by IPCC[14]

**Table 4.2_4. Average milk yield per cow, fat content and percentage of cows that gave birth in 2005**

| County | Average milk yield per cow[17], kg | Fat content[18], % | Percentage of cows that gave birth in 2005, % |
|---|---|---|---|
| Estonian average | 5,886 | 4.21 | 84.0 |
| Harju county | 5,756 | 4.27 | 70.9 |
| Hiiu county | 4,987 | 4.19 | 73.2 |
| Ida-Viru county | 5,492 | 4.09 | 82.3 |
| Jõgeva county | 6,188 | 4.17 | 89.8 |
| Järva county | 6,330 | 4.28 | 75.7 |
| Lääne county | 4,731 | 4.25 | 86.4 |
| Lääne-Viru county | 6,205 | 4.11 | 91.6 |
| Põlva county | 6,506 | 4.27 | 89.0 |
| Pärnu county | 5,806 | 4.23 | 82.5 |
| Rapla county | 6,105 | 4.11 | 86.7 |
| Saare county | 5,113 | 4.27 | 85.9 |
| Tartu county | 6,423 | 4.22 | 94.2 |
| Valga county | 5,259 | 4.21 | 76.9 |
| Viljandi county | 5,098 | 4.26 | 89.3 |
| Võru county | 5,481 | 4.26 | 75.2 |

Methane emission factors were estimated based on above presented method (*Tier 2* method), available Estonian data and IPCC default parameters (Table 4.2_5).

[15] IPCC 2000, Agriculture, Equation 4.14, pp. 4.26,
[16] IPCC 1996, Agriculture, Reference Manual, Table A-1- Data for estimating enteric fermentation emission factors for dairy cattle. pp. 4.31
[17] [Agriculture 2005]
[18] http://www.jkkeskus.ee/pages/sta/2005/ka2005.htm

**Table 4.2_5. $CH_4$ emission factor from enteric fermentation of cattle in 2005**

| County | Emission factors for Enteric Fermentation, kg $CH_4$/head/yr | | | | | | |
|---|---|---|---|---|---|---|---|
| | Dairy Cattle | | Non-Dairy Cattle | | | | |
| | | | Mature Males | Mature Females | Bovine animals | Calves | IPCC [19] |
| | used in the estimation | IPCC | used in the estimation | used in the estimation | used in the estimation | used in the estimation | |
| Total | | 100 | | | | | 48 |
| Harju county | 121 | | 60 | 68 | 63 | 34 | |
| Hiiu county | 110 | | 60 | 68 | 63 | 34 | |
| Ida-Viru county | 116 | | 60 | 68 | 63 | 34 | |
| Jõgeva county | 125 | | 60 | 68 | 63 | 34 | |
| Järva county | 127 | | 60 | 68 | 63 | 34 | |
| Lääne county | 108 | | 60 | 68 | 63 | 34 | |
| Lääne-Viru county | 124 | | 60 | 68 | 63 | 34 | |
| Põlva county | 129 | | 60 | 68 | 63 | 34 | |
| Pärnu county | 120 | | 60 | 68 | 63 | 34 | |
| Rapla county | 123 | | 60 | 68 | 63 | 34 | |
| Saare county | 113 | | 60 | 68 | 63 | 34 | |
| Tartu county | 128 | | 60 | 68 | 63 | 34 | |
| Valga county | 114 | | 60 | 68 | 63 | 34 | |
| Viljandi county | 113 | | 60 | 68 | 63 | 34 | |
| Võru county | 117 | | 60 | 68 | 63 | 34 | |

#### *4.2.2.2.2. Pigs*

The *Tier 1* (IPCC 1996) was used for the estimation of $CH_4$ emission from enteric fermentation of pigs, the estimation was carried out for the main sub-categories of pigs reported by the ESO [Agriculture 2005].

Feed intake was calculated using the method (the algorithms) presented in literature [Oll *et al.*, 1991; Turnpenny *et al.*, 2001], IPCC default parameters were used in the process of estimation.

The algorithm of the estimation of $CH_4$ emissions from pigs by sub-categories with disaggregation on county level of Estonia is presented below.

**Table 4.2_6. Symbols used in the algorithm for swine (see also Figure 4.2_3)**

| County | Swine classes |
|---|---|
| i1- Harju county | j1- Piglets, live weight less than 20 kg |
| i2- Hiiu county | j2- Young pigs, live weight20–<50 kg |
| i3- Ida-Viru county | j3- Pigs, with live weight 50–<80 kg |
| i4- Jõgeva county | j4- Pigs, with live weight 80–<110 kg |
| i5- Järva county | j5- Pigs, with live weight 110 kg or more |
| i6- Lääne county | j6- Breeding pigs, live weight 50 kg or more |
| i7- Lääne-Viru county | |
| i8- Põlva county | |
| i9- Pärnu county | |
| i10- Rapla county | |
| i11- Saare county | |
| i12- Tartu county | |
| i13- Valga county | |

[19] IPCC 1996, Agriculture. Reference Manual. Table 4-4 - Enteric fermentation emission factors for cattle. pp – 4.11

| | |
|---|---|
| i14- Viljandi county | |
| i15- Võru county | |

**Gross energy intake by swine**

$$E_{ji} = 2.0 \times w_{ji}^{0.63} \qquad (4.11)^{20}$$

Where:
GE – Gross energy intake by *j* category of swine in *i* county, MJ/head/day;
w – Live weight of *j* category in *i* county, kg;

**Methane emission factor from livestock category**

$$E = \left[GE \times Y_m \times (365 days/yr)\right] / \left[55.65 MJ / CH_4\ kg\right] \qquad (4.12)^{21}$$

Where:
E – Methane emission from enteric fermentation, kg $CH_4$ / year;
GE – Gross energy intake, MJ/head/day;
$Y_m$ – Methane conversion rate, which is the factor of gross energy in feed converted to methane;

Estimated $CH_4$ emission factors of enteric fermentation of pigs are presented in Table 4.2_7.

**Table 4.2_7. Enteric fermentation methane emission factors for pigs**

| Swine category | Emission factor, kg $CH_4$ / year / head | |
|---|---|---|
| | used in the estimation | IPCC[22] |
| Total | | 1.5 |
| Piglets, live weight less than 20 kg | 0.3 | |
| Young pigs, live weight 20–<50 kg | 0.7 | |
| Fattening pigs | | |
| …live weight 50–<80 kg | 1.1 | |
| …live weight 80–<110 kg | 1.4 | |
| …live weight 110 kg or more | 1.9 | |
| Breeding pigs, live weight 50 kg or more | 1.2 | |

### *4.2.2.2.3. Sheep, Goats, Horses and Poultry*

The IPCC (1996) reports the average methane emission factor for some livestock types for developing and for developed countries. The emissions factors (for developed countries) were used in the process of the estimation of $CH_4$ emission from sheep, goats and horses (Table 4.2_8).

**Table 4.2_8. Enteric fermentation methane emission factors[23]**

| Enteric Fermentation | Emission Factor , kg $CH_4$/head/yr |
|---|---|
| Sheep | 8 |

[20] Oll *et al.*, 1991; Turnpenny *et al.*, 2001
[21] IPCC 200. Agriculture. Equation 4.14. pp. 4.26
[22] IPCC 1996. Agriculture. Reference Manual. Table 4-3 – Enteric Fermentation Emission Factors. pp. 4.10
[23] IPCC 1996. Agriculture. Reference Manual. Table 4-3 Enteric Fermentation Emission Factors (default values for developed countries) pp. 4.10

| | |
|---|---|
| Goats | 5 |
| Horses | 18 |
| Poultry | Not estimated |

The algorithm based on the *Tier 1* (IPCC 1996) and is presented below by the formula (4.13).

$$CH_4 \text{ Emissions} = EF_{ji} \times \text{population}_{ji} / (10^6 \text{ kg/Gg}) \qquad (4.13)^{24}$$

Where:
$CH_4$ Emissions$_{ji}$ – Methane emission from enteric fermentation from *j* category of animals in *i* county, Gg $CH_4$/year;
$EF_{ji}$ – Methane emission factor for *j* category of animals in *i* county, $CH_4$ kg/head/year;
Population$_{ji}$ – The number of *j* category of animals in *i* county, head;

#### *4.2.2.3. Quantitative overview – $CH_4$ emissions from enteric fermentation in 2005*

The quantity of $CH_4$ emission from enteric fermentation of animals was 21.122 Gg in 2005 (Table 4.2_9), the main value of $CH_4$ is emitted by cattle (96.3%). The allocation of $CH_4$ emission by counties is illustrated on Figure 4.2_4.

**Table 4.2_9. Total $CH_4$ emission from enteric fermentation of livestock in Estonia in 2005**

| | Methane emission from Enteric Fermentation of animals, Gg $CH_4$/yr |
|---|---|
| Total | **21.122** |
| Cattle | 20.348 |
| Swine | 0.276 |
| Sheep | 0.397 |
| Goats | 0.014 |
| Horses | 0.086 |

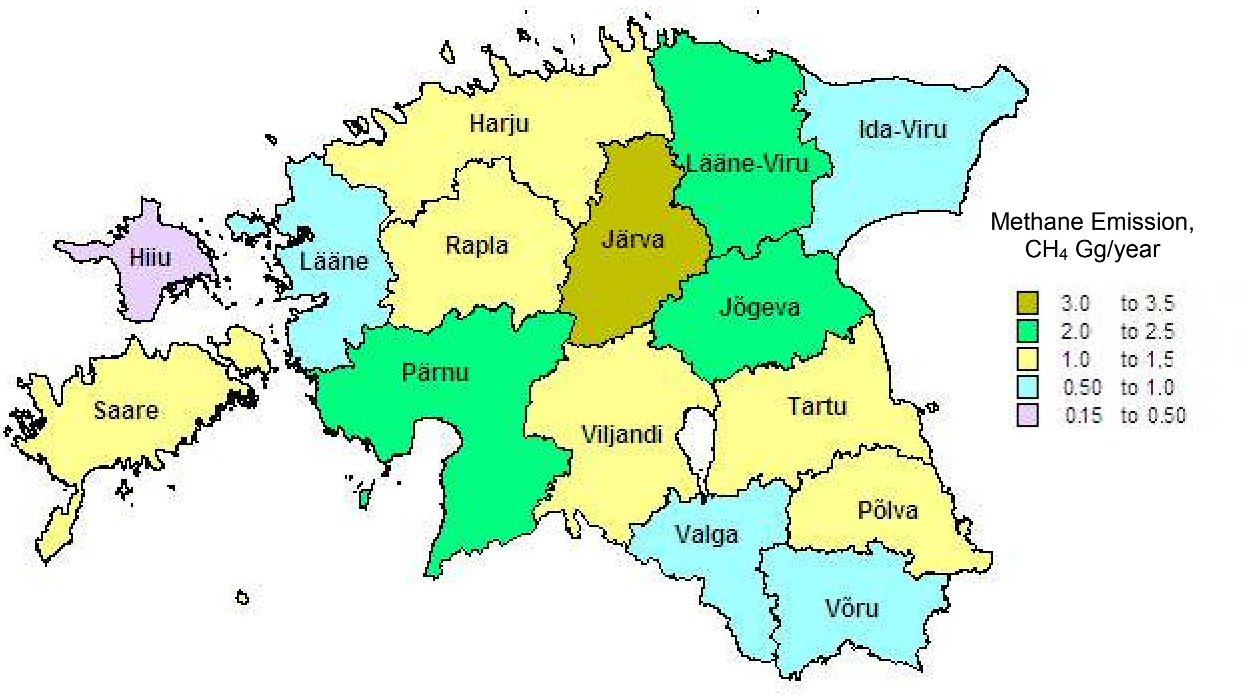



Figure 4.2_4: $CH_4$ emissions from enteric fermentation by counties of Estonia in 2005

[24] IPCC 2000. Agriculture. Equation 4.12. pp. 4.25

$CH_4$ emission (recalculated) from enteric fermentation decreased 2.5 fold (Figure 4.2_5) due to the decreasing of the animal population from 1990 to 2005 (Figure 4.2_1, Figure 4.2_2).

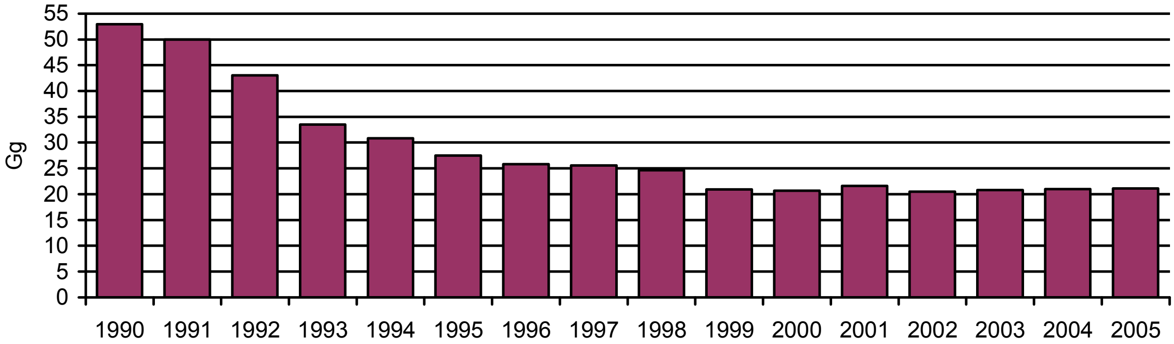



Figure 4.2_5: $CH_4$ emission from enteric fermentation in 1990–2005, Gg

#### *4.2.2.3.1. Quantitative overview – $CH_4$ emissions from enteric fermentation of cattle in 2005*

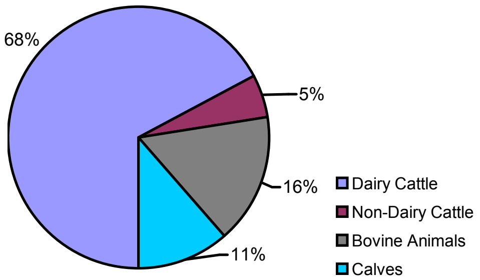
The number of livestock by sub-categories of cattle and by county of Estonia was obtained from the annual report of the ESO (Table 4.2_10).

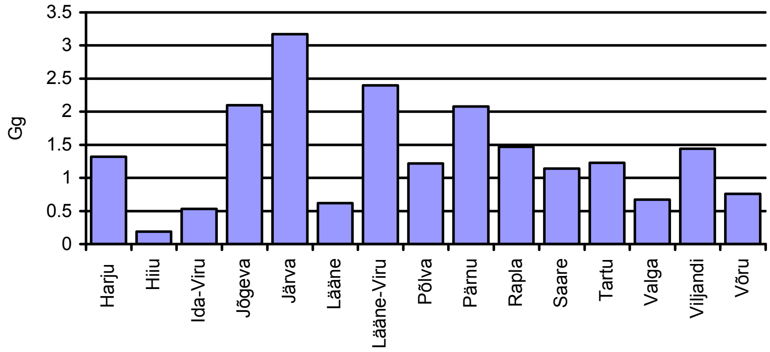
**Table 4.2_10. Number of cattle livestock in 2005, 1000 heads [Agriculture 2005]**

| County | Total | Cows, bulls and heifers (2 years and over) | | | Bovine animals (aged between 1 and 2 years) | Calves (less than 1 year old) |
|---|---|---|---|---|---|---|
| | | Dairy Cattle | Non-Dairy Cattle | | | |
| | | | Mature Males | Mature Females | | |
| Total | **249.5** | **112.8** | **0.8** | **16.8** | **51.9** | **67.2** |
| Harju | 16.3 | 7.2 | 0.1 | 1.5 | 3.2 | 4.3 |
| Hiiu | 2.8 | 0.9 | 0 | 0.4 | 0.6 | 0.9 |
| Ida-Viru | 6.7 | 3.1 | 0 | 0.4 | 1.4 | 1.8 |
| Jõgeva | 25.9 | 11.3 | 0 | 1.1 | 5.8 | 7.7 |
| Järva | 36.2 | 18.1 | 0.1 | 1.7 | 7.4 | 8.9 |
| Lääne | 9 | 3 | 0.1 | 1.5 | 1.7 | 2.7 |
| Lääne-Viru | 29.8 | 12.3 | 0.1 | 1.7 | 7.6 | 8.1 |
| Põlva | 14 | 6.8 | 0 | 0.9 | 2.4 | 3.9 |
| Pärnu | 24.3 | 12.4 | 0.1 | 1.7 | 4.5 | 5.6 |
| Rapla | 18.1 | 7.8 | 0.2 | 1.2 | 4 | 4.9 |
| Saare | 14.9 | 6.5 | 0 | 1.3 | 3 | 4.1 |
| Tartu | 14.8 | 6.5 | 0 | 0.9 | 3.2 | 4.2 |
| Valga | 8.8 | 3.9 | 0 | 0.7 | 1.5 | 2.7 |
| Viljandi | 18.3 | 8.6 | 0.1 | 1.2 | 3.7 | 4.7 |
| Võru | 9.6 | 4.4 | 0 | 0.6 | 1.9 | 2.7 |

The quantity of $CH_4$ emission from enteric fermentation of cattle was 20.35 Gg in 2005.

The allocation of $CH_4$ emissions by sub-categories of cattle livestock and by counties of Estonia is presented in Figures 4.2_6.




**a)** **b)**

Figure 4.2_6: $CH_4$ emission from enteric fermentation by sub-categories of cattle (a) and by counties (b) of Estonia in 2005

### *4.2.2.3.2. Quantitative overview – $CH_4$ emissions from enteric fermentation of swine in 2005*

The number of livestock by sub-categories of pigs and by county of Estonia was obtained from an annual report of the ESO (Table 4.2_11).

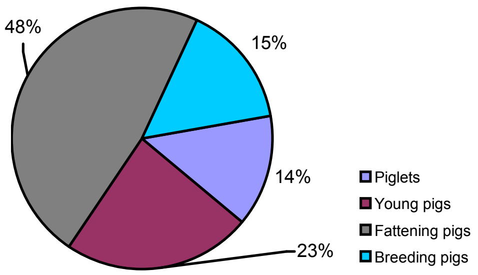
**Table 4.2_11. Number of pigs by category and county in 2005, 1000 heads [Agriculture 2005]**

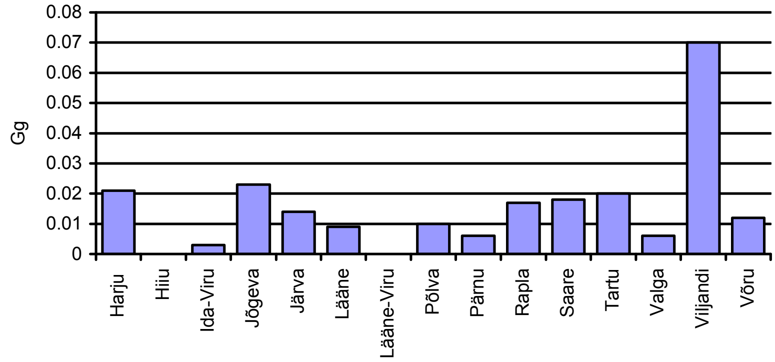
| County | Piglets, live weight less than 20 kg | Young pigs, live weight20–<50 kg | Fattening pigs | | | Breeding pigs, live weight 50 kg or more |
|---|---|---|---|---|---|---|
| | | | live weight 50–<80 kg | live weight 80–<110 kg | live weight 110 kg or more | |
| Total | 113.3 | 87.2 | 77.2 | 31.7 | 1.5 | 35.6 |
| Harju | 4.8 | 7.4 | 6.6 | 4.1 | 0.1 | 2.4 |
| Hiiu | x[25] | x | x | x | x | x |
| Ida-Viru | 0.7 | 1 | 0.9 | 0.6 | 0 | 0.3 |
| Jõgeva | 7.4 | 7 | 9.1 | 1.6 | 0 | 3 |
| Järva | 4.8 | 3.8 | 3.1 | 2.2 | 0.3 | 1.9 |
| Lääne | 1.8 | 2.5 | 2.9 | 1 | 0.3 | 0.8 |
| Lääne-Viru | x | x | x | x | x | x |
| Põlva | 10.9 | 3.6 | 1.7 | 1 | 0 | 0.3 |
| Pärnu | 1.1 | 2.3 | 1.9 | 0.9 | 0 | 0.5 |
| Rapla | 5.4 | 6.2 | 5.2 | 1.4 | 0 | 2.6 |
| Saare | 7.7 | 6.6 | 3.5 | 2.6 | 0.1 | 2.5 |
| Tartu | 4.5 | 9.7 | 6.1 | 1.9 | 0 | 1.8 |
| Valga | 1.1 | 0.8 | 3.4 | 0.8 | 0.1 | 0.4 |
| Viljandi | 49.2 | 18.2 | 12.7 | 7.5 | 0.2 | 13.2 |
| Võru | 2.5 | 3.9 | 4.1 | 1.5 | 0.3 | 0.9 |

Total $CH_4$ emission from enteric fermentation of pigs was 0.276 Gg in 2005.

The allocation of $CH_4$ emission from enteric fermentation by county and by sub-categories of pigs is presented on Figure 4.2_7.

[25] x – the number of animals is not defined in the county [Agriculture 2005]




a) b)
Figure 4.2_7: $CH_4$ emissions from enteric fermentation of pigs by sub-categories (a) and by counties of Estonia (b) in 2005

#### *4.2.2.3.3. Quantitative overview – $CH_4$ emissions from enteric fermentation of sheep, goats, horses and poultry in 2005*

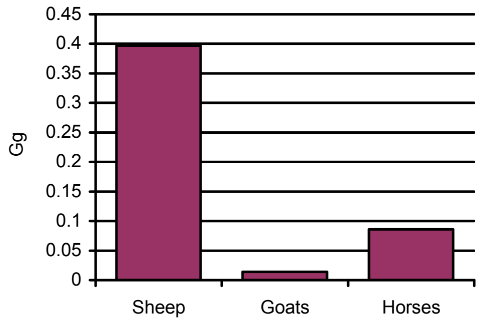
The number of sheep and goats increased from 41,000 to 52,400 (by 28%) from 2004 to 2005; the number of poultry decreased from 2,183,000 to 1,878,700 (by 14%) during the same period [Agriculture 2005].

**Table 4.2_12. Number of sheep, goats and horses by counties, 1000 heads [Agriculture 2005]**

| County | Sheep | Goats | Horses | Poultry |
|---|---|---|---|---|
| Total | **49.6** | **2.8** | **4.8** | **1,878.7** |
| Harju county | 3.1 | 0.3 | 0.5 | |
| Hiiu county | 2.5 | 0.1 | 0.3 | |
| Ida-Viru county | 0.7 | 0.1 | 0.1 | |
| Jõgeva county | 3.4 | 0 | 0.1 | |
| Järva county | 2 | 0.1 | 0.1 | |
| Lääne county | 1.2 | 0.2 | 0.2 | |
| Lääne-Viru county | 2 | 0.2 | 0.3 | |
| Põlva county | 3.4 | 0.1 | 0.1 | |
| Pärnu county | 2.8 | 0.3 | 0.4 | |
| Rapla county | 2.4 | 0 | 0.4 | |
| Saare county | 9 | 0.2 | 0.7 | |
| Tartu county | 3.6 | 0.1 | 0.5 | |
| Valga county | 3.8 | 0 | 0.1 | |
| Viljandi county | 3.6 | 0.2 | 0.5 | |
| Võru county | 3.3 | 0.1 | 0.2 | |
| Agricultural household plots[26] | 2.8 | 0.8 | 0.3 | |

$CH_4$ emission from enteric fermentation of goats, sheep and horses was 0.497 Gg in Estonia in 2005. The allocation of $CH_4$ emission by classes of livestock and by county (only for agricultural holdings) is shown on Figure 4.2_8.

[26] Specific county is not defined [Agriculture 2005]



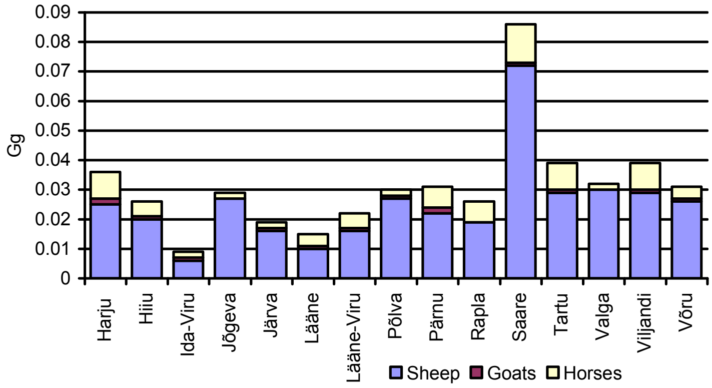




Figure 4.2_8: $CH_4$ emission from enteric fermentation by category of livestock and by counties of Estonia in 2005

#### *4.2.2.4. Source-specific recalculations*

Recalculations carried related to $CH_4$ emissions from the enteric fermentation of livestock are presented in chapter 7.

### 4.2.3. Methane emission from manure management (CRF 4.B)

#### *4.2.3.1. Source category description*

Methane is produced from the decomposition of the organic matter remaining in the manure under anaerobic conditions [IPCC 2001]. The quantities of $CH_4$ emission from manure management directly depend on the manure management system and temperature (van't Hoff-Arrhenius equation).

#### *4.2.3.2. Methodology*

The key methodology used for the estimation of $CH_4$ emission from manure management was the *Tier 1* method (IPCC 1996).

#### *4.2.3.2.1. Cattle*

$CH_4$ production from manure of dairy cattle, non-dairy cattle was estimated based on the algorithm presented in the IPCC (2000) using specific country data and IPCC default factors.

**$CH_4$ emission from manure management**

$$CH_4\_Emissions_{ji} = Emission\_Factor_{ji} \times Population_{ji} / (10^6 \, kg/Gg) \qquad (4.14)$$ [27]

Where:
$CH_4$ Emissions$_{ji}$ – Methane emission from manure management of *j* category of cattle in *i* county, Gg $CH_4$/yr;
Emission Factor$_{ji}$ – Methane emission factor for *j* category of cattle in *i* county, kg$CH_4$/head/yr;
Population$_{ji}$ – The number of head in *j* category of cattle in *i* county, heads;

[27] IPCC 2000. Agriculture. Equation 4.15. pp 4.30

**Emission factor from manure management**

$$EF_{ji} = VS_{ji} \times 365\_days/yr \times B_{oji} \times 0.67 kg/m^3 \times \sum_{nK} MCF_{nk} \times MS\%_{jiK} \quad (4.15)$$ [28]

Where:
$EF_{ji}$ - Annual methane emission factor for *j* category of cattle in *i* county, kg;
$VS_{ji}$ - Daily VS excreted for for *j* category of cattle in *i* county, kg;
$Bo_{ji}$ – Maximum $CH_4$ producing capacity for manure produced by *j* category of cattle in *i* county, kg of VS;
$MCF_{ik}$ - $CH_4$ conversion factors for each manure management system *n* by climate region *k*;
$MS_{ijk}$ - Fraction of animal species/category *j*'s manure handled using manure system *n* in *i* country in climate region *k*;

**Volatile Solid excretion rates**

$$VS_{ji}\ (kg\ dm/day) = \frac{GE_{ii}}{18.45} \times (1 - \frac{DE_{ji}\%}{100\%}) \times (1 - \frac{ASH\%}{100\%}) \quad (4.16)$$ [29]

Where:
$VS_{ji}$ – Volatile solid excretion per day on a dry-matter weight basis of *j* category of cattle in *i* county, kg DM/day;
$GE_{ji}$ – Daily gross energy intake per head of *j* category of cattle in *i* county, MJ/day;
1 dm kg – 18.45 MJ;
$DE_{ji}$ - Digestible energy of the feed for *j* category of cattle in *i* county, %;
ASH – Ash content of the manure as a percentage, % (8%);

**4.2.3.2.1.1. Data availability and sources**

The data on the population of dairy cattle and non-dairy cattle were obtained from the database of the ESO (Table 4.2_10). Methane conversion factor and the system of manure management usage (%) for cattle manure storage are presented in Table 4.2_13. The factors were obtained from IPCC tables on default factors (IPCC 1996).

Estimated factors on $CH_4$ emission from manure management system are reported in Table 4.2_14.

[28] IPCC 2000. Agriculture. Equation 4.17. pp 4.34
[29] IPCC 2000. Agriculture. Equation 4.16. pp.4.30

**Table 4.2_13. Manure management system usage (%) and methane conversion factor (MCFs)**

| | Lagoon | Liquid/ Slurry Solid | Solid Storage | Dry lot | Pasture/ Range | Daily Spread | Digester | Burned for Fuel | Other |
|---|---|---|---|---|---|---|---|---|---|
| | Manure Management System Usage (%)[30] | | | | | | | | |
| Dairy Cattle | 0 | 40 | 18 | 0 | 19 | 20 | 0 | 2 | 1 |
| Non-Dairy Cattle | 0 | 50 | 0 | 2 | 38 | 0 | 0 | 2 | 8 |
| | Methane Conversion Factors (MCFs)[31] | | | | | | | | |
| | 90% | 10% | 1% | 1% | 1% | 0.1% | 10.0% | 7.5% | 1% |

**Table 4.2_14. Methane emission factors from manure management by sub-categories of cattle and counties of Estonia**

| County | Emission factors for Enteric Fermentation, kg $CH_4$/head/yr | | | | | | |
|---|---|---|---|---|---|---|---|
| | Dairy Cattle | | Non-Dairy Cattle | | | | |
| | | | Mature Males | Mature Females | Bovine animals | Calves | IPCC |
| | used in the estimation | IPCC | used in the estimation | used in the estimation | used in the estimation | used in the estimation | |
| Total | | 14 | | | | | 6 |
| Harju county | 16.3 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Hiiu county | 14.9 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Ida-Viru county | 15.7 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Jõgeva county | 16.9 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Järva county | 17.1 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Lääne county | 14.7 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Lääne-Viru county | 16.8 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Põlva county | 17.5 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Pärnu county | 16.3 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Rapla county | 16.6 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Saare county | 15.3 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Tartu county | 17.3 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Valga county | 15.4 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Viljandi county | 15.3 | | 7.6 | 6.7 | 7.7 | 3.7 | |
| Võru county | 15.8 | | 7.6 | 6.7 | 7.7 | 3.7 | |

### *4.2.3.2.2. Swine*

Methane production from the manure of swine by sub-categories was estimated based on the algorithm presented in the IPCC (2000) and which was described in Chapter 4.2.3.2.1, specific country data and IPCC default factors were used in the process of estimation.

#### 4.2.3.2.2.1. Data availability and sources

The data on population of swine by sub-categories and by counties of Estonia were obtained from the database of the ESO (Table 4.2_11). Methane conversion factor and the system of manure management usage (%) for cattle manure storage are presented in Table 4.2_15. The factors were obtained from IPCC tables on default factors (IPCC 1996).

[30] For Dairy Cattle – IPCC 1996. Agriculture. Reference Manual. Table B-3 – Manure Management Emission Derivation for Dairy Cattle. pp. 4.43
For Non-Dairy Cattle – IPCC 1996. Agriculture. Reference Manual. B-4 - Manure Management Emission Derivation for Non-Dairy Cattle. pp. 4.44

[31] IPCC 2000. Agriculture. Table 4-10 – MCF Values for Manure Management System (for cool climate). pp 4.37

Estimated factors on $CH_4$ emission from manure management system are reported in Table 4.2_16.

**Table 4.2_15. Manure Management System Usage (%) and Methane Conversion Factor (MCFs)**

| | Solid Storage | Dry lot | Pit < 1 month | Pit > 1 month | Other |
|---|---|---|---|---|---|
| | Manure Management System Usage (%)[32] | | | | |
| Swine | 21 | 2 | 3 | 73 | 1 |
| | Manure Management Conversion Factor (MCFs)[33] | | | | |
| Swine | 1% | 1% | 5% | 10% | 1% |

**Table 4.2_16. Methane emission factors from swine manure management systems**

| Category of Swine | Emission factor, kg $CH_4$/head/yr | |
|---|---|---|
| | used in the estimation | IPCC |
| Estonian average | | 3.0[34] |
| Piglets, live weight less than 20 kg | 0.96 | |
| Young pigs, live weight20–<50 kg | 2.11 | |
| Fattening pigs | | |
| ...live weight 50–<80 kg | 3.12 | |
| ...live weight 80–<110 kg | 3.96 | |
| …live weight 110 kg or more | 5.39 | |
| Breeding pigs, live weight 50 kg or more | 3.41 | |

### *4.2.3.2.3. Other livestock (sheep, goats, horses and poultry)*

#### 4.2.3.2.3.1. Methodology

$CH_4$ emission from manure management for other livestock was calculated in accordance with the formula (4.14) using activity data on the population of livestock and IPCC factors (IPCC 1996).

#### 4.2.3.2.3.1. Data availability and sources

The activity data on the population of sheep, goats, horses and poultry by counties of Estonia were obtained from the database of the ESO (Table 4.2_12). Methane emission factors for categories of livestock were taken from the IPCC Guidelines (1996) (Table 4.2_17)

**Table 4.2_17. Methane emission factors for 'other livestock' from manure management [35]**

| Category of livestock | Emission Factor, kg $CH_4$/head/yr |
|---|---|
| Sheep | 0.19 |
| Goats | 0.12 |
| Horses | 1.4 |
| Poultry | 0.078 |

[32] IPCC 1996. Agriculture. Reference Manual. Table B-6 – Manure Management Emission Factor Derivation (for swine)

[33] IPCC 2000. Agriculture. Table 4 -10 – MCF Values for Manure Management System (for cool climate). pp 4.37

[34] IPCC 1996. Agriculture. Reference Manual. Table 4-6 – Manure management emission factors for cattle, swine and buffalo (Western Europe, cool climate)

[35] IPCC 1996. Agriculture. Reference Manual. Table 4-5 manure management emission factors (developed countries, cool climate region). pp. 4-12

### *4.2.3.3. Quantitative overview – $CH_4$ emissions from manure management in 2005*

The quantity of $CH_4$ emitted from manure management was 2.492 Gg in Estonia in 2005 (Table 4.2_18).

**Table 4.2_18. $CH_4$ emissions from manure management by category of livestock in 2005**

| | $CH_4$ emission from manure management of livestock, Gg $CH_4$/yr |
|---|---|
| Total | **2.492** |
| Cattle | 1.540 |
| Swine | 0.788 |
| Sheep | 0.009 |
| Goats | 0.0003 |
| Horses | 0.007 |
| Poultry | 0.147 |


Figure 4.2_9: $CH_4$ emissions from manure management by counties of Estonia from all categories of animals (excepting poultry) in 2005

$CH_4$ emission from manure management decreased by 4.7 times compared to 1990 (Figure 4.2_10).

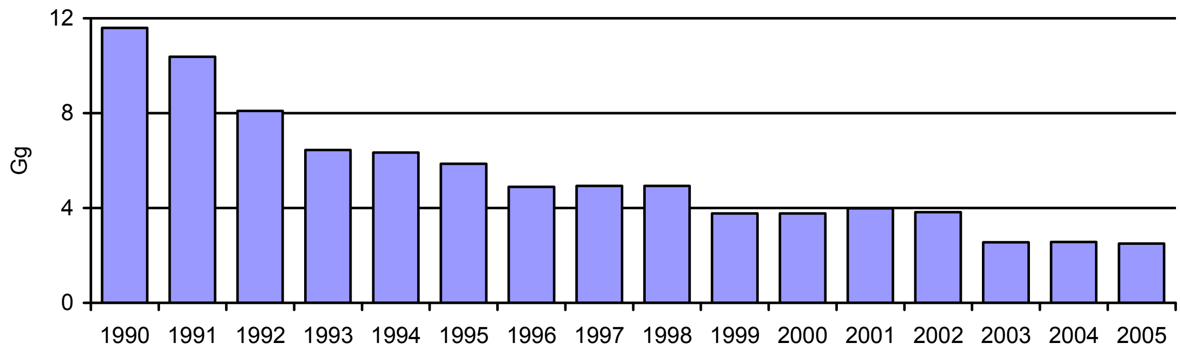



Figure 4.2_10: $CH_4$ emission from manure management from 1990 to 2005 in Estonia[36], Gg

[36] The 1990 – 2004 data was obtained from [Greenhouse gas emissions in Estonia 1990–2004]

#### *4.2.3.3.1. Quantitative overview – $CH_4$ emissions from cattle manure management in 2005*

The quantity of $CH_4$ emission from cattle manure management was 1.540 Gg in 2005, 94% of emitted $CH_4$ was from dairy cattle manure management.

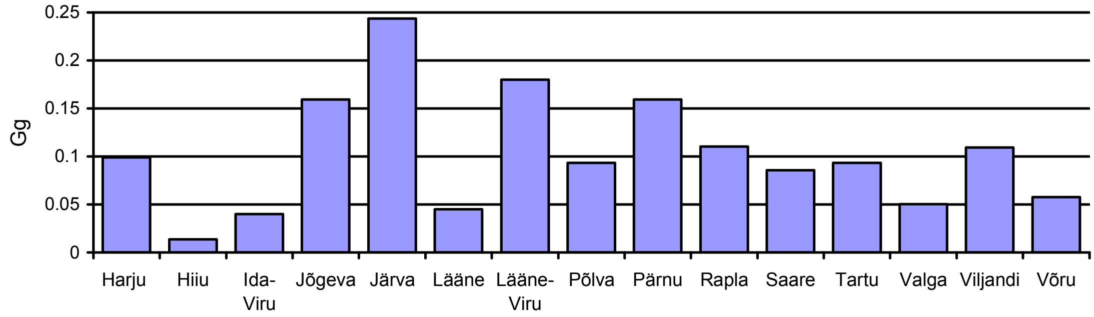



Figure 4.2_11: $CH_4$ emission from manure management of cattle by counties of Estonia in 2005

#### *4.2.3.3.2. Quantitative overview – $CH_4$ emissions from swine manure management in 2005*

The quantity of $CH_4$ emissions from manure management was 0.788 Gg in 2005 in Estonia. Figure 4.2_12 illustrates the allocations of $CH_4$ emission by counties of Estonia, however $CH_4$ emission from swine manure management for Hiiu and Lääne-Viru counties is not presented due to the absence of population data for the counties[37].

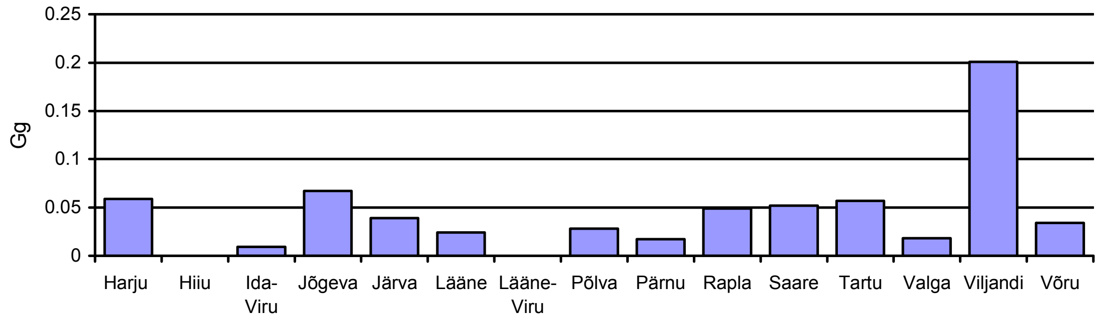



Figure 4.2_12: $CH_4$ emission from manure management by pigs by counties of Estonia in 2005

#### *4.2.3.3.3. Quantitative overview – $CH_4$ emissions from 'other livestock' manure management in 2005*

The quantity of $CH_4$ emission from other livestock' manure management was 0.163 Gg in Estonia in 2005.

**Table 4.2_19. $CH_4$ emission from other livestock' manure management in 2005**

| Livestock category | $CH_4$ emission from manure management, Gg/yr |
|---|---|
| Sheep | 0.009 |
| Goats | 0.0003 |
| Horses | 0.007 |
| Poultry | 0.147 |

### *4.2.3.4. Source-specific recalculations*

Recalculations carried related to $CH_4$ emission from livestock manure management are presented in chapter 7.

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[37] The total quantity of methane emission from manure management was estimated based on the total population of pigs in Estonia in 2005.

### 4.2.4. $N_2O$ emissions from manure management (CRF 4.B)

#### *4.2.4.1. Source category description*

Production of $N_2O$ during storage and treatment of animal wastes can occur via combined nitrification-denitrification of nitrogen contained in the wastes [Jun *et al.*, 2003].

#### *4.2.4.2. Methodology*

The key methodology used for the estimation of $N_2O$ emission from manure management was *Tier 1* method (IPCC 1996). Due to lack of county specific data, the estimation based on livestock sub-categories and on counties was not applied for the estimation of $N_2O$ emission from manure management.

$$(N_2O-N)_{(mm)} = \sum_{(S)} \{[\sum_{(T)} N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}] \bullet EF_{3(S)}\} \quad (4.17)$$ [38]

Where:
$(N_2O\text{-}N)_{(mm)}$ – $N_2O$-N emissions from manure management in the country, kg $N_2O$-N/year;
$N_{(T)}$ – Number of head of livestock species *j* in the country;
$Nex_{(T)}$ – Annual average N excretion per head of livestock species *j* in the country, kg N/head/year;
$MS_{(T,S)}$ – Fraction of total annual excretion for each livestock species *T* that is managed in manure management system *S* in the country;
$EF_{3(S)}$ – $N_2O$ emission factor for manure management system *S* in the country, kg $N_2O$-N/kg N in manure management system *S*;
S – Manure management system;
T – Species of livestock;

Conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions for reporting purposes is performed by using the following equation:

$$N_2O_{(mm)} = (N_2O-N)_{(mm)} \bullet 44/28 \quad (4.18)$$

#### *4.2.4.3. Data availability and sources*

The data on population of livestock by categories were obtained from database of the ESO (Table 4.2_10). The data on nitrogen excretion factor per head of livestock category (Table 4.2_20), percentage of manure production per animal waste management systems (Table 4.2_21) and emission factors for $N_2O$ from manure management (Table 4.2_22) were used from the reports of IPCC (1996).

**Table 4.2_20. Nitrogen Excretion factor per head of animal, kg/animal/yr**[39]

| Animal category | Nitrogen Excretion factor, kg/head/year |
|---|---|
| Non-Dairy Cattle | 70 |
| Dairy Cattle | 100 |
| Poultry | 0.6 |
| Sheep | 20 |
| Swine | 20 |
| Other Animals | 25 |

[38] IPCC 2000. Agriculture. Equation 4.18. pp. 4.42
[39] IPCC 1996. Agriculture. Workbook. Table 4-20 - Tentative default values for nitrogen excretion per head of animal per region. pp – 4.99

**Table 4.2_21. Percentage of Manure Production per Animal Waste Management Systems, %[40]**

| Type of Animal | Anaerobic Lagoon | Liquid System | Daily Spread | Solid Storage and Dry lot | Pasture Range and Paddock | Other System |
|---|---|---|---|---|---|---|
| Non-Dairy Cattle | 0 | 55 | 0 | 2 | 33 | 9 |
| Dairy Cattle | 0 | 46 | 24 | 21 | 8 | 1 |
| Poultry | 0 | 13 | 0 | 1 | 2 | 84 |
| Sheep | 0 | 0 | 0 | 2 | 87 | 11 |
| Swine | 0 | 77 | 0 | 23 | 0 | 0 |
| Other animals | 0 | 0 | 0 | 0 | 96 | 4 |

**Table 4.2_22. Default Emission Factors for $N_2O$ from Manure Management [41]**

| | Anaerobic Lagoon | Liquid System | Daily Spread | Solid Storage and Dry lot | Pasture Range and Paddock | Other System |
|---|---|---|---|---|---|---|
| $EF_3$ (kg $N_2O$-N/kg Nitrogen excreted) | 0.001 | 0.001 | 0.0 | 0.02 | 0.02[42] | 0.005[43] |

### *4.2.4.4. Quantitative overview - $N_2O$ emissions from manure management in 2005*

The quantity of $N_2O$ emission from manure management was 0.172 Gg in Estonia in 2005 (Table 4.2_23).

**Table 4.2_23. $N_2O$ emission from manure management in Estonia in 2005**

| | $N_2O$ emission, Gg |
|---|---|
| **Total** | 0.172 |
| Cattle | 0.104 |
| Swine | 0.0585 |
| Other livestock | 0.0096 |

#### *4.2.4.4.1. Quantitative overview - $N_2O$ emissions from cattle manure management in 2005*

The quantity of $N_2O$ emission from cattle manure management was 0.104 Gg. The quantity of $N_2O$ emission is reported in Table 4.2_24.

**Table 4.2_24. Nitrogen excretion by cattle and $N_2O$ emission from cattle manure management system in 2005**

| Category of livestock | Manure management system | | | | | |
|---|---|---|---|---|---|---|
| | Anaerobic Lagoon | Liquid System | Daily Spread | Solid Storage and Dry lot | Pasture, Range and Paddock | Other System |
| | Nitrogen **excretion** per animal waste management system (kg N/yr) | | | | | |
| Non-Dairy Cattle | | 5,262,950 | | 191,380 | 3,187,770 | 861,210 |
| Dairy cattle | | 5,188,800 | 2,707,200 | 2,368,800 | 902,400 | 112,800 |
| **Total, kg N / yr** | | **10,451,750** | **2,707,200** | **2,560,180** | **4,060,170** | **974,010** |
| $N_2O$ emission, Gg | | 0.0164 | | 0.0804 | -[44] | 0.0076 |

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[40] IPCC 1996. Agriculture. Reference Manual. Table 4-7 –Default values for percentage of manure N production in different animal waste management systems in different world regions (Default values for Western Europe were used). pp 4-11

[41] IPCC 2000. Agriculture. Table 4.12 – Default emission factors for $N_2O$ from manure management. pp 4.43

[42] The factors were used in the 'Animal waste applied to soils and excreted on pasture' chapter

[43] Cattle and Swine Deep Litter from IPCC 2000. Agriculture. Table 4.13 – Default emission factors for $N_2O$ from manure management system not specified in the IPCC. pp 4.44

#### *4.2.4.4.2. Quantitative overview - $N_2O$ emissions from swine manure management in 2005*

The quantity of $N_2O$ emission from pig manure management was 0.0585 Gg in Estonia in 2005 (Table 4.2_25).

**Table 4.2_25. Nitrogen excretion by pigs and $N_2O$ emission from pig manure management system in 2005**

| Category of livestock | Manure management system | | | | | |
|---|---|---|---|---|---|---|
| | Anaerobic Lagoon | Liquid System | Daily Spread | Solid Storage and Dry lot | Pasture, Range and Paddock | Other System |
| | Nitrogen **excretion** per animal waste management system (kg N/yr) | | | | | |
| Swine | | 5,336,100 | | 1,593,900 | | |
| **Total, kg N / yr** | | **5,336,100** | | **1,593,900** | | |
| $N_2O$ emission, Gg | | 0.008 | | 0.05 | | |

#### *4.2.4.4.3. Quantitative overview - $N_2O$ emissions from other livestock manure management in 2005*

The quantity of $N_2O$ emission from sheep manure management was 0.0096 Gg in Estonia in 2005 (Table 4.2_26).

**Table 4.2_26. Nitrogen excretion by 'other livestock' $N_2O$ emission from sheep manure management system in 2005**

| Category of livestock | Manure management system | | | | | |
|---|---|---|---|---|---|---|
| | Anaerobic Lagoon | Liquid System | Daily Spread | Solid Storage and Dry lot | Pasture, Range and Paddock | Other System |
| | Nitrogen excretion per animal waste management system (kg N/yr) | | | | | |
| Sheep | | | | 19,840 | 863,040 | 109,120 |
| Goats | | | | | 67,200 | 2,800 |
| Horses | | | | | 115,200 | 4,800 |
| Poultry | | 146,539 | | 11,272 | 22,544 | 946,865 |
| **Total, kg N / yr** | | **146,539** | | **31,112** | **1,067,984** | **1,063,585** |
| $N_2O$ emission, Gg | | 0.0002 | | 0.001 | -[42] | 0.0084 |

#### *4.2.4.5. Source-specific recalculations*

Recalculations carried related to $N_2O$ emission from livestock manure management are presented in chapter 7.

## 4.3. Direct emissions from agricultural soils (CRF 4.D.1)

$N_2O$ oxide is produced naturally in soils through the microbial processes of nitrification and denitrification. A number of agricultural activities add nitrogen to soils, increasing the amount of nitrogen (N) available for nitrification and the amount of $N_2O$ emitted [IPCC 2001].

[44] According to IPCC guidelines [2001], the $N_2O$ emissions from 'pasture, range and paddock' manure management system is reported under the IPCC category 'agricultural soils', therefore the quantity of $N_2O$ emitted from 'pasture, range and paddock' manure management system is not included in the total quantity of $N_2O$ emission from cattle manure management.

The following agricultural activities exert influence on N flows in agricultural soils:
- Synthesis fertilizers;
- Animal excreta nitrogen used as fertilizer;
- Biological nitrogen fixation;
- Crop residue and sewage sludge application;
- Glasshouse farming;
- Cultivation of high organic content soils;

### 4.3.1. Methodology

The key methodology used for the estimation of N emission from agricultural soils was *Tier 1* method (IPCC 1996, 2000). Estonian activity data and IPCC default factors were used in the process of estimation.

$$N_2O_{direct} - N = [(F_{SN} + F_{AM} + F_{BN} + F_{CR}) \bullet EF_1] + (F_{OS} \bullet EF_2) \qquad (4.19)^{45}$$

Where:
$N_2O_{Direct}$-N – Emission of $N_2O$ from agricultural soils, kg N;
$F_{SN}$ – Annual amount of synthetic fertilizer nitrogen applied to soils adjusted to account for the amount that volatilizes as $NH_3$ and $NO_x$;
$F_{AM}$ – Annual amount of animal manure nitrogen intentionally applied to soils adjusted to account for the amount that volatilizes as $NH_3$ and $NO_x$;
$F_{BN}$ – Amount of nitrogen fixed by N-fixing crops cultivated annually;
$F_{CR}$ – Amount of nitrogen in crop residues returned to soils annually;
$F_{OS}$ – Area of organic cultivated annually;
$EF_1$ – Emission factor for emissions from N inputs (kg $N_2O$-N/kg N input);
$EF_2$ – Emission factor for emissions from organic soil cultivation (kg $N_2O$-N/kg N input);

$$N_2O_{(mm)} = (N_2O - N)_{(mm)} \bullet 44/28 \qquad (4.20)$$

### 4.3.2. $N_2O$ emissions from synthetic fertilizer nitrogen applied to soils ($F_{SN}$) (CRF 4.D.1.1)

#### *4.3.2.1. Source category description*

The emission of $N_2O$ is estimated from annual synthetic nitrogen applied to soils. In Estonia, on average 44 kg N per hectare of fertilizers is used in the agriculture, the agricultural area makes up 460 thousand hectares (Table 4.3_2).

#### *4.3.2.2. Methodology*

The algorithm reported in IPCC (2000) was used for the estimation of nitrogen input into agricultural soils adjusted for volatilization.

$$F_{SN} = N_{FERT} \times (1 - Frac_{GASF}) \qquad (4.21)^{46}$$

Where:
$N_{FERT}$ - Total use of synthetic fertilizer in country, kg N/year;
$Frac_{GASF}$ – Fraction of total synthetic fertilizer nitrogen that is emitted as $NO_x$+$NH_3$, kg N/kg N;

[45] IPCC 2000. Agriculture. Equation 4.20. pp. 4.54
[46] IPCC 1996. Agriculture. Workbook. Equation 1. pp. 4.33

$N_2O$ emission into the atmosphere from using of synthetic nitrogen was calculated based on the formula (4.21).

$$N_2O_{direct} - N = F_{SN} \bullet EF \bullet 44/28_1 \qquad (4.22)$$ [47]

**Table 4.3_1. IPCC default factors used in the estimation**

| Factors | |
|---|---|
| $EF_1$ for $F_{SN}$ | 1.25%[48] |
| $Frac_{GASF}$ | 0.1 kg $NH_3$-N + $NO_x$-N/kg of synthetic fertilizer nitrogen applied[49] |

### *4.3.2.3. Quantitative overview - $N_2O$ emission from synthetic fertilizer nitrogen applied to soils in 2005*

$N_2O$ emission into the atmosphere from the use of synthetic fertilizer on agricultural fields was 0.394 Gg in Estonia in 2005 (Table 4.3_2).

**Table 4.3_2. Synthetic fertilizer using and $N_2O$ emission into the atmosphere in Estonia in 2005**

| County | Use, tonnes | Fertilized area, ha | Kg per hectare | Emission of $N_2O$, Gg |
|---|---|---|---|---|
| **Total** | **20,083** | **459,742** | **43.7** | **0.394** |
| *Agricultural holdings* | *19,896* | *456,748* | *43.6* | *0.391* |
| Harju county | 1,042 | 25,321 | 41.2 | 0.020 |
| Hiiu county | 172 | 4,435 | 38.8 | 0.003 |
| Ida-Viru county | 334 | 10,690 | 31.2 | 0.007 |
| Jõgeva county | 1,889 | 48,307 | 39.1 | 0.037 |
| Järva county | 2,621 | 55,099 | 47.6 | 0.051 |
| Lääne county | 568 | 11,889 | 47.8 | 0.011 |
| Lääne-Viru county | 2,914 | 64,797 | 45.0 | 0.057 |
| Põlva county | 1,591 | 33,781 | 47.1 | 0.031 |
| Pärnu county | 1,344 | 27,377 | 49.1 | 0.026 |
| Rapla county | 941 | 26,248 | 35.9 | 0.018 |
| Saare county | 547 | 12,931 | 42.3 | 0.011 |
| Tartu county | 2,288 | 48,508 | 47.2 | 0.045 |
| Valga county | 821 | 18,888 | 43.5 | 0.016 |
| Viljandi county | 2,079 | 45,823 | 45.4 | 0.041 |
| Võru county | 745 | 22,654 | 32.9 | 0.015 |
| *Agricultural household plots* | *187* | *2,994* | *62.5* | *0.004* |

### *4.3.2.4. Source-specific recalculations*

Recalculations carried related to $N_2O$ emission from synthetic fertilizers applied on agricultural soil are presented in chapter 7.

[47] The formula was transformed from the formula (4.18)

[48] IPCC 2000. Agriculture. Table 4-17. Updated default emission factors to estimate direct $N_2O$ emissions from agricultural soils, pp. 4.60

[49] IPCC 1996. Agriculture. Reference Manual. Table 4-17 Summary of default values for parameters, 1996, 4.35

### 4.3.3. $N_2O$ emission from animal waste applied to soils and excreted on pasture ($F_{AW}$) (CRF 4.D.1.2)

#### *4.3.3.1. Source category description*

$N_2O$ emits from agricultural soil through manure application to fields as organic fertilizer and animal pastures by grazing animals.

#### *4.3.3.2. Methodology*

$N_2O$ emission into the atmosphere from animal waste applied to agricultural fields as organic fertilizer was estimated according to the algorithm suggested by IPCC (1996).

$$N_2O_{direct} - N = F_{AW} \bullet EF_1 \quad (4.23)$$

$$F_{AW} = (Nex \bullet (1 - Frac_{FUEL} + Frac_{GRAZ} + Frac_{GASM})) \quad (4.24)$$ [50]

$$Nex = \sum [N_{(T)} \times Nex_{(T)}] \quad (4.25)$$ [43]

$$Nex_{(AWMS)} = \sum [N_{(T)} \times Nex_{(T)} \times AWMS_{(T)}] \quad (4.26)$$ [43]

Where:
$F_{AW}$ – Manure nitrogen used as fertilizer in country, corrected for $NH_3$ and $NO_x$ emissions and excluding manure produced during grazing, kg N/yr;
$AWMS_{(T)}$ – Fraction of $Nex_{(T)}$ that is produced in the different distinguished animal waste management systems in country;
$Frac_{FUEL}$ – Fraction of livestock nitrogen excretion contained in excrements burned for fuel, kg N/kg N totally excreted;
$Frac_{GRAZ}$ – Fraction of livestock nitrogen excreted and deposited onto soil during grazing, kg N/kg N excreted;
$Frac_{GASM}$ – Fraction of total nitrogen excretion that is emitted as NOx or $NH_3$, kg N/kg N;
$N_{(T)}$ – Number of animals per type of animal in country;
Nex – Total nitrogen excretion by animals in country, kg N/yr;
$Nex_{(T)}$ – Nitrogen excretion per Type of animal in country, kg/yr;
$Nex_{(AWMS)}$ – Nitrogen excretion per Animal Waste Management System, kg/yr;

Nitrogen excretion generated per type of animals and per animals waste management system was estimated in '$N_2O$ emissions from manure management' chapter.

IPCC default factors were used to estimate nitrogen input to agricultural soils (Table 4.3_3).

**Table 4.3_3. IPCC default factors used in the estimation of $N_2O$ emission from animal waste applied to soils**

| Factor | |
|---|---|
| $Frac_{FUEL}$ | 0.0 kg N/kg nitrogen excreted[51] |
| $Frac_{GRAZ}$ | 0.02 (Table 4.2_23) |
| $Frac_{GASM}$ | 0.2 kg $NH_3$-N + $NO_x$-N/kg of nitrogen excreted by livestock[45] |

[50] IPCC 1996. Agriculture. Workbook. Equations 2- 4. pp 4.33
[51] IPCC 1996. Agriculture. Workbook. Table 4-17 – Summary of default values for parameters. pp 4.35

### *4.3.3.3. Quantitative overview - $N_2O$ emission from animal waste applied to soils and excreted on pasture in 2005*

The total amount of manure generated by animals in Estonia was **2,100,303** tonnes (basing on the estimation carried out in the report using *Tier 1* and *Tier 2* methods).

According to data from the ESO**, 2,025,777** tonnes of manure were used on agricultural fields (Table 4.3_4), the area fertilized by manure was 73 thousand hectares, on average 28 tonnes of manure was applied to each hectare.

The estimation of nitrogen input into soil and the quantity directly emitted into the atmosphere from agricultural soils was calculated using the method (*Tier 1*) described above.

**Table 4.3_4. Use of manure for agricultural crops [Agriculture 2005]**

| County | Use, tonnes | Fertilized area, ha | Tonnes per hectare |
|---|---|---|---|
| **Total** | **2,025,777** | **72,577** | **28** |
| *Agricultural holdings* | *1,992,226* | *71,659* | *25* |
| Harju county | 137,493 | 3,963 | 35 |
| Hiiu county | 9,291 | 589 | 16 |
| Ida-Viru county | 31,734 | 1,378 | 23 |
| Jõgeva county | 226,310 | 5,498 | 41 |
| Järva county | 217,043 | 6,428 | 34 |
| Lääne county | 74,723 | 3,149 | 24 |
| Lääne-Viru county | 171,039 | 6,775 | 25 |
| Põlva county | 172,785 | 5,619 | 31 |
| Pärnu county | 211,201 | 8,544 | 25 |
| Rapla county | 110,492 | 3,287 | 34 |
| Saare county | 119,147 | 4,990 | 24 |
| Tartu county | 101,416 | 5,337 | 19 |
| Valga county | 59,310 | 3,183 | 19 |
| Viljandi county | 286,610 | 9,531 | 30 |
| Võru county | 63,632 | 3,388 | 19 |
| *Agricultural household plots* | *33,551* | *918* | *37* |

The quantity of $N_2O$ emitted into the atmosphere from livestock grazing was 0.161 Gg; the quantity of direct $N_2O$ emissions from animal waste applied to soils was 0.566 Gg in Estonia in 2005.

### *4.3.3.4. Source-specific recalculations*

Recalculations carried related to $N_2O$ emission from animal waste applied to soils are presented in chapter 7.

## 4.3.4. Nitrogen input in N-fixing crops ($F_{BN}$) (CRF 4.D.1.3)

### *4.3.4.1. Source category description*

The amount of nitrogen fixed by N-fixing crops cultivated annually [IPCC 2001].

### *4.3.4.2. Methodology*

The *Tier 1* method (IPCC 1996) was used to estimate emissions from N fixing crops and pastures.

$$F_{BN} = 2 \times Crop_{BF} \times Frac_{NCRBF} \quad (4.27)^{52}$$

Where:
$Crop_{BF}$ – Production of pulses + soybeans in country, kg dry biomass/yr;
$Frac_{NCRBF}$ – Fraction of nitrogen in N-fixing crop, kg N/kg of dry biomass;

The factor 2, which converts the crop production to total crop biomass, was changed by the factor from presented in the work of [Jonas *et al*., 2001] (Table 4.3_5).

The activity data on the production of N-fixing crops in Estonia were obtained from the ESO (Table 4.3_6). IPCC default factor was in the estimation (Table 4.3_5). The factor for conversion of the crop production from Fresh Matter (FM) to Dry Matter (DM) was obtained from [Jonas *et al.*, 2001].

Annual $N_2O$ emission from N-fixing crops was calculated using the formula (4.28) (*Tier 1*, IPCC 1996)

$$N_2O_{direct} = F_{BN} \bullet EF_1 \bullet 44/28 \quad (4.28)$$

Where:
$EF_1$ – IPCC default factor for N-fixing crops (Table 4.3_5);

**Table 4.3_5. Factors used in the algorithm of the estimation**

| Factor | |
|---|---|
| $Frac_{NCRBF}$[53] | 0.03 kg N/kg of Dry Matter |
| Conversion factor from FM to DM[54] | 0.87 t DM / t FM |
| Grain-to-Straw ratio for Legumes[48] | 1.525 |
| $EF_1$ for $F_{BN}$ | 1.25% |

**Table 4.3_6. Production of legumes in Estonia in 2005 [Agriculture 2005]**

| | Sown area, ha | Production (Grain), tonnes FM | Production (Grain), tonnes DM | Production (Total Biomass), tonnes DM |
|---|---|---|---|---|
| **Total** | **4,440** | **5,690** | **4,950** | **8,196** |
| *Agricultural holdings* | 4,440 | 5,690 | 4,950 | 8,196 |
| Harju county | 429 | 634 | 552 | 913 |
| Hiiu county | 61 | 111 | 97 | 160 |
| Ida-Viru county | 110 | 132 | 115 | 190 |
| Jõgeva county | 67 | 53 | 46 | 76 |
| Järva county | 523 | 574 | 499 | 827 |
| Lääne county | 392 | 426 | 371 | 614 |
| Lääne-Viru county | 76 | 104 | 90 | 150 |
| Põlva county | 150 | 135 | 117 | 194 |
| Pärnu county | 781 | 829 | 721 | 1,194 |
| Rapla county | 208 | 177 | 154 | 255 |
| Saare county | 215 | 318 | 277 | 458 |
| Tartu county | 413 | 675 | 587 | 972 |
| Valga county | 310 | 410 | 357 | 591 |
| Viljandi county | 562 | 844 | 734 | 1,216 |
| Võru county | 143 | 268 | 233 | 386 |
| *Agricultural household plots* | - | - | - | - |

[52] IPCC 1996. Agriculture. Workbook. Equation 5. pp. 4.35
[53] IPCC 1996. Agriculture. Workbook. Table 4-17 – Summary of default values for parameters. pp 4.35
[54] Jonas *et al*., 2001

### *4.3.4.3. Quantitative overview - Nitrogen input in N-fixing crops in 2005*

The quantity of $N_2O$ emitted from N-fixing crops production was 0.0049 Gg in Estonia in 2005.

### *4.3.4.4. Source-specific recalculations*

Recalculations carried related to $N_2O$ emission from N-fixing crops production are presented in chapter 7.

## 4.3.5. $N_2O$ emission from nitrogen input from crops residues ($F_{CR}$) (CRF 4.D.1.4)

### *4.3.5.1. Source category description*

The amount of nitrogen returned to soils annually through the incorporation of crop residues.

### *4.3.5.2. Methodology*

The default IPCC *Tier 1* method was used for the estimation emissions from crop residues returned to the soil.

$$F_{CF} = 2 \times [Crop_0 \times Frac_{NCR0} + Crop_{BF} \times Frac_{NCRBF}] \times (1 - Frac_R) \times (1 - Frac_{BURN}) \qquad (4.29)$$ [55]

Where:
$Crop_{BF}$ - Production of pulses + soybeans in country, kg dry biomass/yr;
$Crop_0$ – Production of non-N-fixing crops in country, kg dry biomass/yr;
$Frac_{NCRBF}$ – Fraction of nitrogen in N-fixing crops, kg N/kg of dry biomass;
$Frac_{NCR0}$ – Fraction of nitrogen in non-N-fixing crops, kg N/kg of dry biomass;
$Frac_R$ – Fraction of crop residue that is removed from the field as crop, kg N/kg crop-N;
$Frac_{BURN}$ – Fraction of crop residue that is burned rather than left on field;
2 – The factor converts the crop production to total crop biomass. The factor was suggested by IPCC methodology, however the factors from [Jonas *et al*, 2001] were used instead of this factors in the estimation;

Annual $N_2O$ emission from crop residues was calculated using the formula (4.30) (*Tier 1* method, IPCC 1996).

$$N_2O_{direct} = F_{CR} \bullet EF_1 \bullet 44/28 \qquad (4.30)$$

**Table 4.3_7. Factors used in the algorithm of the estimation of $N_2O$ emissions from crop residues**[56]

| Factor | Unit |
|---|---|
| $Frac_{NCRBF}$ | 0.03 kg N/kg of Dry Matter |
| $Frac_{NCR0}$ | 0.015 kg N/kg of Dry Matter |
| $Frac_R$ | 0.45 kg N/kg crop-N |
| $Frac_{BURN}$ | 0.10, kg N/kg crop-N (for developed countries) |
| $EF_1$ for $F_{CF}$ | 1.25%[57] |

[55] IPCC 1996. Agriculture. Workbook. Equation 6. pp. 4.36
[56] IPCC 1996. Agriculture. Workbook. Table 4-17 – Summary of default values for parameters. pp 4.35
[57] IPCC 2000. Agriculture. Table 4-17 – Updated default emission factors to estimate direct N2O emissions from agricultural soils. pp 4.60

#### *4.3.5.3. Quantitative overview - Nitrogen input from crops residues in 2005*

The production of crops was 1,062 thousand tonnes in 2005, that is 1,515 thousand tonnes of dry matter (including residues) (Table 4.3_8). The quantity of $N_2O$ emitted into the atmosphere from crop residue production was 0.215 Gg.

**Table 4.3_8. The crop production in Estonia in 2005 [Agriculture 2005]**

| | Production, 1000 tonnes FM | Residue, 1000 tonnes FM | Total, 1000 tonnes DM |
|---|---|---|---|
| Cereals | 760.1 | 726 | 1,277 |
| Potatoes | 209.8 | 323 | 159 |
| Forage roots | 3.1 | 6 | 2 |
| Industrial crops | 83.067 | 33 | 76 |
| TOTAL | **1,062** | **1,089** | **1,515** |

#### *4.3.5.4. Source-specific recalculations*

Recalculations carried related to $N_2O$ emission from crop residues are presented in chapter 7.

## 4.4. Indirect $N_2O$ emissions from nitrogen used in agriculture (CRF 4.D.3)

Nitrous oxide is produced naturally in soils and aquatic systems through the microbial processes of nitrification and denitrification. A number of agricultural and other anthropogenic activities add nitrogen (N) to soils and aquatic systems, increasing the amount of N available for nitrification and denitrification, and ultimately the amount of $N_2O$ emitted [IPCC 2001].

The IPCC provides methods to estimate $N_2O$ emissions from (the formula 4.31):

- Leaching and runoff of N that is applied to, or deposited on, soils;
- Disposal of sewage N;
- Formation of $N_2O$ in the atmosphere from $NH_3$ emissions originating from anthropogenic activities;
- Disposal of processing effluents from food processing and other operations;

$$N_2O - N = N_2O_{(G)} + N_2O_{(L)} + N_2O_{(S)} \qquad (4.31)$$ [58]

Where:
$N_2O_{indirect\text{-}N}$ – Emissions of $N_2O$ in units of nitrogen;
$N_2O_{(G)}$ – $N_2O$ produced from volatilisation of applied synthetic fertiliser and animal manure N, and its subsequent atmospheric deposition as $NO_x$ and $NH_4$, kg N/yr;
$N_2O_{(L)}$ – $N_2O$ produced from leaching and runoff of applied fertiliser and animal manure N, kg N/yr;
$N_2O_{(S)}$ – $N_2O$ produced from discharge of human sewage N into rivers or estuaries, kg N/yr;

### 4.4.1. Atmospheric deposition of $NO_x$ and $NH_4$ ($N_2O_{(G)}$) (CRF 4.D.3.1)

#### *4.4.1.1. Source category description*

Atmospheric deposition of nitrogen compounds such as nitrogen oxides ($NO_x$) and ammonium ($NH_4$) fertilises soils and surface waters, which results in enhanced biogenic $N_2O$ formation [IPCC 2001].

[58] IPCC 200. Agriculture. Equation 4.30. pp 4.67

4.4.1.2. Methodology

The default IPCC *Tier 1* method was is used to estimate emissions from the atmospheric deposition.

$$N_2O_{(G)} - N = [(N_{FERT} \bullet Frac_{GASF}) + (\sum_T (N_{(T)} \bullet Nex_{(T)}) \bullet Frac_{GASM})] \bullet EF_4 \qquad (4.32)$$ [59]

Where:
$N_2O_{(G)}$ – $N_2O$ produced from atmospheric deposition of N, kg N/yr;
$N_{FERT}$ – Total amount of synthetic nitrogen fertilizer applied to soils, kg N/yr;
$\sum_T(N_{(T)} \bullet Nex_{(T)})$ – total amount of animal manure nitrogen excreted in a country, kg N/yr;
$Frac_{GASF}$ – Fraction of synthetic N fertilizer that volatilises as $NH_3$ and $NO_x$, kg $NH_3$-N and $NO_x$-N/kg of N input;
$Frac_{GASM}$ – Fraction of animal manure N that volatilises as $NH_3$ and $NO_x$, kg $NH_3$-N and $NO_x$-N/kg of N excreted;
$EF_4$ – Emission factor for $N_2O$ emissions from atmospheric deposition of N on soils and water surfaces kg $N_2O$-N/kg $NH_3$-N and $NO_x$-N emitted;

**Table 4.4_1. Factors used in the algorithm of the estimation of atmospheric deposition**

| Factor | |
|---|---|
| $Frac_{GASF}$ | 0.1 kg $NH_3$-N + $NO_x$-N/kg of synthetic fertilizer nitrogen applied[60] |
| $Frac_{GASM}$ | 0.2 kg $NH_3$-N + $NO_x$-N/kg of nitrogen excreted by livestock[45] |
| $EF_4$ | 0.01 kg $N_2O$-N per kg $NH_3$-N and $NO_x$-N emitted |

### *4.4.1.3. Quantitative overview - Atmospheric deposition of $NO_x$ and $NH_4$ in 2005*

The quantity of $N_2O$ emission from the atmospheric deposition into the atmosphere was 0.126 Gg in Estonia in 2005.

### *4.4.1.4. Source-specific recalculations*

Recalculations carried related to $N_2O$ emission from the atmospheric deposition are presented in chapter 7.

## 4.4.2. Leaching/runoff of applied or deposited nitrogen ($N_2O_{(L)}$) (CRF 4.D.3.2)

### *4.4.2.1. Source category description*

A large proportion of nitrogen is lost from agricultural soils through leaching and runoff. This nitrogen enters the groundwater, riparian areas and wetlands, rivers, and eventually the ocean, where it enhances biogenic production of $N_2O$ [IPCC 2001].

### *4.4.2.2. Methodology*

The default IPCC *Tier 1* method was is used to estimate emissions from the atmospheric deposition.

$$N_2O_{(L)} - N = [N_{FERT} + \sum_T (N_{(T)} \bullet Nex_{(T)})] \bullet Frac_{LEACH} \bullet EF_5 \qquad (4.33)$$ [61]

[59] IPCC 200. Agriculture. Equation 4.31. pp 4.68
[60] IPCC 1996. Agriculture. Workbook. Table 4-17 Summary of default values for parameters. pp. - 4.35
[61] IPCC 2000. Agriculture. Equation 4.34, pp. 4.71

Where:
$N_{FERT}$ – Total amount of synthetic nitrogen fertilizer applied to soils, kg N/yr;
$\sum_T(N_{(T)} \bullet Nex_{(T)})$ – Total amount of animal manure nitrogen excreted in a country, kg N/yr;
$Frac_{LEACH}$ – The amount of applied N that leaches or runs off, kg N/kg (Table 4.4_2);

**Table 4.4_2. Factors used in the algorithm of the estimation of leaching/runoff**

| Factor | |
|---|---|
| $Frac_{LEACH}$ | 0.3 kg N/kg nitrogen of fertilizer or manure[62] |
| $EF_5$ | 0.025 kg $N_2O$-N per kg $NH_3$-N and $NO_x$-N emitted[63] |

#### *4.4.2.3. Quantitative overview - Leaching/runoff of applied or deposited nitrogen in 2005*

The quantity of $N_2O$ emission from leaching was 0.590 Gg in Estonia in 2005.

#### *4.2.2.4. Source-specific recalculations*

Recalculations carried related to $N_2O$ emission from leaching and run-off are presented in chapter 7.

### 4.4.3. $N_2O$ emission from human consumption followed by municipal sewage treatment ($N_2O_{(S)}$) (CRF 6.B.2.2)

#### *4.4.3.1. Source category description*

Human consumption of food results in the production of sewage, that can be processed in septic systems or wastewater treatment facilities, and may then seep into groundwater systems, be disposed of directly on land, or be discharged into a water source (e.g. rivers and estuaries) [IPCC 2001].

#### *4.4.3.2. Methodology*

The default IPCC (*Tier 1*) method was used to estimate emissions from the atmospheric deposition.

$$N_2O - N = PROTEIN \bullet Nr_{PEOPLE} \bullet Frac_{NPR} \bullet EF_6 \qquad (4.34)$$ [64]

Where:
PROTEIN – The annual per capita protein consumption, kg protein/person-year;
$Nr_{PEOPLE}$ - The national population;
$Frac_{NPR}$ - The fraction of protein that is nitrogen, kg N/kg of protein (Table 4.4_3);

**Table 4.4_3. Factors used in the algorithm of human consumption followed by municipal sewage treatment**

| Factor | |
|---|---|
| $Frac_{NPR}$ | 0.16 kg N/kg of protein[65] |
| $EF_6$ | 0.01 kg $N_2O$-N/ kg N discharged sewage effluent[66] |

---

[62] IPCC 1996. Agriculture. Workbook. Table 4-17 Summary of default values for parameters. pp. - 4.35
[63] IPCC 2000. Agriculture. Table 4-18 –Default emission factors for estimating indirect $N_2O$ emissions from N used in agriculture. pp 4.73
[64] IPCC 2000. Agriculture. Equation 4.39, pp. 4.72
[65] IPCC 1996. Agriculture. Workbook. Table 4-24 - Default values of parameters for indirect emissions. pp 4.106

The data on population of Estonia (1,347,510 people) were obtained from the ESO, the annual per capita protein consumption was used from FAO statistical databases – 93.7 g/person/day (the average number for the last four years, as the data for 2005 has not been not reported yet).

#### *4.4.3.3. Quantitative overview - Human consumption followed by municipal sewage treatment in 2005*

The quantity of $N_2O$ emission from human consumption was 0.116 Gg in Estonia in 2005 (the number is reported in 'Waste' Chapter).

#### *4.4.3.4. Source-specific recalculations*

Recalculations carried related to $CH_4$ emission from enteric fermentation of livestock are presented in chapter 7.

## 4.5. $CH_4$ and $N_2O$ emissions from agricultural residue burning (CRF 4.F)

### 4.5.1. Source category description

The burning of crop residues emits $CH_4$, $N_2O$, CO and $NO_x$ into the atmosphere. $CO_2$ from the burning of agricultural residues is not estimated, as it is assumed that the carbon is reabsorbed by plants during the next growing season.

The emission of gases from the burning of crop residues was not estimated for 2005, due to the lack of data (the crop residue burning practice of Estonia).

## 4.6. Emission of greenhouse gases from agriculture (CRF 4)

The quantity of emissions of GHG from agriculture is presented in Table 4.6_1.

**Table 4.6_1. Emission of GHG from agriculture in Estonia in 2005, Gg**

| | $CH_4$ | $N_2O$ |
|---|---|---|
| Enteric Fermentation | 21.122 | |
| Manure Management | 2.492 | 0.172 |
| Pasture range and Paddock | | 0.161 |
| Direct emission from agricultural soils | | |
| … Synthetic fertilizer nitrogen applied to soils | | 0.394 |
| … Animal waste applied to soils | | 0.566 |
| … Nitrogen input in N-fixing crops | | 0.005 |
| … Nitrogen input from crops residues | | 0.214 |
| Indirect emission from agricultural soils | | |
| …Atmospheric deposition | | 0.126 |
| … Nitrogen Leaching and Run-off | | 0.590 |

[66] IPCC 1996. Agriculture. Workbook. Table 4-18 –Default emission factors for estimating indirect $N_2O$ emissions from N used in agriculture. pp 4.73

# CHAPTER 5. LAND USE, LAND USE CHANGE AND FORESTRY (CRF 5)

## 5.1. Overview of source category description and methodology

It was estimated that (– 8,093) Gg $CO_2$-equivalent was removed from Estonia in 2006 due to forestry. This continues the trend of net sequestration of $CO_2$ by Estonian forests presented in Figure 5.1_1.

The methods used to estimate all GHG flows are presented in Table 5.1_1 and Table 5.1_2 presents Estonian land use reported by the National Forest Inventory (NFI) along with their respective GPG LULUCF categories.

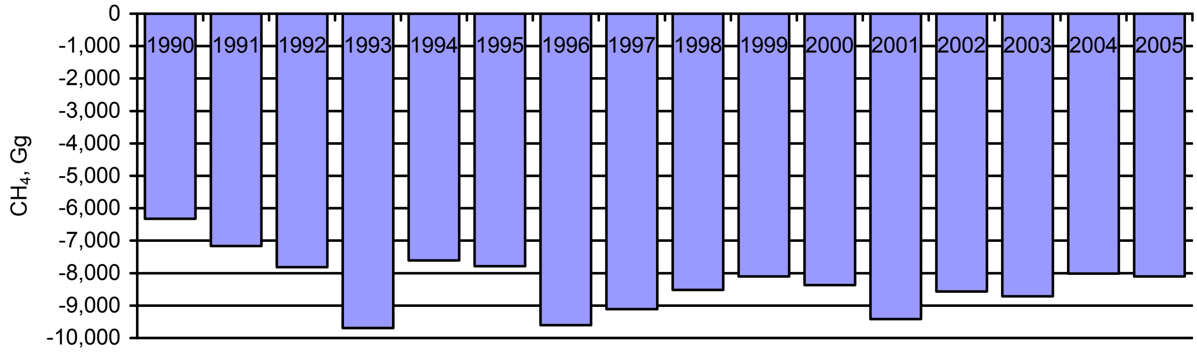



Figure 5.1_1: Net sequestration of $CO_2$ by Estonian forests from 1990 – 2005

**Table 5.1_1. Methods and emission factors used to estimate the emission/removal of $CO_2$ from Estonian lands. Only forested land was accounted for in this report.**

| Greenhouse gases source and sink categories | $CO_2$ | | $CH_4$ | | $N_2O$ | |
|---|---|---|---|---|---|---|
| | Method Applied | EF | Method Applied | EF | Method Applied | EF |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 5. Land Use, Land use Change and Forestry | | | | | | |
| **A. Forest land** | | | | | | |
| 1. Forest Land remaining Forest Land | | | | | | |
| Managed Native Forests | T1 | IPCC, CS | | | | |
| Plantations | | | | | | |
| Fuelwood consumed | T1 | IPCC, CS | | | | |
| Biomass Burning | T1 | IPCC, CS | | IPCC, CS | | IPCC, CS |
| 2. Land converted to Forest Land | NE | NE | | | | |
| **B. Croplands** | | | | | | |
| 1. Cropland remaining Cropland | NE | NE | | | | |
| 2. Land converted to Cropland | NE | NE | | | | |
| **C. Grassland** | | | | | | |
| 1. Grassland remaining Grassland | NE | NE | | | | |
| 2. Land converted to Grassland | NE | NE | | | | |
| **D. Wetlands** | | | | | | |
| 1. Wetlands remaining Wetlands | NE | NE | | | | |
| 2. Land converted to (from) Wetlands | NE | NE | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **E. Settlements** | | | | | | |
| 1. Settlements remaining Settlements | NE | NE | | | | |
| 2. Land converted to Settlements | NE | NE | | | | |
| **F. Other lands** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Other Lands remaining Other Lands | NE | NE | | | | |
| Land converted to Other Lands | NE | NE | | | | |

EF – Emission Factor; CS – country specific; NE – not estimated; T1 – Tier 1 method

### 5.1.1. Source category description

According to the decision (11/CP.7) of the Conference of Parties (COP), the IPCC was invited to elaborate on methods to estimate, measure, monitor, and report changes in carbon stocks and anthropogenic greenhouse gas emissions from sources, and removals by sinks resulting from land use, change in land use, and forestry activities under Article 3, paragraphs 3 and 4, and Articles 6 and 12 of the Kyoto Protocol [LULUCF 2003, pp – 1.5].

Hence, countries are responsible to report both changes in their carbon stocks, and emissions due to changes in land use. Unfortunately, this submission does not include emissions from Croplands, Grasslands, Wetlands, and Settlements and other lands due to a lack of data requested in GPG LULUCF [LULUCF 2003] to perform GHG inventory in this land category using the *Tier 1* method.

To uphold this responsibility in future years, Estonia is developing databases and methods needed to report in complete accordance with LULUCF guidelines, including the improvement in our method of collecting national data on land use. These reforms will enable Estonia to report in full accordance to these guidelines in all submissions to follow this one.

**Table 5.1_2. Estonian land use in1000's of ha reported by the NFI with their corresponding GPG LULUCF land use categories.**

| Land-use categories | 2000[67] | 2001[68] | 2001[69] | 2004[70] | 2005[71] | 2005[72] | Land-use categories of GPG LULUCF |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Forest land | 2,249.4 | 2,250.7 | | 2,267.3 | 2,264.2 | | Forest land |
| *Of which stocked* | *2,114.8* | *2,091.1* | | *2,112.8* | *2,121.7* | | |
| *unstocked* | *134.6* | *159.6* | | *154.5* | *142.5* | | |
| Other wooded land (bushes) | 84.2 | 86.7 | | 66.0 | 76.2 | | Forest land |
| Agricultural land | 1,336.8 | 1,328.7 | 871.2 | 1,344.8 | 1,325.2 | 828.9 | |
| *Of which arable land* | *772.1* | *792.1* | *591.9* | *NA* | *1,028.4* | *584.4* | Croplands |
| *natural grassland* | *564.7* | *536.6* | | *NA* | *296.8* | | Grasslands |
| Peatlands | 247.4 | 255 | | 267.5 | 230.8 | | Wetlands |
| Inland water bodies | 345.6 | 88.9 | | 242.2 | 108.8 | | Wetlands |
| Settlements | 127.5 | 144.6 | | 143.1 | 169.6 | | Settlements |
| Roads | 47.1 | 51.1 | | 53.4 | 54.1 | | Settlements |
| Infrastructures (electric lines, etc) | 65.1 | 58.3 | | 59.2 | 64.5 | | Settlements |
| Opencast minings | 51.1 | 47.3 | | 29.9 | 29.8 | | Settlements |
| Other land | 68.6 | 11.2 | | 49.5 | 46.6 | | Other lands |
| **Total** | **4522.7** | **4,522.7** | | **4522.7** | **4,522.7** | | |

67 NIF data published in the Forest Yearbook 2000
68 NIF data published in the Forest Yearbook 2002
69 www.stat.ee
70 NIF data published in the Forest Yearbook 2004 (Estonia Forest 2004)
71 NIF data published in the Forest Yearbook 2005 (Estonian Forest 2005)
72 www.stat.ee

## 5.2. Forest land (CRF 5.A)

The category includes carbon stock changes in the biomass growing on forested land and greenhouse gas emissions and removals associated with both changes in biomass (due to annual increment of biomass and drain of biomass), and soil organic carbon on forested lands and lands converted to forest [LULUCF 2003].

Estonia's forest biomass is monitored using two methods. The first method, employed by the National Forest Inventory, is based on Statistical Sampling Method (NFI) with a 5 years taxation cycle. The NFI inventory is carried out on clusters termed field plots. The second method, termed Complete Forest Inventory (CFI), is employed by the Estonian Centre of Forest Protection and Silviculture (CFPS), and mostly covers the area and biomass of governmental forests.

Estimations of carbon sequestration were carried out using data collected by the NFI according to the national definition of forest land. Forested land is any land with an area of 0.5 ha or more, which is: 1) covered with trees higher than 1.3 m with a canopy closure of at least 30%, and 2) managed in order to produce forest products or to preserve forest vegetation for other objectives. All forests are considered managed [Greenhouse gas emissions…, 2005].

The data on carbon stock changes in forest soil and litter due to land use change were taken from [Global Forest Resources Assessment. Estonia. 2005], where changes of carbon stock for the years 1990, 1991, 2000, 2002 and 2005 were estimated using IPCC defaults factors.

### 5.2.1. Methodology

*Method 1* (IPCC 2003) was used to estimate the annual removal and emission of carbon from Estonia's biomass:

$$\Delta C_{FF_{LB}} = (\Delta C_{FF_G} - \Delta C_{FF_L}) \qquad (5.1)$$ [73]

Where:
$\Delta C_{FFLB}$ – Annual change in carbon stock of living biomass (includes above- and belowground biomass) in land remaining forested, tonnes C $yr^{-1}$;
$\Delta C_{FFG}$ – Annual increase in carbon stock due to biomass growth, tonnes C $yr^{-1}$;
$\Delta C_{FFL}$ – Annual decrease in carbon stock due to biomass loss, tonnes C $yr^{-1}$;

#### *5.2.1.1. Annual increase in carbon stock due to growth of biomass in forest land remaining forest land*

$$\Delta C = \sum_{ij} (A_{ij} \bullet G_{TOTAL_{IJ}}) \bullet CF \qquad (5.2)$$ [74]

Where:
$\Delta C_{FFG}$ – Annual increase in carbon stock due to growth of biomass in land remaining forest land, by forest type and climatic zone, tonnes C $yr^{-1}$;
$A_{ij}$ – Area of land remaining forest land, by forest type ($i$ = 1 to $n$) and climatic zone ($j$ = 1 to $m$), ha;

[73] IPCC 2003. Chapter 3. LUCF Sector Good Practice Guidance. Equation 3.2.2 – Annual change in carbon stock in living biomass in forest remaining forest land (default method). pp – 3.24
[74] IPCC 2003. Chapter 3. LUCF Sector Good Practice Guidance. Equation 3.2.4 – Annual increase in carbon stock due to biomass increment in forest land remaining forest land. pp – 3.25

$G_{TOTALij}$ – Average annual increase in total biomass on a dry matter basis, by forest type ($i$ = 1 to $n$) and climatic zone ($j$ = 1 to $m$), tonnes d.m. $ha^{-1}$ $yr^{-1}$;
CF – Carbon fraction of dry matter, tonnes C (tonne d.m.)$^{-1}$;

### *5.2.1.2. Annual increment in biomass*

$$G_{TOTAL} = I_V \bullet D \bullet BEF \quad (5.3)$$ [75]

Where:
$G_{TOTAL}$ – Average annual increase in biomass above and below ground, tonnes d.m. $ha^{-1}$ $yr^{-1}$;
$I_V$ – Net annual increase in volume suitable for industrial processing, $m^3$ $ha^{-1}$ $yr^{-1}$;
D – Average wood density, tonnes d.m. $m^{-3}$ (Table 5.2_1.);
BEF – Biomass expansion factor for the conversion of net annual increase to total increase in tree biomass (above ground and below ground) (Table 5.2_1.);

**Table 5.2_1. Basic wood densities, biomass expansion factors (BEF), and carbon content of stem wood used in the estimations**

| Tree species | BEF[76] | Density of stem wood[77] (tonne d.m./$m^3$ f.m.) | Carbon content[8] (tonne C/ tonne d.m.) |
|---|---|---|---|
| Pine | 1.527 | 0.46 | 0.519 |
| Spruce | 1.859 | 0.44 | 0.519 |
| Birch | 1.678 | 0.61 | 0.505 |
| Asp | 1.678 | 0.50 | 0.505 |
| Alder | 1.678 | 0.55 | 0.505 |
| Others | 1.678 | 0.50 | 0.505 |

### *5.2.1.3. Annual decrease in carbon stocks due to biomass loss in forest land*

$$\Delta C_{FF_L} = L_{felling} + L_{fuelwood} + L_{other\_losses} \quad (5.4)$$ [78]

Where:
$\Delta C_{FFL}$ – Annual decrease in carbon stock due to biomass loss in forest land remaining forest land, tonnes C $yr^{-1}$;
$L_{fellings}$ – Annual carbon loss due to commercial felling, tonnes C $yr^{-1}$;
$L_{fuelwood}$ – Annual carbon loss due to fuel wood gathering, tonnes C $yr^{-1}$;
$L_{other\ losses}$ – Other annual losses of carbon, tonnes C $yr^{-1}$;

**Annual loss of carbon due to commercial felling**

*Tier 1* method was used to estimate annual carbon losses due to commercial felling (LULUCF 2003).

$$L_{felling} = H \bullet D \bullet BEF_2 \bullet (1 - f_{BL}) \bullet CF \quad (5.5)$$ [79]

[75] Modified from IPCC 2003. Chapter 3. LUCF Sector Good Practice Guidance. Equation 3.2.5 – Average annual increment in biomass. pp – 3.26
[76] Tomppo E., 2000
[77] Fischer G., et al., 2001
[78] IPCC 2003. Chapter 3. LUCF Sector Good Practice Guidance. Equation 3.2.6 – Annual decrease in carbon stocks due to biomass loss in forest land remaining forest land. pp – 3.26
[79] IPCC 2003. Chapter 3. LUCF Sector Good Practice Guidance. Equation 3.2.7 – Annual carbon loss due to commercial felling. pp – 3.27

Where:
$L_{fellings}$ – Annual carbon loss due to commercial felling, tonnes C $yr^{-1}$;
H – Annual extracted volume of roundwood, $m^3$ $yr^{-1}$;
D – Average wood density, tonnes d.m. $m^{-3}$ (Table 5.2_1);
$BEF_2$ – Biomass expansion factor for converting the volume of extracted roundwood to total above ground biomass (including bark), dimensionless (Table 5.2_1);
$f_{BL}$ – Fraction of biomass left to decay in the forest (transferred to dead organic matter);
CF – Carbon fraction of dry matter, tonnes C (tonne d.m.)$^{-1}$ (Table 5.2_1);

The factor $f_{BL}$ was set to zero in the above estimation, as the extracted roundwood is considered an immediate emission in this submission; however Estonia is considering estimating emissions from harvested biomass using a method employing the flow of harvested wood products (LULUCF 2003) in forthcoming submissions.

**Annual carbon loss due to the gathering of biomass in forest land**

The annual carbon emissions due to fuelwood gathering (cutting) was not estimated in order to avoid double accounting (felling is considered as an immediate emissions in this submissions), as the emission from solid biomass combustion was reported in the section on Energy (CRF 1).

**Annual carbon losses due to disturbances**

$$L_{other\_losses} = A_{disturbance} \bullet B_W \bullet (1 - f_{BL}) \bullet CF \qquad (5.6)$$ [80]

Where:
$L_{other\ losses}$ – Annual other losses of carbon, tonnes C $yr^{-1}$;
$A_{disturbance}$ – Forest areas affected by disturbances, ha $yr^{-1}$;
$B_W$ – Average biomass stock of forest areas, tonnes d.m. $ha^{-1}$;
$f_{BL}$ – Fraction of biomass left to decay in forest land (transferred to dead organic matter);
CF – Carbon fraction of dry matter, tonnes C (tonne d.m.)$^{-1}$;

Due to lack of data on forest losses affected by disturbances and further usage of damaged or disturbed biomass, only carbon losses from forest fires were estimated in 2007 submissions, however Estonia is considering the improvement in data for forthcoming submissions.

### 5.2.2. Activity data

The data for the estimation of carbon flows in forest land were taken from the ESO, Estonia forest 2005 [Centre of Forest Protection and Silviculture (CFPS)] and Forest Resources Assessment 2005 [FAO, CFPS]

### 5.2.3. Quantitative overview – Carbon removal by forest biomass in 2005

The forest biomass stock (only stems) were evaluated by the NFI) at 454,461 thousand $m^3$ in 2005 [Estonian forest, 2005], the average biomass being 201 $m^3$ per hectare. The average increase in biomass was 5.8 $m^3$/ha in 2005 (Table 5.2_2).

[80] IPCC 2003. Chapter 3. LUCF Sector Good Practice Guidance. Equation 3.2.9 – Annual other losses of carbon, pp – 3.28

**Table 5.2_2. Overall characterization of Estonian forests in 2005 [Estonian forest, 2005]**

| | Area, 1000 ha | Stock, 1000 $m^3$ | Stock, m3/ha | Increment, 1000 $m^3$ | Increment, $m^3$/ha |
|---|---|---|---|---|---|
| Pine | 709.1 | 162,494 | 229.2 | 3,516 | 5.0 |
| Spruce | 360.8 | 83,585 | 231.7 | 2,592 | 7.2 |
| Birch | 650.1 | 118,071 | 181.6 | 3,104 | 4.8 |
| Asp | 109.4 | 30,705 | 280.7 | 695 | 6.4 |
| Alder | 257.6 | 49,989 | 412.4 | 1,647 | 6.0 |
| Others | 34.8 | 6,796 | 195.3 | 192 | 5.5 |
| | 2,121.8 | 451,640 | 218.7 | 11,746 | 5.8 |

The volume of $CO_2$ sequestrated by Estonian forests was 17,759 Gg in 2005 – 8.64 $CO_2$ tonnes per ha.

The $CO_2$ emission due to commercial felling was 9,655 Gg, the net removal of $CO_2$ by Estonian forests was 8,103.58 Gg in 2005.

Data on the change of carbon stock in forest land was reported in [Forest Resources Assessment 2005], Estonia's activity data and IPCC default factors were used in the estimation (Table 5.2_3). However, the carbon content of Estonia's forest biomass was not estimated, therefore this data were not used in this report.

**Table 5.2_3. Carbon stock change in forest land[81]**

| | **Carbon (Million tonnes)** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Forest** | | | | **Other wooded land** | | | |
| | 1990 | 2000 | 2003 | 2005 | 1990 | 2000 | 2003 | 2005 |
| Carbon in above-ground biomass | No data | 132.416 | 130.792 | 129.597 | No data | 1.4485 | 1.389 | 1.3635 |
| Carbon in below-ground biomass | No data | 38.452 | 37.936 | 37.561 | No data | 0.393 | 0.376 | 0.3685 |
| **Sub-total: Carbon in living biomass** | **No data** | **170.868** | **168.728** | **167.157** | **No data** | **1.842** | **1.765** | **1.732** |
| Carbon in dead wood | No data | 7.727 | 8.112 | 8.208 | No data | 0.034 | 0.0325 | 0.032 |
| Carbon in litter | No data | No data | No data | No data | No data | No data | No data | No data |
| **Sub-total: Carbon in dead wood and litter** | **No data** | **7.727** | **8.112** | **8.208** | **No data** | **0.034** | **0.033** | **0.032** |
| **Soil carbon in soil cover[82]** | **No data** | **349.820** | **353.563** | **356.214** | **No data** | **14.66** | **13.725** | **12.789** |
| **TOTAL CARBON** | **No data** | **528.415** | **530.403** | **531.579** | **No data** | **16.536** | **15.523** | **14.553** |

The total volume of harvested woodfuel biomass was 2.1 million $m^3$, of which 105,000 tonnes were exported. In addition, 2,000 tonnes of fuelwood was imported [FAO databases]. However, the immediate $CO_2$ emission from fuelwood felling was not considered in Chapter 5.1 in order to avoid double accounting of $CO_2$ emissions, as $CO_2$ emission from consumption fuelwood was taken into account in the section on Energy.

[81] Global Forest Resources Assessment 2005. Estonia. pp - 20

[82] Soil cover or solum as a whole, whose depth reaches from the surface to the unchanged parent material or C horizon

**Table 5.2_4. Gross forest felling in 1990, 1991, 2000, 2002 and 2005[83]**

| | Volume in 1000 $m^3$ of roundwood over bark | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Forest | | | | | Other wooded land | | | | |
| | 1990 | 1991 | 2000 | 2002 | 2005 | 1990 | 1991 | 2000 | 2002 | 2005 |
| Industrial roundwood | 2,174 | 1,991 | 8,974 | 8,554 | 7,502 | No data | No data | 1 | 1 | 1 |
| Woodfuel | 1,032 | 1,016 | 2,190 | 1,975 | 2,100 | No data | No data | 4 | 4 | 5 |
| TOTAL | 3,206 | 3,007 | 11,164 | 10,529 | 9,577 | No data | No data | 5 | 5 | 6 |

## 5.3. Cropland (CRF 5.B) and carbon emission from agricultural liming (CRF (IV))

As mentioned in the beginning of this chapter, not all data requested in GPG LULUCF (LULUCF 2003) was available to perform a complete GHG inventory in this land category using the *Tier 1* method. Thus, Estonia is unable to report emissions from Croplands in the submission, however all future reports will consider emissions from Croplands.

## 5.4. Grassland (CRF 5.C)

As mentioned in the beginning of this chapter, not all data requested in GPG LULUCF was available to perform a complete GHG inventory in this land category using the *Tier 1* method. Thus, Estonia is unable to report emissions from Grasslands in this submission, however all future reports will consider carbon flows (emissions/removals) of Grassland.

## 5.5. Wetland (CRF 5.D)

As mentioned in the beginning of this chapter, not all data requested in GPG LULUCF was available to perform a complete GHG inventory in this land category using the *Tier 1* method. Thus, Estonia is unable to report emissions from Wetlands in this submission, however all future reports will consider carbon flows (emissions/removals) of Wetlands.

## 5.6. Settlements (CRF 5.E) and other lands (CRF 5.F)

As mentioned in the beginning of this chapter, not all data requested in GPG LULUCF was available to perform a complete GHG inventory in this land category using the *Tier 1* method. Thus, Estonia is unable to report emissions from Settlements and other lands in this submission.

## 5.7. Non-$CO_2$ emissions

### 5.7.1. Biomass burning (CRF 5 (V))

#### *5.7.1.1. Source category description*

This source category includes greenhouse gas emissions (only $CH_4$ and $N_2O$) from biomass burning on forested land due to wildfires.

#### *5.7.1.2. Methodology*

Equation (5.6) was used to estimate the emissions of non-$CO_2$ greenhouse gases. The combustion factor (0.34) was taken from Table 3A.1.12[84] (LULUCF 2003), and the Nitrogen-Carbon ratio (0.01)[85] of burned biomass was taken from [IPCC 1996].

[83] Global Forest Resources Assessment 2005. Estonia. pp – 30 – 31

**Table 5.7_1. Factors used to estimated the emission of non-$CO_2$ greenhouse gases emitted due to forest fires**[86]

| | Emission ratios |
|---|---|
| $CH_4$ | 0.012 |
| CO | 0.06 |
| $N_2O$ | 0.007 |
| NOx | 0.121 |

### *5.7.1.3. Activity data*

The data on the area of forest fires were taken from the ESO.

### *5.7.1.4. Quantitative overview – GHG emissions from wildfires in 2005*

The total area of forest land disturbed by fire in 2005 was 57.2 ha [www.stat.ee]. The emission of $CO_2$ from these fires was 6.65 Gg, $CH_4$ – 0.03 Gg, and $N_2O$ – 0.0002 Gg.

[84] LULUCF Combustion factor values (proportion of prefire biomass consumed) for fires in a range of vegetation types, pp – 3.179

[85] Revised 1996 IPCC Guidelines for National Greenhouse gas Inventories: Workbook. Land Use Change and Forestry. pp – 5.18

[86] LULUCF 2003, Table 3A.1.15 – Emissions ratios for open burning of cleared prests

# CHAPTER 6. WASTE (CRF 6)

## 6.1. Overview of source category description and methodology

The estimated emissions for 2005 were 530.58 Gg $CO_2$-equevalent; the majority (93%) of these emissions were from solid waste disposal on landfills.

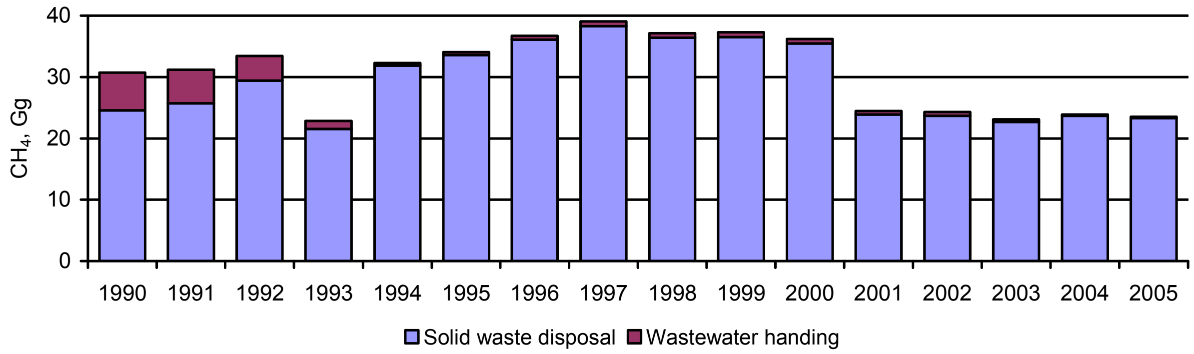



Figure 6.1_1: Trend in $CH_4$ emissions from solid waste disposal on landfills and wastewater handing, 1990 – 2000

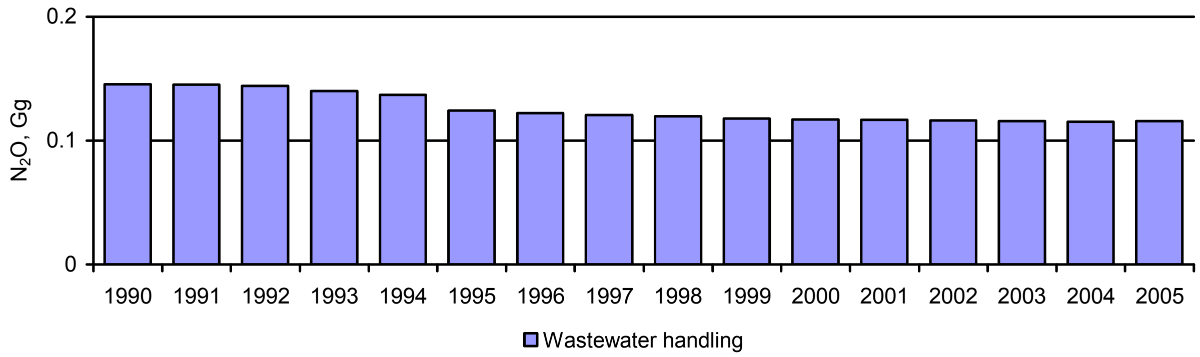



Figure 6.1_2: Trend in $N_2O$ emissions from wastewater handing, 1990 – 2005

Methods used to estimate flows of GHG are presented in Table 6.1_1.

**Table 6.1_1. Methods and emissions factors used for the estimation of emissions from waste**

| Greenhouse gases source and sink categories | $CO_2$ | | $CH_4$ | | $N_2O$ | |
|---|---|---|---|---|---|---|
| | Method Applied | EF | Method Applied | EF | Method Applied | EF |
| **6. Waste** | | | | | | |
| A. Solid Waste Disposal on Landfills | | | T1 | IPCC, CS | | |
| B. Wastewater handing | | | T1 | IPCC, CS | T1 | IPCC, CS |
| C. Waste Incineration | NE | NE | NE | NE | NE | NE |

NE – not estimated; T1 – Tier 1 method; CS – country specific

## 6.2. $CH_4$ emission from solid waste disposal (CRF 6.A)

### 6.2.1. Source category description

Methane is emitted during the anaerobic decomposition of organic waste disposed of in solid waste disposal sites (SWDS). Organic waste decomposes at a diminishing rate and takes many years to decompose completely [IPCC 2001].

### 6.2.2. Methodology

*Tier 1* method (IPCC 1996) was used to estimate $CH_4$ emissions from solid waste disposal sites.

**Solid waste disposal**

$$CH_4\_emission, Gg/yr = (MSW_T \times MSW_F \times MCF \times DOC \times DOC_F \times F \times 16/12 - R) \times (1 - OX) \quad (6.1)$$ [87]

Where:
$MSW_T$ – Total MSW generated, Gg/yr;
$MSW_F$ – Fraction of MSW disposed to solid waste disposal sites;
MCF – Methane correction factor (fraction);
DOC – Degradable organic carbon (fraction), kg C/ kg SW (Table 6.2_2);
$DOC_F$ – Fraction DOC dissimilated;
F – Fraction of $CH_4$ in landfill gas;
16/12 – Conversion of C to $CH_4$;
R – Recovered $CH_4$, Gg/yr;
OX – Oxidation factor;

**Table 6.2_1. IPCC default factors used in the estimation**

| Factors | Value |
|---|---|
| MCF | 1[88] |
| F | 0.5[89] |
| $DOC_F$ | 0.6[90] |
| OX | 0[91] |

The DOC was estimated for both municipal and industrial waste (Table 6.2_2).

**Table 6.2_2. Default DOC Values for Major Waste Streams**

| | Per cent DOC (by weight) | Municipal waste | | Industrial waste | |
|---|---|---|---|---|---|
| | | Fraction of waste[92] | DOC (by weight) | Fraction of waste | DOC (by weight) |
| Paper and textiles | 40% | 25.93 | 10.37 | 20.13 | 8.05 |
| Garden and park waste | 17% | 10.69 | 1.82 | 30.03 | 5.11 |
| Food waste | 15% | 30.43 | 4.56 | 0.00 | 0.00 |
| Wood and straw waste | 30% | 1.83 | 0.55 | 49.84 | 14.95 |
| **Total** | | | **17.30** | | **28.11** |

### 6.2.3. Data availability and sources

Data were mostly obtained from the reports of the Estonian Environment Information Center (EEIC) and the ESO.

[87] IPCC 1996. Waste. Workbook. Table 6-2 – Calculation of Methane Correction Factor. pp – 6.8
[88] IPCC 2000. Waste. Table 5.1 – SWDS Classification and Methane Correction Factors. pp – 5.9
[89] IPCC 2000. Waste. pp – 5.10
[90] IPCC 2000. Waste. pp – 5.9
[91] IPCC 2000. Waste. pp – 5.10
[92] The data on Fraction of Waste by Municipal waste were used from [National Inventory Report 1990 – 2004]

### 6.2.4. Quantitative overview - $CH_4$ emission from solid waste disposal in 2005

The total amount of solid waste generated was 556,006 tonnes. Of this municipal waste amounted to 457,323 tonnes, with 79% (or 359,674 tonnes) being disposed of in landfills (Table 6.2_3).

**Table 6.2_3. Municipal waste generation in 2005**

| Category | Unit |
|---|---|
| Total generation of municipal waste (incl. collected) (t) | 556,006 |
| …mixed municipal waste | 457,323 |
| …collected by type | 60,796 |
| % from all generation | 13 |
| Mixed municipal waste generation (kg/y per capita) | 412.6 |
| Total generation of municipal waste (kg/y per capita) | 339.4 |
| Number of inhabitants | 1,347,510 |
| Municipal waste disposed (t) | 369,486 |
| …mixed municipal waste disposed | 359,674 |

The $CH_4$ emissions from waste streams originating from the agro-food industry, the pulp and paper industry, and wood industry was estimated in the inventory. The amount of waste generated from these industries was 1,324 thousand tonnes, of which only 0.9% was disposed of in landfills (Table 6.2_4).

**Table 6.2_4. Waste generation by Estonian industry in 2005, tonnes**

| | Waste generation | Waste storage onto landfills |
|---|---|---|
| Paper and textiles | 68,090 | 2,417 |
| Garden and park waste | 26,607 | 3,607 |
| Wood and straw waste | 1,230,098 | 5,985 |
| | **1,324,794** | **12,008** |

The $CH_4$ recovered from landfills was 5 tce[93] [Energy Balance 2005] or 2.93 Gg (Figure 6.2_1).

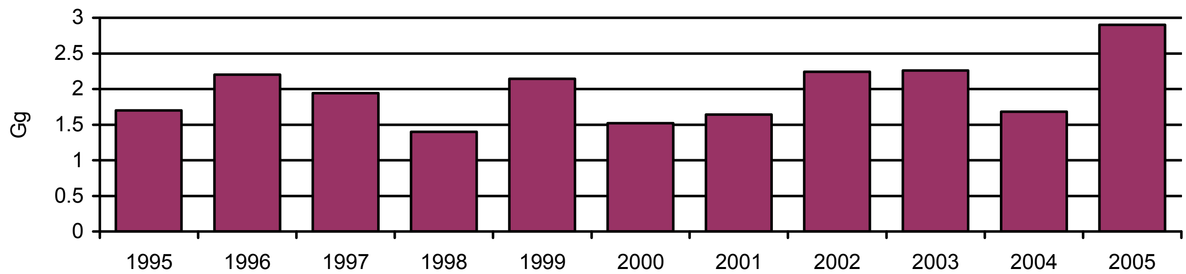



Figure 6.2_1: $CH_4$ recovered from landfills in the years 1995 – 2005 [94]

The emission of $CH_4$ from landfills was 23.31 Gg (Figure 6.2_2).

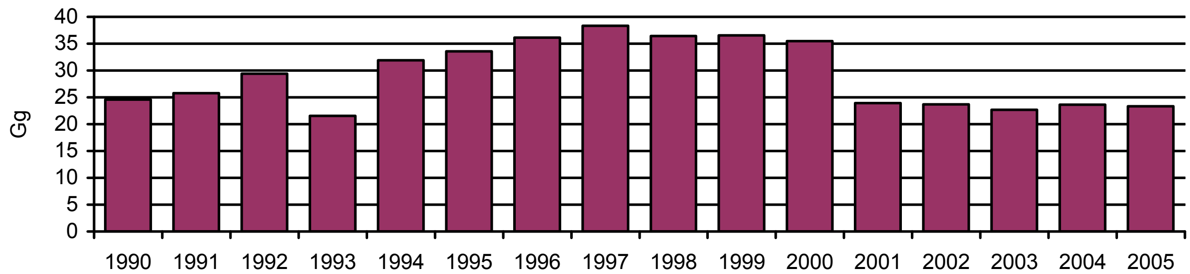



Figure 6.2_2: $CH_4$ emission from waste in the years 1990 - 2005, Gg

[93] [Energy Balance 2005], pp - 17
[94] The data was derived from the Estonian National Report and Energy Balance 2005

## 6.3. $CH_4$ emission from wastewater handling (domestic/commercial) (CRF 6.B)

### 6.3.1. Source category description

The handling of domestic and industrial wastewater under anaerobic conditions produces $CH_4$ [IPCC 2001].

### 6.3.2. Methodology

*Tier 1* method (IPCC 1996) was used to estimate $CH_4$ emissions from SWDS.

$$Emissions = (Total\_Organic\_Waste \bullet Emission\_Factor) - Methane\_Recovery \qquad (6.2)$$

The emission of $CH_4$ from domestic and industrial wastewater was estimated by the formulas below.

**Domestic wastewater:**

$$TOW_{dom} = P \times D_{dom} \times (1 - DS_{dom}) \qquad (6.3)$$[95]

Where:
$TOW_{dom}$ – Total domestic/commercial organic wastewater in kg BOD/yr;
$TOS_{dom}$ – Total domestic/commercial organic sludge in kg BOD/yr;
P – Population in 1000 persons;
$D_{dom}$ – Domestic/commercial degradable organic component in kg BOD/1000 persons/yr;
$DS_{dom}$ – Fraction of domestic/commercial degradable organic component removed as sludge;

**Industrial wastewater:**

$$TOW_{ind}(kgCOD/yr) = W \times O \times D_{ind} \times (1 - DS_{ind}) \qquad (6.4)$$[96]

Where:
$TOW_{ind}$ – Total industrial organic wastewater in kg COD/yr;
$TOS_{ind}$ – Total industrial organic sludge in kg COD/yr;
W – Wastewater consumed in $m^3$/tonne of product;
O – Total output by selected industry in tonnes/yr;
$D_{ind}$ – Industrial degradable organic component in kg COD/$m^3$ wastewater;
$DS_{ind}$ – Fraction of industrial degradable organic component removed as sludge;

$$WM = \sum_i (TOW_i \times EF_i - MR_i) \qquad (6.5)$$[97]

Where:
WM – Total methane emissions from wastewater in kg $CH_4$;
$TOW_i$ – Total organic waste for wastewater type *i* in kg DC/yr;
$EF_i$ – Emission factor for wastewater type *i* in kg $CH_4$/kg DC;
$MR_i$ – total amount of methane recovered or flared from wastewater type i in kg $CH_4$;

[95] IPCC 1996. Waste. Reference Manual. Equation 6. pp – 6.18
[96] IPCC 1996. Waste. Reference Manual. Equation 8. pp – 6.19
[97] IPCC 1996. Waste. Reference Manual. Equation 12. pp – 6.22

The emission of $CH_4$ from sludge was not carried out as the amount of sludge was added to the total amount of waste transferred to landfill.

### 6.3.3. Data availability and sources

Data on the number and volume of wastewater streams, both domestic and industrial, treated in 2005, and the methods used to treat them were obtained from the EEIC.

Data on the population of Estonia (1,347,510 people) and the amount of goods produced (for equation 6.5) were derived from the ESO.
Data on wastewater consumed in $m^3$ per products and industrial degradable organic component in kg COD/$m^3$ wastewater were used from Table 55.2_2[98] – Industrial Wastewater Data (IPCC 2000).

### 6.3.4. Quantitative overview - $CH_4$ emission from wastewater handing in 2005

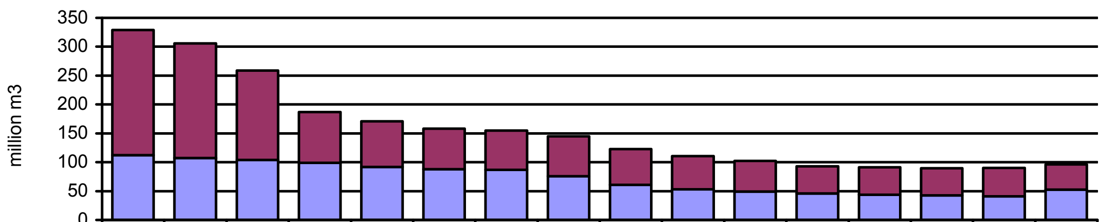
The total amount of wastewater released in 2005 was 1.62 million $m^3$, from which 324 thousand $m^3$ was treated and the remaining 1.255 million $m^3$ used as cooling water for the production of energy, avoiding the need for treatment (Table 6.3_1).

**Table 6.3_1. Wastewater generation by type of wastewater[99], $m^3$**

| | Total | Cooling water | Total wastewater, exp cooling water | …Mining water | …Sewage | …Rainfall water |
|---|---|---|---|---|---|---|
| Wastewater | 1,619,735 | 1,255,599 | 364,130 | 231,252 | 120,860 | 12,019 |

**Table 6.3_2. Wastewater generated by various sectors of the Estonian economy in 2005[100] [2005. aasta Eesti veemajanduse…]**

| | Cooling / Energy | Cooling / industry | Other | Agriculture | Domestic | Industry |
|---|---|---|---|---|---|---|
| Wastewater, 1000 $m^3$ | 11,434 | 4,752 | 6,860 | 4,373 | 52,332 | 39,276 |




| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Industrial (inc. agriculture) | 217 | 199 | 155 | 88 | 79 | 70 | 68 | 69 | 62 | 57.5 | 53.3 | 47 | 47.8 | 47.2 | 49.6 | 43.6 |
| Domestic | 112 | 107 | 104 | 99 | 92 | 88 | 87 | 76 | 61 | 53 | 49 | 46 | 43.7 | 42.4 | 40.7 | 52.3 |

Figure 6.3_1: Amounts of wastewater treated in Estonia in 1990 – 2005[101]

In 2005, the quantity of methane emission from domestic wastewater treatment was 0.04 Gg, and the quantity of $CH_4$ emission from industrial wastewater treated was 0.21 Gg.

[98] IPCC 2000. Waste. pp – 5.22
[99] Source: Tabelid "2005. aasta Eesti veemajanduse…, 2006
[100] The Table presents water consumption by various industrial sectors in Estonia; however all consumed water flows to treatment stations. This means that the amount of wastewater generated is equal to the amount of consumed water.
[101] The data on 1990-2004 was derived from [Greenhouse gas emissions in Estonia 1990-2004] and the data on 2005 were obtained from [Tabelid "2005. aasta Eesti veemajanduse…, 2006]

The quantity of $N_2O$ from human sewage was 0.116 Gg, the method of this estimation was considered in the section on Agriculture (CRF 4).

### 6.3.5. Specific planned improvements

All country specific data and methodologies are kept for review and improvement.

# CHAPTER 7. RECALCULATIONS AND IMPROVEMENTS

## 7.1 Introduction

The paper summarizes recalculations and improvements carried out in the Estonian National Inventory of GHG since submissions of the 2005 inventory.

The recalculations of the sectors Energy and Industrial Processes are presented in the Chapter 7.2 and Annex 4.

The recalculations of the sectors Agriculture, LULUC and Waste were carried out for the following sub-sectors:

- AGRICULTURE (CRF 4)
  - $CH_4$ emission from Enteric Fermentation;
  - $CH_4$ emission from Manure Management;
  - $N_2O$ emission from Manure Management;
  - $N_2O$ emission from Animal Manure Applied to Soils;
  - $N_2O$ emission from growing of N-fixing crops;
  - $N_2O$ emission from Crop Residues;
  - $N_2O$ emission from Atmospheric Deposition;
  - $N_2O$ emission from Nitrogen Leaching and Run-off;
- LULUC (CRF 5)
  - $CO_2$ and $CH_4$ emission from biomass burning;
- WASTE (CRF 6)
  - $CH_4$ emission from Municipal Waste Disposed of in Landfills;
  - $CH_4$ emission from Industrial Wastewater Treatment;
  - $CH_4$ emission from Domestic and Commercial Wastewater Treatment;

Explanations and justifications for these recalculations are presented below in Chapters 7.3 – 7.5.

## 7.2 Explanations and justification for recalculations, implications on emission levels and trends including time series consistency (Energy and Industrial Processes)

Some recalculations have been made since the last inventory submission to take into account methodological improvements and better activity data. The recalculations made since the previous inventory submission are described in more detail in the sectoral chapters. Reasoning and impact of the recalculations for the years 1990-2004 can be found from Annex 4 of the report.

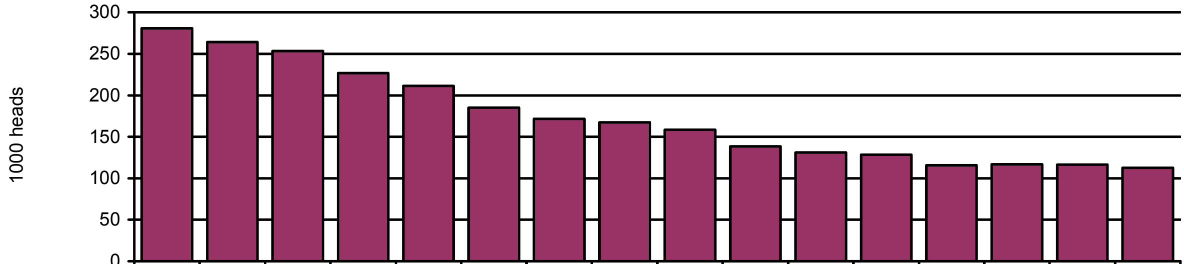
In the Energy Sector emissions for the whole times series for fuel combustion activities in CRF categories 1.A 2 f (Other / Construction), 1.A 3 (Transport), 1.A 4 (Other Sectors) and 1.A 5 (Other) have been recalculated to improve the consistency. These categories cover all non-point sources in the Energy Sector. Improvements in methods, activity data and emission factors have in previous years been applied only in a limited way to the whole time series. This had resulted in inconsistencies which have now been corrected. As a result of the recalculations, the $CO_2$ equivalent emissions from fuel combustion as a whole have increased for the base year (0.26%) and for the year 2004 (0.8%). The decrease is largely due to changes in the $N_2O$ emissions, which have increased significantly for the whole time series. The changes in $CO_2$ emissions are small, but the allocation of the emissions has changed and emission factor of Other Kerosene has been improved. The methane emissions have increased somewhat, but the implications on the total $CO_2$ equivalent emissions are small.

Under Industrial Processes emissions from cement production have been recalculated using clinker production as the basis of estimates for the first time. All inventory years have been recalculated using the new methodology. Emissions from ammonia production have been added to the inventory. These additions have been made for the whole time series. The effect of these recalculations to the overall Industrial Processes sector is rather big – emissions are increased from one third up to 80% compared to the previous emissions.

## 7.3 Agriculture (CRF 4)

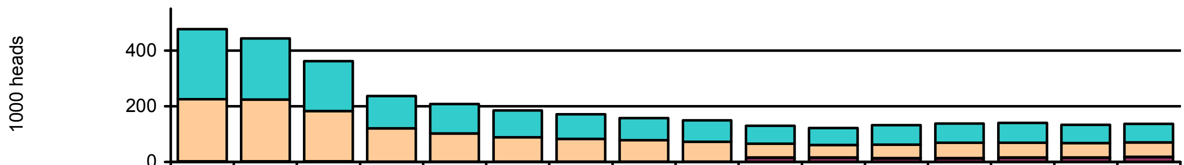
### 7.3.1 Enteric Fermentation (CRF 4.A)

In order to improve estimates of methane emission from enteric fermentation and livestock manure management, activity data on livestock population were updated. Estimates (for 1990 - 2005) were carried out based on sub-categories of Cattle (Dairy Cattle, Non-Dairy Cattle: Mature Females, Mature Males, Bovine animals (aged between 1 and 2 years) and Calves (less than 1 year old)) and Swine (Piglets, live weight less than 20 kg, Young pigs, live weight 20–<50 kg, Fattening pigs, with live weight 50–<80 kg, with live weight 80–<110 kg, with live weight 110 kg or more and Breeding pigs, live weight 50 kg or more) in the submissions of 2007 (Figures 7.3_1, 7.3_2 and 7.3_3).



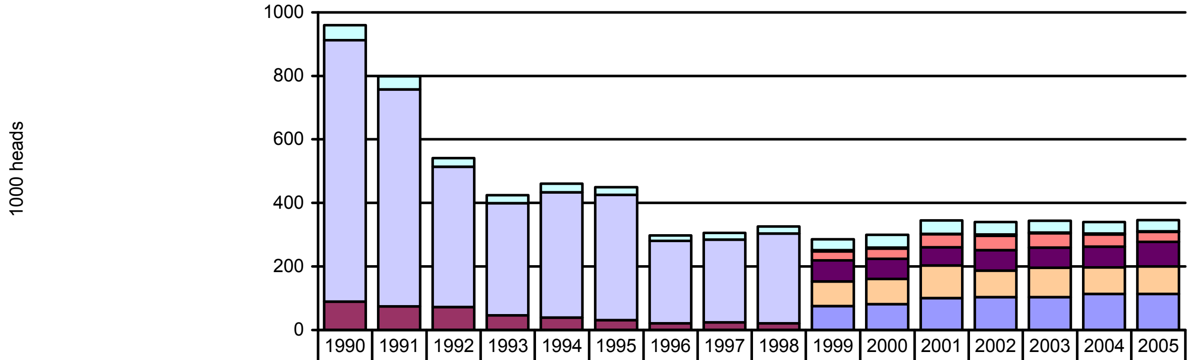

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dairy-Cattle | 280.7 | 264.3 | 253.4 | 226.7 | 211.4 | 185.4 | 171.6 | 167.7 | 158.6 | 138.4 | 131 | 128.6 | 115.6 | 116.8 | 116.5 | 112.8 |

Figure 7.3_1: Population of Dairy Cattle in Estonia in 1990 – 2005, 1000 heads




| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Calves | 251.9 | 220 | 178.8 | 116.9 | 105.8 | 97 | 89.1 | 80.4 | 77.1 | 64.3 | 61.1 | 69.9 | 70 | 72.3 | 66.3 | 67.2 |
| Bovine Animals | 223.2 | 221.9 | 180.8 | 119 | 101.1 | 87.3 | 81.7 | 76.9 | 71 | 48.5 | 44.8 | 48.8 | 55.1 | 52.8 | 51 | 51.9 |
| Mature Males | 2 | 2.1 | 1.6 | 0.6 | 1.2 | 0.7 | 0.6 | 0.6 | 0.8 | 1.6 | 1.2 | 1.2 | 1.1 | 0.8 | 1.3 | 0.8 |
| Mature Females | | | | | | | | | | 14.5 | 14.7 | 12 | 12.1 | 14.5 | 14.7 | 16.8 |

Figure 7.3_2: Population of non-dairy cattle in Estonia in 1990 – 2005, 1000 heads




| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Breeding pigs | 47.1 | 41.5 | 27.7 | 25.3 | 26.6 | 23.4 | 17.6 | 21.3 | 22.6 | 33.8 | 40.5 | 41.6 | 39.8 | 37.9 | 35.9 | 35.6 |
| Fattening pigs | 823.3 | 682.1 | 440.9 | 352.3 | 394.2 | 393.9 | 259.8 | 261.1 | 282.3 | | | | | | | |
| ...live weight 110 kg or more | | | | | | | | | | 3.8 | 3.2 | 1.7 | 3.6 | 1.8 | 3.3 | 1.5 |
| ...live weight 80–<110 kg | | | | | | | | | | 29 | 32 | 40.8 | 45.8 | 44.6 | 37.8 | 31.7 |
| ...live weight 50–<80 kg | | | | | | | | | | 66 | 63.8 | 57 | 64.7 | 64.3 | 65.5 | 77.2 |
| Young pigs, live weight 20–<50 kg | | | | | | | | | | 77.9 | 79.5 | 103.6 | 82.8 | 91.9 | 83.9 | 87.2 |
| Piglets, live weight less than 20 kg | | | | | | | | | | 75.2 | 81.2 | 100.3 | 104.1 | 104.1 | 113.7 | 113.3 |
| Young sows (4 months and over) | 89.5 | 75 | 72.5 | 46.7 | 39 | 31.5 | 21 | 23.9 | 21.5 | | | | | | | |

Figure 7.3_3: Population of pigs in Estonia in 1990–2005, 1000 heads

### *7.3.1.1. Dairy Cattle (CRF 4.A)*

There is one recalculation in the 'Methane emission from enteric fermentation of dairy cattle' for the 2007 submission. The upgrade of the algorithm of the estimation of $CH_4$ emission from Tier 1 to Tier 2 approach was made. Milk yield per cow by countries of Estonia and milk fat were taken into account, other factors were used as default from the IPCC Guidelines (1996) (Figure 7.3_4 and Table 7.3_1).

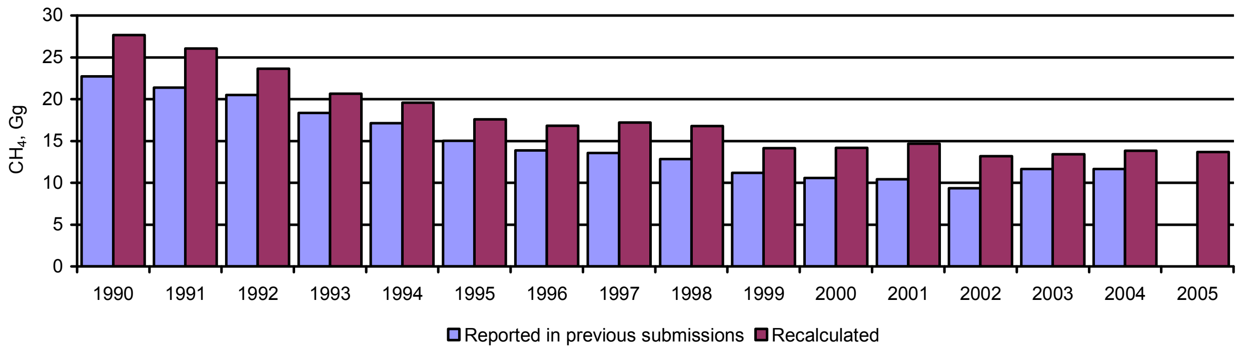



Figure 7.3_4: $CH_4$ emissions from enteric fermentation of dairy cattle in 1990 – 2005, Gg

**Table 7.3_1. $CH_4$ emissions from enteric fermentation of dairy cattle in 1990 – 2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
|---|---|---|
| 1990 | 22.7367 | 27.6957 |
| 1991 | 21.4083 | 26.0776 |
| 1992 | 20.5254 | 23.6443 |
| 1993 | 18.3627 | 20.6610 |
| 1994 | 17.1234 | 19.6091 |
| 1995 | 15.0174 | 17.5873 |
| 1996 | 13.8996 | 16.8281 |
| 1997 | 13.5837 | 17.1943 |
| 1998 | 12.8466 | 16.7916 |
| 1999 | 11.2104 | 14.1606 |

| | | |
|---|---|---|
| 2000 | 10.6110 | 14.2034 |
| 2001 | 10.4166 | 14.6736 |
| 2002 | 9.3636 | 13.2011 |
| 2003 | 11.68 | 13.4384 |
| 2004 | 11.65 | 13.8540 |
| 2005 | | 13.6994 |

### *7.3.1.2. Non-Dairy Cattle (CRF 4.A)*

There is one recalculation in the 'Methane emission from enteric fermentation of non-dairy cattle' for the 2007 submission.

Emissions were carried out based on updated activity data. Hence, Tier 2 approach instead Tier 1 was used (Figure 7.3_5 and Table 7.3_2).

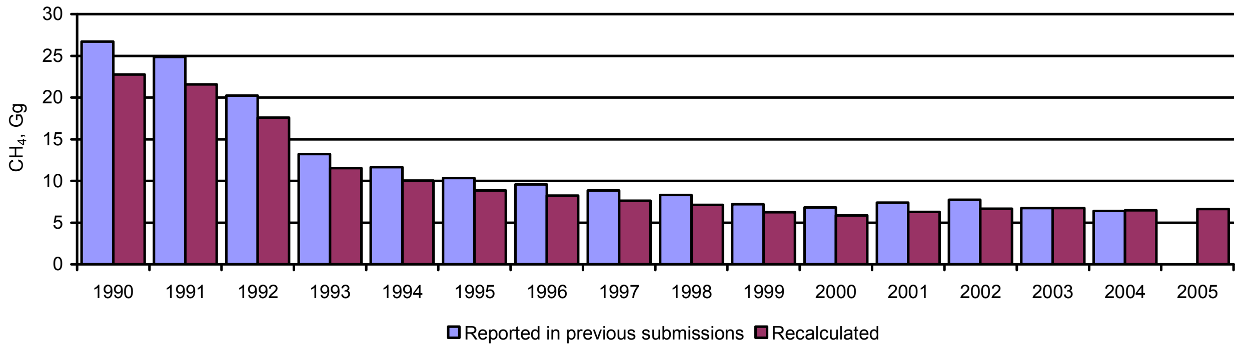



Figure 7.3_5: $CH_4$ emissions from enteric fermentation of non-dairy cattle in 1990 – 2005, Gg

**Table 7.3_2. $CH_4$ emissions from enteric fermentation of non-dairy cattle in 1990 – 2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
|---|---|---|
| 1990 | 26.7176 | 22.7808 |
| 1991 | 24.864 | 21.6004 |
| 1992 | 20.2272 | 17.5841 |
| 1993 | 13.244 | 11.5466 |
| 1994 | 11.6536 | 10.0330 |
| 1995 | 10.36 | 8.8577 |
| 1996 | 9.5984 | 8.2318 |
| 1997 | 8.8424 | 7.6288 |
| 1998 | 8.3384 | 7.1423 |
| 1999 | 7.2184 | 6.2517 |
| 2000 | 6.8208 | 5.8923 |
| 2001 | 7.3864 | 6.2874 |
| 2002 | 7.7448 | 6.6882 |
| 2003 | 6.7392 | 6.7443 |
| 2004 | 6.3984 | 6.4700 |
| 2005 | | 6.6488 |

### *7.3.1.3. Swine (CRF 4.A)*

There is one recalculation in the 'Methane emission from enteric fermentation of swine' for the 2007 submission.

The estimates were carried out based on updated activity data (by sub-categories of pigs), Tier 2 approach was used instead of Tier 1 (Figure 7.3_6 and Table 7.3_3).

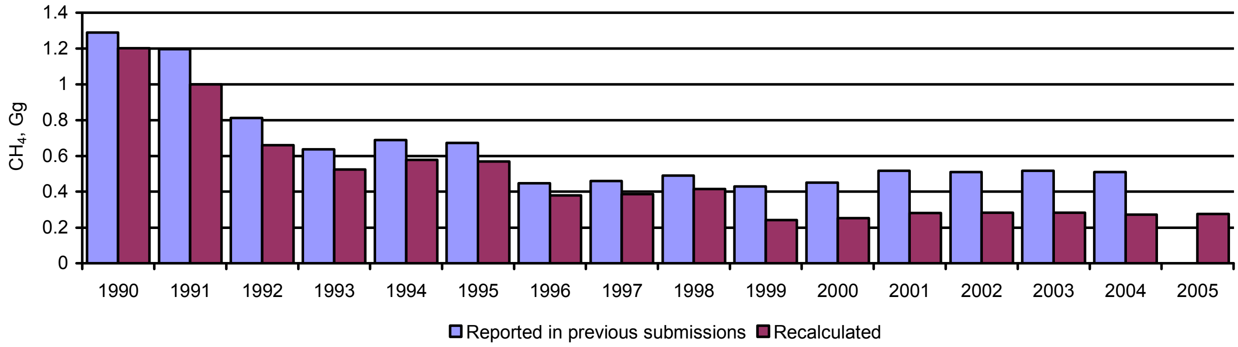



Figure 7.3_6: $CH_4$ emissions from enteric fermentation of swine in 1990–2005, Gg

**Table 7.3_3. $CH_4$ emissions from enteric fermentation of swine in 1990 - 2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
|---|---|---|
| 1990 | 1.2899 | 1.2019 |
| 1991 | 1.1979 | 0.9992 |
| 1992 | 0.8117 | 0.6598 |
| 1993 | 0.6365 | 0.5250 |
| 1994 | 0.6897 | 0.5783 |
| 1995 | 0.6732 | 0.5700 |
| 1996 | 0.4476 | 0.3787 |
| 1997 | 0.4595 | 0.3864 |
| 1998 | 0.4896 | 0.4149 |
| 1999 | 0.4286 | 0.2413 |
| 2000 | 0.4503 | 0.2533 |
| 2001 | 0.5175 | 0.2814 |
| 2002 | 0.5112 | 0.2833 |
| 2003 | 0.5169 | 0.2830 |
| 2004 | 0.5102 | 0.2720 |
| 2005 | | 0.2761 |

### *7.3.1.4. Other Animals (Sheep, Goats and Horses) (CRF 4.A)*

There is one recalculation in the $CH_4$ emission from enteric fermentation of ‘other livestock’ in the 2007 submission. $CH_4$ emissions from enteric fermentation of sheep and goats were estimated separately for the years 1990–1995, as reported $CH_4$ emissions were estimated based on total population of sheep and goats in previous submissions (Figures 7.3_7, 7.3_8 and Table 7.3_4).

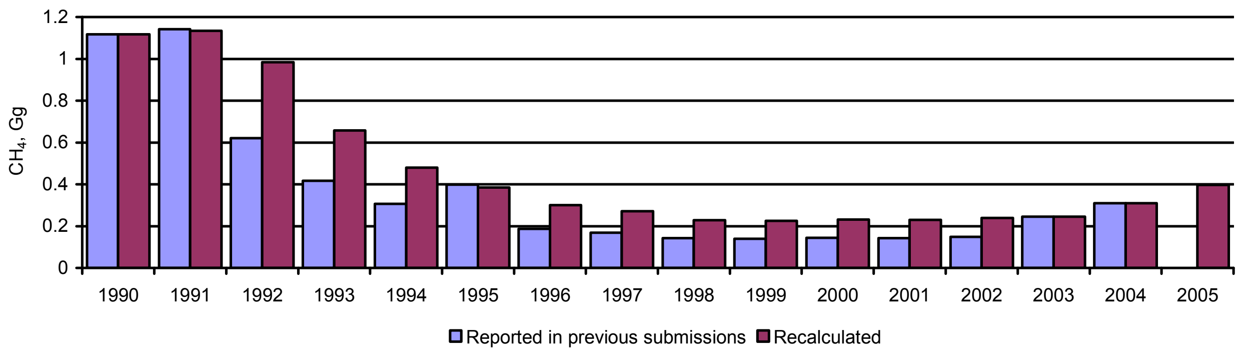



Figure 7.3_7: $CH_4$ emissions from enteric fermentation of sheep, Gg

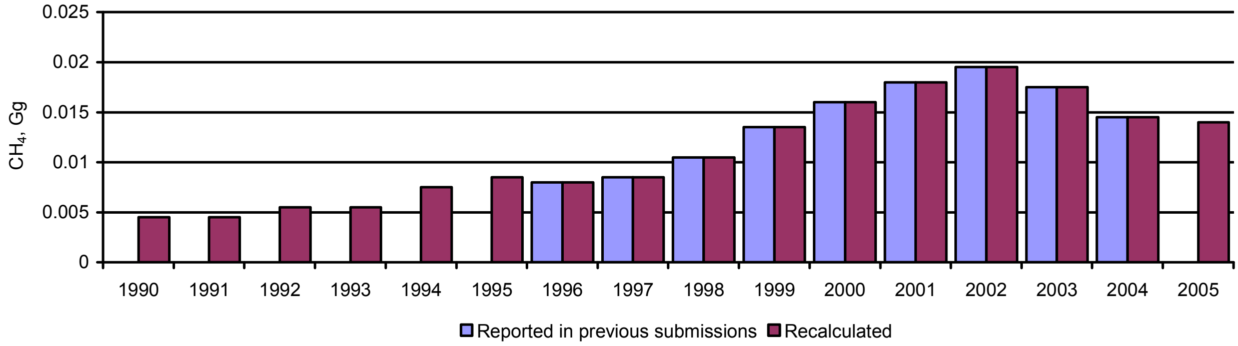



Figure 7.3_8: $CH_4$ emissions from enteric fermentation of goats, Gg

**Table 7.3_4. $CH_4$ emissions from enteric fermentation of sheep and goats in 1990–2005, Gg**

| Year | Sheep | | Goats | |
|---|---|---|---|---|
| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ | Reported emissions of $CH_4$ in 1990– 2004 | Recalculated emissions of $CH_4$ |
| 1990 | 1.1184 | 1.1184 | - | 0.0045 |
| 1991 | 1.1424 | 1.1352 | - | 0.0045 |
| 1992 | 0.6215 | 0.9848 | - | 0.0055 |
| 1993 | 0.4165 | 0.6576 | - | 0.0055 |
| 1994 | 0.3075 | 0.4800 | - | 0.0075 |
| 1995 | 0.3984 | 0.3856 | - | 0.0085 |
| 1996 | 0.1880 | 0.3008 | 0.0080 | 0.0080 |
| 1997 | 0.1695 | 0.2712 | 0.0085 | 0.0085 |
| 1998 | 0.1435 | 0.2296 | 0.0105 | 0.0105 |
| 1999 | 0.1410 | 0.2256 | 0.0135 | 0.0135 |
| 2000 | 0.1450 | 0.2320 | 0.0160 | 0.0160 |
| 2001 | 0.1440 | 0.2304 | 0.0180 | 0.0180 |
| 2002 | 0.1495 | 0.2392 | 0.0195 | 0.0195 |
| 2003 | 0.2464 | 0.2464 | 0.0175 | 0.0175 |
| 2004 | 0.3104 | 0.3104 | 0.0145 | 0.0145 |
| 2005 | | 0.3968 | | 0.0140 |

### 7.3.2. Manure Management (CRF 4.B)

#### *7.3.2.1. $CH_4$ emissions from Cattle Manure Management (CRF 4.B)*

#### *7.3.2.1.1. Dairy–Cattle (CRF 4.B)*

There are two recalculations in the estimation of 'Methane emission from dairy cattle manure management' in the 2007 submission. The upgrade Tier 1 to Tier 2 approach was used. Since 2003, Estonia has begun to estimate emissions based on Western Europe's allocation of manure management system (by types)[102] (Figure 7.3_9 and Table 7.3_5).

In order to achieve an accurate estimation of $CH_4$ emission from manure management, Estonia will keep investigating and improving estimates based on Estonia's manure management systems in the future.

[102] Until 2003, the estimates were provided basing on manure management system presented for Eastern Europe

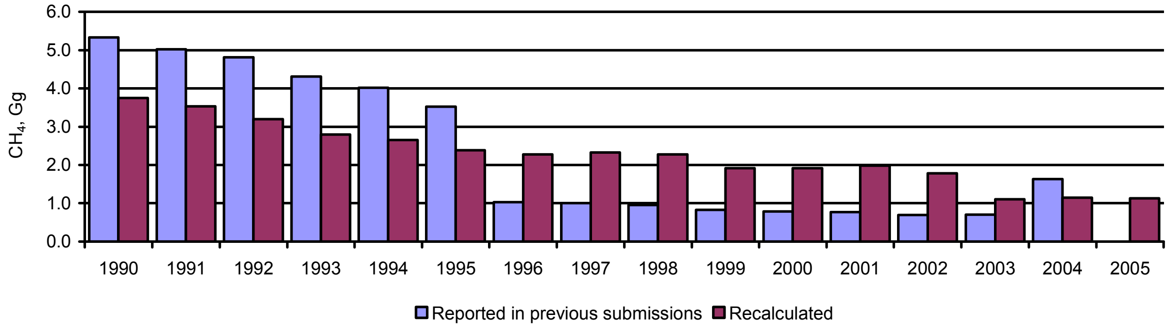



Figure 7.3_9: $CH_4$ emissions from dairy cattle manure management in 1990 – 2005, Gg

**Table 7.3_5. $CH_4$ emissions from dairy cattle manure management in 1990–2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
|---|---|---|
| 1990 | 5.3333 | 3.7487 |
| 1991 | 5.0217 | 3.5296 |
| 1992 | 4.8146 | 3.2003 |
| 1993 | 4.3073 | 2.7965 |
| 1994 | 4.0166 | 2.6541 |
| 1995 | 3.5226 | 2.3805 |
| 1996 | 1.0296 | 2.2777 |
| 1997 | 1.0062 | 2.3273 |
| 1998 | 0.9516 | 2.2728 |
| 1999 | 0.8304 | 1.9167 |
| 2000 | 0.7860 | 1.9193 |
| 2001 | 0.7716 | 1.9861 |
| 2002 | 0.6936 | 1.7868 |
| 2003 | 0.7008 | 1.1077 |
| 2004 | 1.6310 | 1.1420 |
| 2005 | | 1.1293 |

### *7.3.2.1.2. Non-Dairy Cattle (CRF 4.B)*

There are three recalculations in the estimation of methane emission from non-dairy cattle manure management in the 2007 submission. The upgrade Tier 1 to Tier 2 approach based on updated activity data was used. Since 2003, the estimates have been carried out based on Western Europe's manure management system[1] (Figure 7.3_10 and Table 7.3_6).

In order to achieve accurate estimations and to decrease uncertainties, Estonia will investigate the database of Estonia's manure management system.

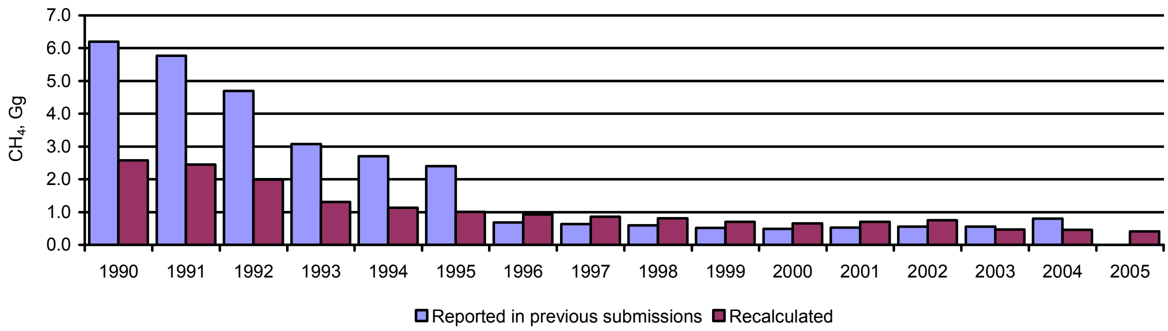



Figure 7.3_10: $CH_4$ emissions from non-dairy cattle manure management, Gg

**Table 7.3_6. $CH_4$ emissions from non-dairy cattle manure management in 1990–2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
|---|---|---|
| 1990 | 6.2023 | 2.5739 |
| 1991 | 5.7720 | 2.4502 |
| 1992 | 4.6956 | 1.9947 |
| 1993 | 3.0745 | 1.3101 |
| 1994 | 2.7053 | 1.1362 |
| 1995 | 2.4050 | 1.0013 |
| 1996 | 0.6856 | 0.9311 |
| 1997 | 0.6316 | 0.8640 |
| 1998 | 0.5956 | 0.8079 |
| 1999 | 0.5156 | 0.6999 |
| 2000 | 0.4872 | 0.6591 |
| 2001 | 0.5276 | 0.7029 |
| 2002 | 0.5532 | 0.7504 |
| 2003 | 0.5616 | 0.4746 |
| 2004 | 0.7998 | 0.4558 |
| 2005 | | 0.4114 |

### *7.3.2.2. $N_2O$ emissions from Cattle Manure Management (CRF 4.B)*

$N_2O$ emissions from cattle manure management were recalculated for both categories of cattle: dairy cattle and non-dairy cattle, for all years (1990 – 2004).

#### *7.3.2.2.1. Dairy Cattle (CRF 4.B)*

Due to transcription errors made in previous submissions, one recalculation was carried out.

Since 2003, Western Europe's manure management system has been used as the base for estimates of $N_2O$ emission. Tier 1 approach was used in the estimates (Figure 7.3_11, Table 7.3_7).

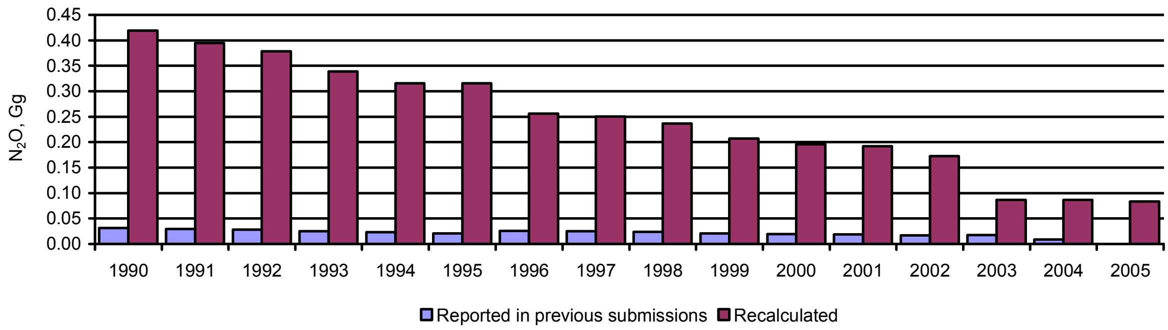



Figure 7.3_11: $N_2O$ emissions from dairy cattle manure management, Gg

**Table 7.3_7. $N_2O$ emissions from dairy cattle manure management in 1990 – 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.0312 | 0.4193 |
| 1991 | 0.0294 | 0.3948 |
| 1992 | 0.0282 | 0.3785 |
| 1993 | 0.0252 | 0.3386 |
| 1994 | 0.0235 | 0.3158 |

| | | |
|---|---|---|
| 1995 | 0.0206 | 0.3158 |
| 1996 | 0.0256 | 0.2563 |
| 1997 | 0.0251 | 0.2505 |
| 1998 | 0.0237 | 0.2369 |
| 1999 | 0.0207 | 0.2067 |
| 2000 | 0.0196 | 0.1957 |
| 2001 | 0.0192 | 0.1921 |
| 2002 | 0.0173 | 0.1727 |
| 2003 | 0.0174 | 0.0864 |
| 2004 | 0.0092 | 0.0862 |
| 2005 | | 0.0835 |

### *7.3.2.2.2. Non-Dairy Cattle (CRF 4.B)*

Due to transcription errors made in previous submissions, recalculations for all years were carried out.

Tier 1 approach was used. Since 2003, the database on Western Europe's manure management systems has been used in the estimates (Figure 7.3_12 and Table 7.3_8).

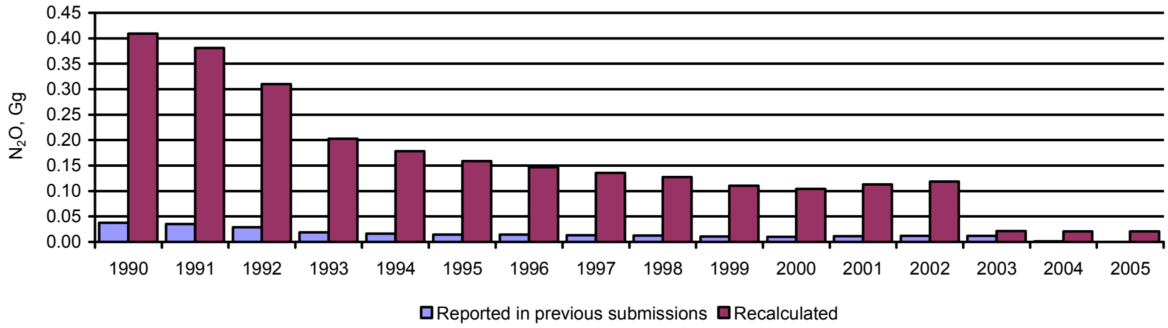



Figure 7.3_12: $N_2O$ emissions from non-dairy cattle manure management, Gg

**Table 7.3_8. $N_2O$ emissions from non-dairy cattle manure management in 1990 – 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.0379 | 0.4094 |
| 1991 | 0.0352 | 0.3810 |
| 1992 | 0.0287 | 0.3099 |
| 1993 | 0.0188 | 0.2029 |
| 1994 | 0.0165 | 0.1785 |
| 1995 | 0.0147 | 0.1587 |
| 1996 | 0.0146 | 0.1471 |
| 1997 | 0.0134 | 0.1355 |
| 1998 | 0.0127 | 0.1278 |
| 1999 | 0.0110 | 0.1106 |
| 2000 | 0.0104 | 0.1045 |
| 2001 | 0.0112 | 0.1132 |
| 2002 | 0.0118 | 0.1187 |
| 2003 | 0.0120 | 0.0216 |
| 2004 | 0.0015 | 0.0205 |
| 2005 | | 0.0211 |

### *7.3.2.3. $CH_4$ emissions from Swine Manure Management (CRF 4.B)*

There are two recalculations in the 'Methane emission from swine manure management' in the 2007 submission. In the period 1990–1995, manure management emission factors were used for warm climates. However, Estonia is a country with a cold climate, therefore recalculations were carried out (Figure 7.3_13 and Table 7.3_9).

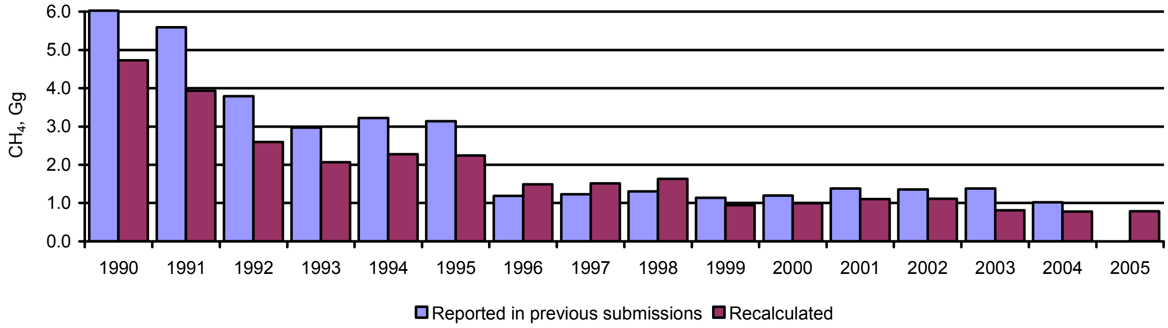



Figure 7.3_13: $CH_4$ emissions from swine manure management, Gg

**Table 7.3_9. $CH_4$ emissions from swine manure management in 1990–2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
|---|---|---|
| 1990 | 6.0193 | 4.7266 |
| 1991 | 5.5902 | 3.9294 |
| 1992 | 3.7877 | 2.5948 |
| 1993 | 2.9701 | 2.0645 |
| 1994 | 3.2186 | 2.2740 |
| 1995 | 3.1416 | 2.2415 |
| 1996 | 1.1936 | 1.4891 |
| 1997 | 1.2252 | 1.5194 |
| 1998 | 1.3056 | 1.6316 |
| 1999 | 1.1428 | 0.9488 |
| 2000 | 1.2008 | 0.9962 |
| 2001 | 1.3800 | 1.1064 |
| 2002 | 1.3632 | 1.1142 |
| 2003 | 1.3784 | 0.8080 |
| 2004 | 1.0203 | 0.7768 |
| 2005 | | 0.7885 |

### *7.3.2.4. $N_2O$ emissions from Swine Manure Management (CRF 4.B)*

Due to transcription errors made in previous submissions, $N_2O$ emission from swine manure management was recalculated for all years.

Tier 1 approach was used, taking into account the total population of pigs. Since 2003, Western Europe's manure management system has been used in the estimates (Figure 7.3_14 and Table 7.3_10).

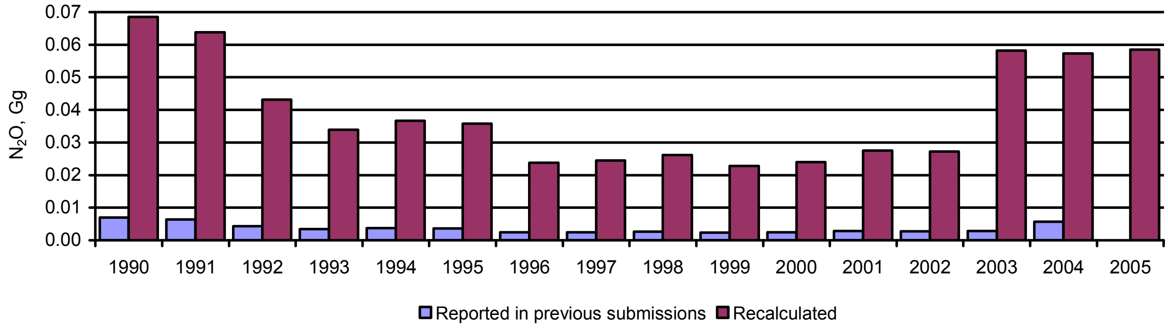



Figure 7.3_14: $N_2O$ emissions from swine manure management, Gg

**Table 7.3_10. of $N_2O$ emissions from swine manure management in 1990 – 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.0069 | 0.0686 |
| 1991 | 0.0064 | 0.0638 |
| 1992 | 0.0043 | 0.0432 |
| 1993 | 0.0034 | 0.0339 |
| 1994 | 0.0037 | 0.0367 |
| 1995 | 0.0036 | 0.0358 |
| 1996 | 0.0024 | 0.0238 |
| 1997 | 0.0024 | 0.0245 |
| 1998 | 0.0026 | 0.0261 |
| 1999 | 0.0023 | 0.0228 |
| 2000 | 0.0024 | 0.0240 |
| 2001 | 0.0028 | 0.0275 |
| 2002 | 0.0027 | 0.0272 |
| 2003 | 0.0028 | 0.0582 |
| 2004 | 0.0057 | 0.0574 |
| 2005 | | 0.0585 |

### *7.3.2.5. $CH_4$ emission from 'Other livestock' manure management (CRF 4.B)*

There is one recalculation in the "Methane emission from 'other livestock' manure management" in the 2007 submission. Manure management emissions factors (defaults) for sheep, goats and horses were used for warm climate for the years 1990 – 1995, and emission factor for developing countries were used for the estimation of $CH_4$ emission from poultry manure management. However, Estonia is a developed country with cold climate. Thus, recalculations based on cold climate emission factors in developed countries were carried out (Figure 7.3_15 and Table 7.3_11).

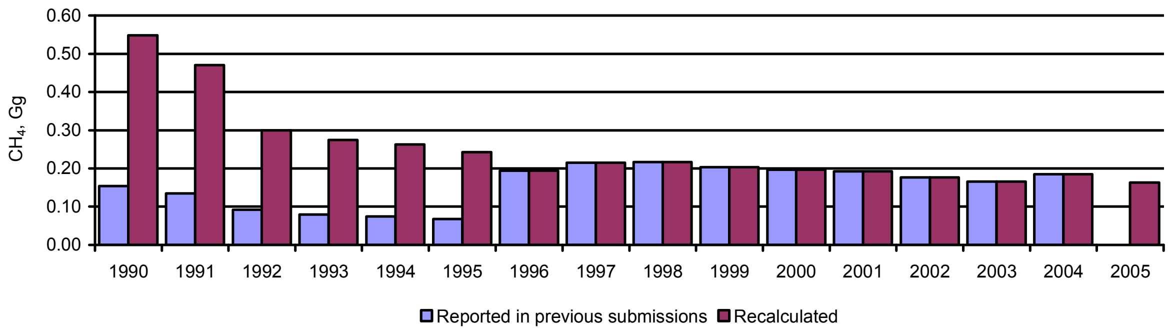



Figure 7.3_15: $CH_4$ emissions from 'other livestock' manure management, Gg

**Table 7.3_11. $CH_4$ emissions from 'other livestock' manure management in 1990 – 2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
|---|---|---|
| 1990 | 0.1541 | 0.5484 |
| 1991 | 0.1353 | 0.4700 |
| 1992 | 0.0922 | 0.2994 |
| 1993 | 0.0799 | 0.2747 |
| 1994 | 0.0744 | 0.2627 |
| 1995 | 0.0679 | 0.2429 |
| 1996 | 0.1946 | 0.1946 |
| 1997 | 0.2155 | 0.2155 |
| 1998 | 0.2167 | 0.2167 |
| 1999 | 0.2032 | 0.2032 |
| 2000 | 0.1964 | 0.1964 |
| 2001 | 0.1926 | 0.1926 |
| 2002 | 0.1771 | 0.1771 |
| 2003 | 0.1661 | 0.1661 |
| 2004 | 0.1851 | 0.1851 |
| 2005 | | 0.1630 |

### *7.3.2.6. $N_2O$ emissions from 'Other livestock' manure management (CRF 4.B)*

Due to transcription errors, recalculations were carried out for all years and for all categories of animals: sheep, goats, horses and poultry.

Tier 1 approach was used in the estimations (Figure 7.3_16 and Table 7.3_12).

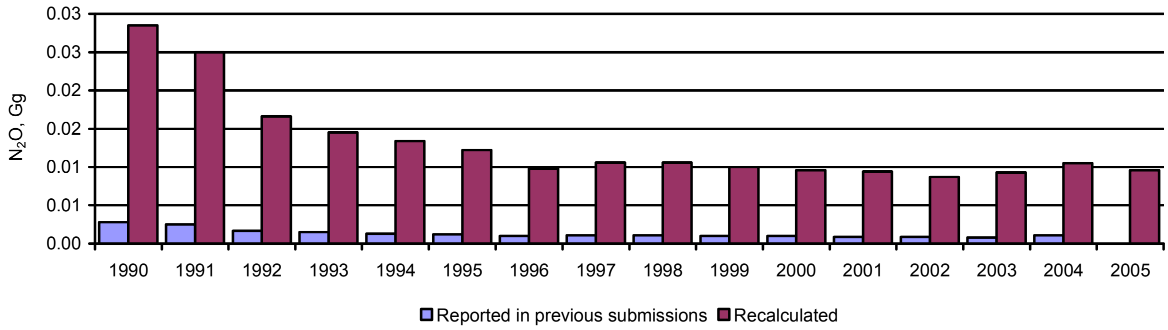



Figure 7.3_16: $N_2O$ emissions from 'other livestock' manure management in Estonia, Gg

**Table 7.3_12. $N_2O$ emissions from 'other livestock' manure management in 1990–2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.0028 | 0.0285 |
| 1991 | 0.0025 | 0.0250 |
| 1992 | 0.0017 | 0.0166 |
| 1993 | 0.0015 | 0.0145 |
| 1994 | 0.0013 | 0.0134 |
| 1995 | 0.0012 | 0.0122 |
| 1996 | 0.0010 | 0.0098 |
| 1997 | 0.0011 | 0.0106 |
| 1998 | 0.0011 | 0.0106 |
| 1999 | 0.0010 | 0.0100 |
| 2000 | 0.0010 | 0.0096 |
| 2001 | 0.0009 | 0.0094 |
| 2002 | 0.0009 | 0.0087 |

| | | |
|---|---|---|
| 2003 | 0.0008 | 0.0093 |
| 2004 | 0.0011 | 0.0105 |
| 2005 | | 0.0096 |

### *7.3.2.7. The Total $N_2O$ emissions from Manure Management (CRF 4.B)*

The total $N_2O$ emissions from Estonia's livestock manure management are presented in Figure 7.3_17 and in Table 7.3_13. The main recalculations were carried out due to transcription errors made in previous submissions.

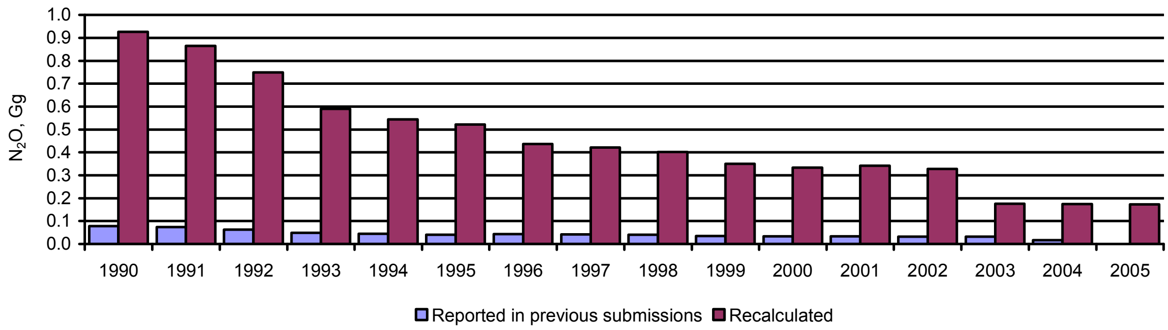



Figure 7.3_17: $N_2O$ emissions from livestock manure management in Estonia, Gg

**Table 7.3_13. $N_2O$ emissions from livestock manure management in 1990 - 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.0788 | 0.9258 |
| 1991 | 0.0735 | 0.8645 |
| 1992 | 0.0628 | 0.7483 |
| 1993 | 0.0488 | 0.5900 |
| 1994 | 0.0450 | 0.5445 |
| 1995 | 0.0401 | 0.5226 |
| 1996 | 0.0436 | 0.4370 |
| 1997 | 0.0419 | 0.4211 |
| 1998 | 0.0400 | 0.4013 |
| 1999 | 0.0349 | 0.3501 |
| 2000 | 0.0333 | 0.3338 |
| 2001 | 0.0341 | 0.3422 |
| 2002 | 0.0326 | 0.3273 |
| 2003 | 0.0330 | 0.1755 |
| 2004 | 0.0175 | 0.1747 |
| 2005 | | 0.1726 |

## 7.3.3. Agricultural Soils (4.D)

### *7.3.3.1. Direct Soil Emissions (CRF 4.D.1)*

#### *7.3.3.1.1. Synthetic Fertilizers (CRF 4.D.1.1)*

There is one recalculation in the 'Synthetic Fertilizers' in the 2007 submission. Recalculation was carried out based on updated activity data (Figure 7.3_18 and Table 7.3_14).

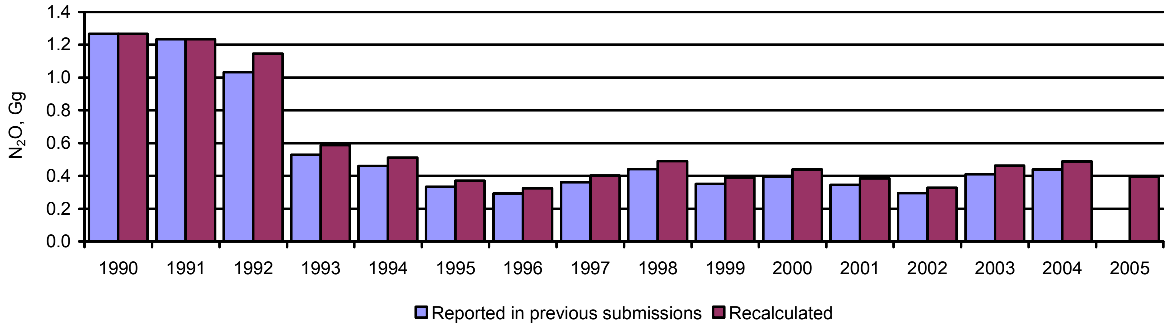



Figure 7.3_18: $N_2O$ emissions from animal manure applied to soils in Estonia, Gg

**Table 7.3_14. $N_2O$ emissions from animal manure applied to soils in 1990 – 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 1.2676 | 1.2676 |
| 1991 | 1.2340 | 1.2340 |
| 1992 | 1.0317 | 1.1464 |
| 1993 | 0.5295 | 0.5883 |
| 1994 | 0.4608 | 0.5121 |
| 1995 | 0.3342 | 0.3713 |
| 1996 | 0.2928 | 0.3253 |
| 1997 | 0.3619 | 0.4021 |
| 1998 | 0.4408 | 0.4897 |
| 1999 | 0.3517 | 0.3908 |
| 2000 | 0.3959 | 0.4399 |
| 2001 | 0.3466 | 0.3851 |
| 2002 | 0.2952 | 0.3280 |
| 2003 | 0.4111 | 0.4627 |
| 2004 | 0.4390 | 0.4878 |
| 2005 | | 0.3945 |

### *7.3.3.1.2. Animal Manure Applied to Soils (CRF 4.D.1.2)*

As transcription errors were made in the process of the estimation of Nitrogen excretion by livestock, $N_2O$ emissions from animal manure applied to soils were estimated incorrectly.

Thus, there is one recalculation in the 'Animal manure applied to soils' in the 2007 submission. Correct activity data were used (Figure 7.3_19 and Table 7.3_15).

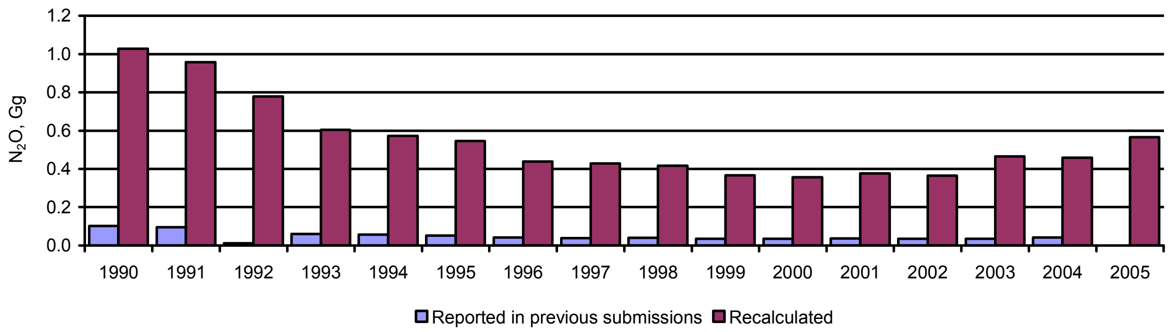



Figure 7.3_19: $N_2O$ emissions from animal manure applied to soils in Estonia, Gg

**Table 7.3_15. $N_2O$ emissions from animal manure applied to soils in 1990 – 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.1030 | 1.0274 |
| 1991 | 0.0960 | 0.9570 |
| 1992 | 0.0125 | 0.7778 |
| 1993 | 0.0608 | 0.6054 |
| 1994 | 0.0574 | 0.5722 |
| 1995 | 0.0520 | 0.5461 |
| 1996 | 0.0426 | 0.4387 |
| 1997 | 0.0393 | 0.4283 |
| 1998 | 0.0406 | 0.4170 |
| 1999 | 0.0357 | 0.3662 |
| 2000 | 0.0348 | 0.3570 |
| 2001 | 0.0367 | 0.3760 |
| 2002 | 0.0355 | 0.3643 |
| 2003 | 0.0357 | 0.4645 |
| 2004 | 0.0416 | 0.4593 |
| 2005 | | 0.5656 |

### *7.3.3.1.3. N-fixing crops (CRF 4.D.1.3)*

$N_2O$ emissions from N-fixing crops are negligible. However, recalculations were carried out. The updated activities data were used (Figure 7.3_20 and Table 7.3_16).

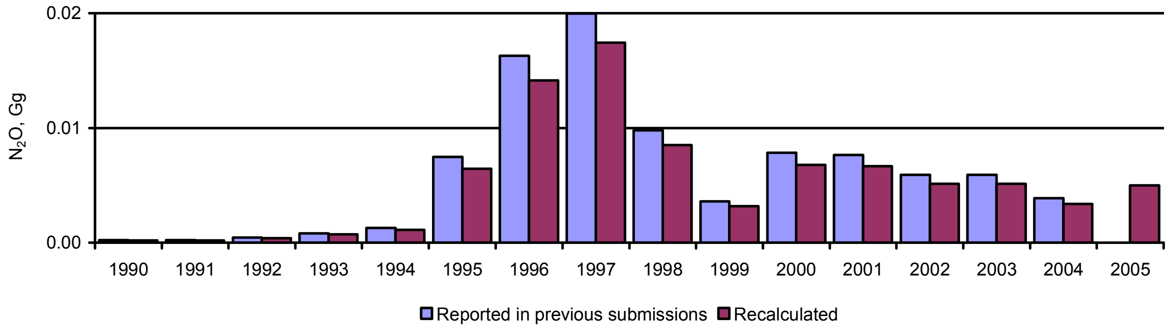



Figure 7.3_20: $N_2O$ emissions from N-fixing crops in Estonia, Gg

**Table 7.3_16. $N_2O$ emissions from N-fixing crops in 1990 – 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.0002 | 0.0002 |
| 1991 | 0.0002 | 0.0002 |
| 1992 | 0.0004 | 0.0004 |
| 1993 | 0.0008 | 0.0007 |
| 1994 | 0.0013 | 0.0011 |
| 1995 | 0.0075 | 0.0065 |
| 1996 | 0.0163 | 0.0141 |
| 1997 | 0.0200 | 0.0174 |
| 1998 | 0.0098 | 0.0085 |
| 1999 | 0.0036 | 0.0032 |
| 2000 | 0.0078 | 0.0068 |
| 2001 | 0.0077 | 0.0067 |
| 2002 | 0.0059 | 0.0051 |
| 2003 | 0.0059 | 0.0051 |
| 2004 | 0.0039 | 0.0034 |

| | | |
|---|---|---|
| 2005 | | 0.0050 |

### *7.3.3.1.4. Crop Residues (CRF 4.D.1.3)*

There is one recalculation in the 'Crop Residues' in the 2007 submission. The updated activity data were used (Figure 7.3_21 and Table 7.3_17).

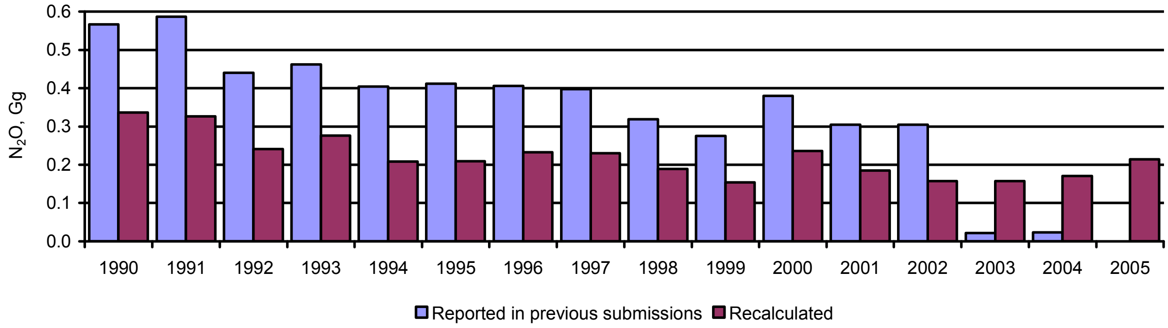



Figure 7.3_21: $N_2O$ emissions from crop residues in Estonia in 1990 – 2005, Gg

**Table 7.3_17. $N_2O$ emissions from crop residues in 1990 – 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emission of $N_2O$ |
|---|---|---|
| 1990 | 0.5662 | 0.3364 |
| 1991 | 0.5866 | 0.3268 |
| 1992 | 0.4401 | 0.2407 |
| 1993 | 0.4613 | 0.2761 |
| 1994 | 0.4038 | 0.2080 |
| 1995 | 0.4113 | 0.2092 |
| 1996 | 0.4058 | 0.2330 |
| 1997 | 0.3976 | 0.2300 |
| 1998 | 0.3192 | 0.1895 |
| 1999 | 0.2749 | 0.1544 |
| 2000 | 0.3800 | 0.2361 |
| 2001 | 0.3050 | 0.1851 |
| 2002 | 0.3050 | 0.1576 |
| 2003 | 0.0222 | 0.1574 |
| 2004 | 0.0234 | 0.1710 |
| 2005 | | 0.2146 |

### *7.3.3.2. Pasture, Range and Paddock Manure (CRF 4.D.2)*

As transcription errors were made in the process of the estimations of Nitrogen excretion by animals, recalculations to estimate $N_2O$ emissions from 'Pasture, range and paddock manure' were carried out.

Since 2003, Estonia has used Western Europe's manure management system (Figure 7.3_22 and Table 7.3_18).

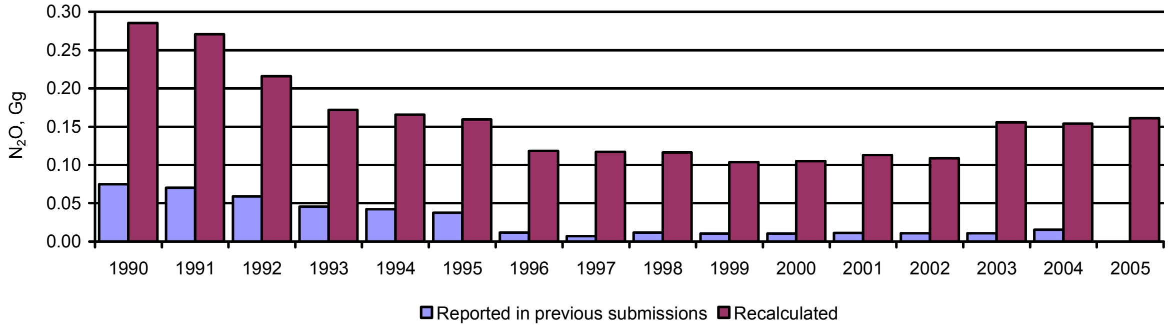



Figure 7.3_22: $N_2O$ emissions from pasture of livestock in Estonia, Gg

**Table 7.3_18. $N_2O$ emissions from pasture of livestock in 1990–2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.0752 | 0.2853 |
| 1991 | 0.0706 | 0.2705 |
| 1992 | 0.0593 | 0.2157 |
| 1993 | 0.0455 | 0.1722 |
| 1994 | 0.0422 | 0.1658 |
| 1995 | 0.0378 | 0.1594 |
| 1996 | 0.0118 | 0.1182 |
| 1997 | 0.0072 | 0.1171 |
| 1998 | 0.0116 | 0.1161 |
| 1999 | 0.0104 | 0.1037 |
| 2000 | 0.0105 | 0.1049 |
| 2001 | 0.0113 | 0.1129 |
| 2002 | 0.0109 | 0.1089 |
| 2003 | 0.0110 | 0.1559 |
| 2004 | 0.0154 | 0.1541 |
| 2005 | | 0.1611 |

### *7.3.3.3 Indirect Emissions (CRF 4.D.3)*

#### *7.3.3.3.1. Atmospheric Deposition (CRF 4.D.3.1)*

There are two recalculations in the ‘Atmospheric deposition’ in the 2007 submission. Activity data on synthetic fertilizers used were updated and transcription errors were corrected, it changed the amounts of $N_2O$ emitted from atmospheric deposition in the years 1990 – 2004 (Figure 7.3_23 and Table 7.3_19).

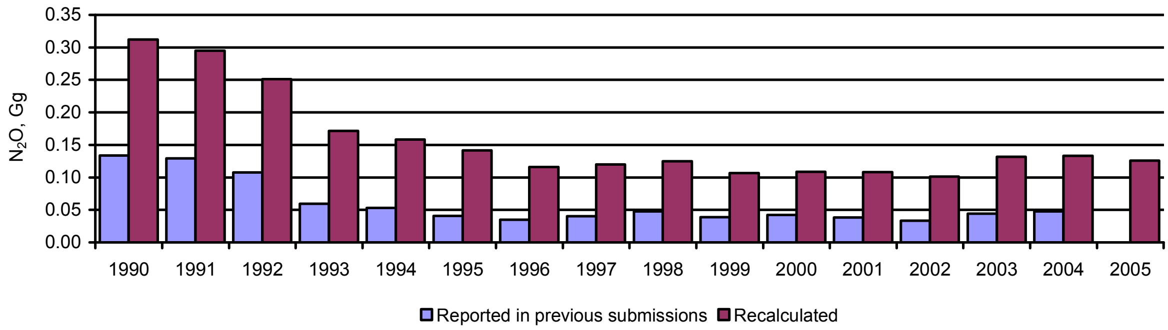



Figure 7.3_23: $N_2O$ emissions from atmospheric deposition in Estonia, Gg

**Table 7.3_19. $N_2O$ emissions from atmospheric deposition in 1990 - 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.1338 | 0.3122 |
| 1991 | 0.1294 | 0.2950 |
| 1992 | 0.1077 | 0.2513 |
| 1993 | 0.0595 | 0.1713 |
| 1994 | 0.0527 | 0.1583 |
| 1995 | 0.0404 | 0.1417 |
| 1996 | 0.0348 | 0.1160 |
| 1997 | 0.0402 | 0.1200 |
| 1998 | 0.0475 | 0.1247 |
| 1999 | 0.0386 | 0.1064 |
| 2000 | 0.0423 | 0.1084 |
| 2001 | 0.0383 | 0.1079 |
| 2002 | 0.0335 | 0.1010 |
| 2003 | 0.0439 | 0.1318 |
| 2004 | 0.0476 | 0.1332 |
| 2005 | | 0.1258 |

### *7.3.3.3.2. Nitrogen Leaching and Run-off (CRF 4.D.3.2)*

There are two recalculations in the 'Nitrogen Leaching and Run-off' in the 2007 submission. The recalculations were carried out as activity data on synthetic fertilizers used were updated and nitrogen excretion by livestock was recalculated (Figure 7.3_24 and Table 7.3_20).

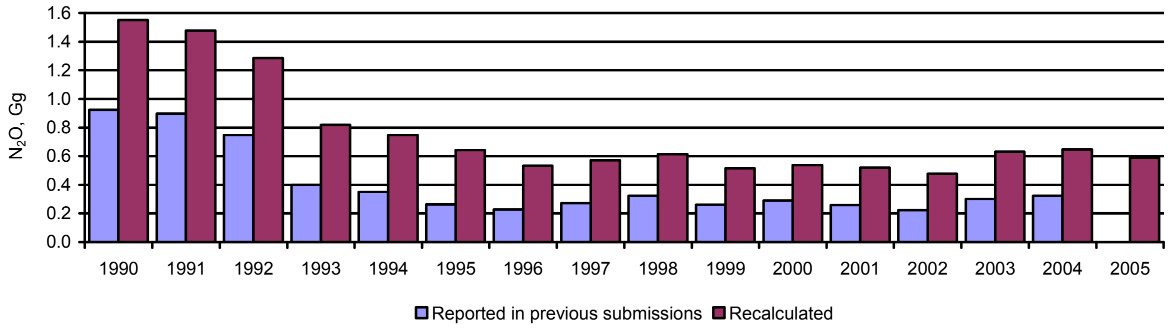



Figure 7.3_24: $N_2O$ emissions from nitrogen leaching and run-off in Estonia, Gg

**Table 7.3_20. $N_2O$ emissions from nitrogen leaching and run-off in 1990 – 2005, Gg**

| | Reported emissions of $N_2O$ in 1990 – 2004 | Recalculated emissions of $N_2O$ |
|---|---|---|
| 1990 | 0.9243 | 1.5509 |
| 1991 | 0.8965 | 1.4765 |
| 1992 | 0.7478 | 1.2861 |
| 1993 | 0.3997 | 0.8187 |
| 1994 | 0.3514 | 0.7473 |
| 1995 | 0.2628 | 0.6429 |
| 1996 | 0.2280 | 0.5326 |
| 1997 | 0.2715 | 0.5707 |
| 1998 | 0.3251 | 0.6146 |
| 1999 | 0.2619 | 0.5162 |
| 2000 | 0.2907 | 0.5386 |
| 2001 | 0.2592 | 0.5203 |
| 2002 | 0.2241 | 0.4770 |
| 2003 | 0.3016 | 0.6314 |

| | | |
|---|---|---|
| 2004 | 0.3247 | 0.6460 |
| 2005 | | 0.5902 |

### 7.3.4. Total emissions of $CO_2$ equiv. from Agriculture (CRF 4)

As recalculations were carried out for almost all sub-sectors, the total emissions are presented in Figure 7.3_25 and in Table 7.3_21.

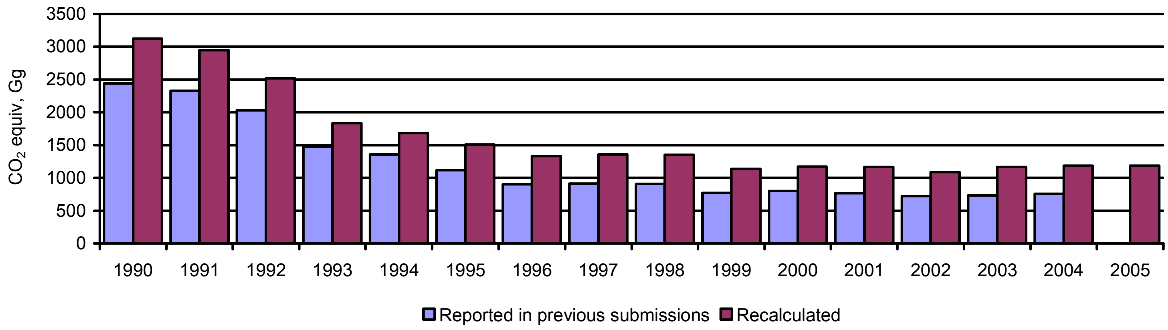



Figure 7.3_25: $CO_2$ equiv. emissions from agriculture in Estonia, Gg

**Table 7.3_21. $CO_2$ equiv. emissions from agriculture in 1990 – 2005, Gg**

| | Reported emissions of $CO_2$ equiv. in 1990 – 2004 | Recalculated emissions of $CO_2$ equiv. |
|---|---|---|
| 1990 | 2,440.4 | 3,124.4 |
| 1991 | 2,327.6 | 2,948.7 |
| 1992 | 2,029.5 | 2,519.5 |
| 1993 | 1,480.5 | 1,837.7 |
| 1994 | 1,358.1 | 1,681.5 |
| 1995 | 1,116.7 | 1,506.4 |
| 1996 | 904.1 | 1,331.6 |
| 1997 | 913.0 | 1,355.4 |
| 1998 | 907.1 | 1,353.5 |
| 1999 | 770.9 | 1,136.5 |
| 2000 | 804.0 | 1,172.2 |
| 2001 | 768.9 | 1,168.3 |
| 2002 | 722.8 | 1,090.9 |
| 2003 | 732.3 | 1,168.3 |
| 2004 | 757.9 | 1,186.2 |
| 2005 | | 1,187.0 |

## 7.4 LULUCF (CRF 5)

Only one recalculation was carried out in the 'LULUCF' sector. However Estonia will continue to improve the estimation of GHG emissions and removals in the future.

### 7.4.1 Forest fires (CRF 5.A.1)

There is one recalculation in the 'Forest Fires' in the 2007 submission. Activity data on forest land area were updated (Figures 7.4_1, 7.4_2 and Table 7.4_1) and average combustion factor (for boreal forest) was used. It changed the emissions of $CO_2$ and $CH_4$ into the atmosphere in 1990 – 2004.

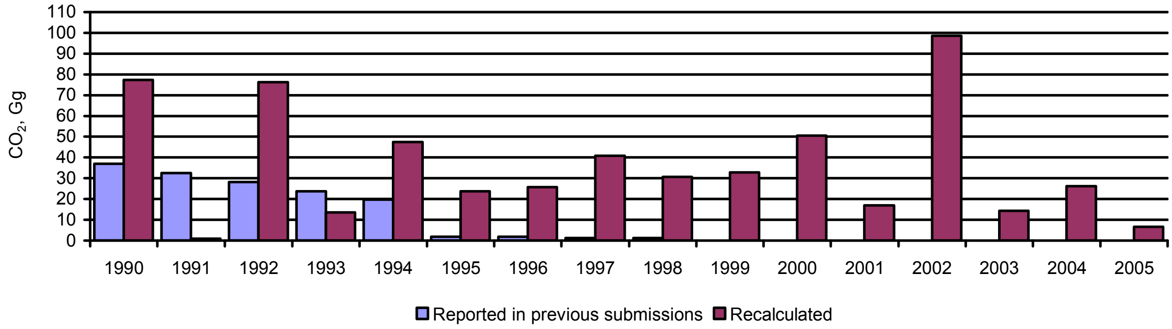



Figure 7.4_1: $CO_2$ emissions from forest fires in Estonia, Gg

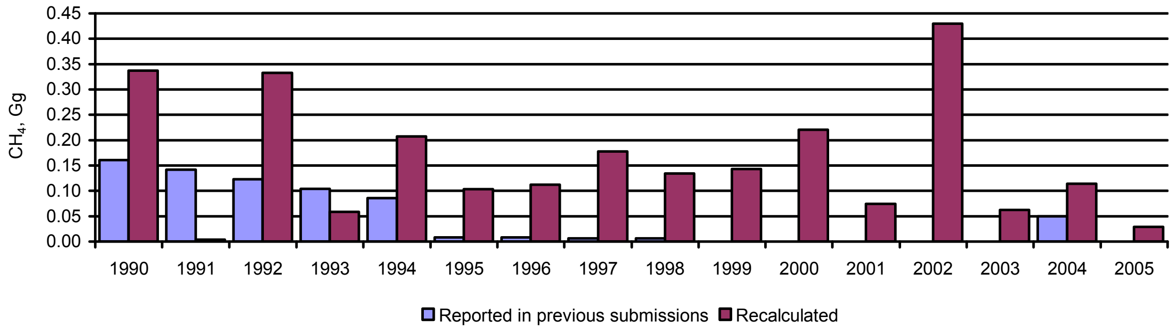



Figure 7.4_2: $CH_4$ emissions from forest fires in Estonia, Gg

**Table 7.4_1. $CO_2$ and $CH_4$ emissions from forest fires in 1990 – 2005, Gg**

| | $CO_2$ | | $CH_4$ | |
|---|---|---|---|---|
| | Reported emissions of $CO_2$ in 1990 – 2004 | Recalculated emissions of $CO_2$ | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
| 1990 | 36.956 | 77.3041 | 0.161 | 0.3373 |
| 1991 | 32.565 | 0.9185 | 0.142 | 0.0040 |
| 1992 | 28.175 | 76.2124 | 0.123 | 0.3326 |
| 1993 | 23.784 | 13.4989 | 0.104 | 0.0589 |
| 1994 | 19.759 | 47.5085 | 0.086 | 0.2073 |
| 1995 | 1.796 | 23.6639 | 0.008 | 0.1033 |
| 1996 | 1.892 | 25.7021 | 0.008 | 0.1122 |
| 1997 | 1.262 | 40.7878 | 0.006 | 0.1780 |
| 1998 | 1.290 | 30.7265 | 0.006 | 0.1341 |
| 1999 | 0 | 32.8052 | 0 | 0.1431 |
| 2000 | 0 | 50.5352 | 0 | 0.2205 |
| 2001 | 0 | 16.9851 | 0 | 0.0741 |
| 2002 | 0 | 98.5497 | 0 | 0.4300 |
| 2003 | 0 | 14.3263 | 0 | 0.0625 |
| 2004 | 0 | 26.1760 | 0.050 | 0.1142 |
| 2005 | | 6.6491 | | 0.0290 |

## 7.5 Waste (CRF 6)

### 7.5.1 $CH_4$ emissions from Municipal Waste Disposed (CRF 6.A.1)

The recalculations on $CH_4$ emission were carried out in the 2006 submission. However, the data are once again presented in this paper (Figure 7.5_1 and Table 7.5_1).

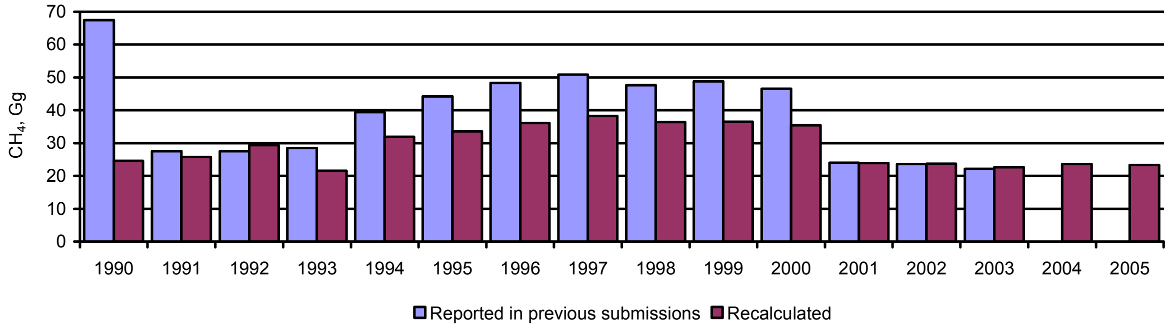



Figure 7.5_1: $CH_4$ emissions from municipal waste disposed in Estonia, Gg

**Table 7.5_1. $CH_4$ emissions from municipal waste disposed in 1990 – 2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
|---|---|---|
| 1990 | 67.4307 | 24.5616 |
| 1991 | 27.5186 | 25.7516 |
| 1992 | 27.5186 | 29.4168 |
| 1993 | 28.4772 | 21.5587 |
| 1994 | 39.4222 | 31.8832 |
| 1995 | 44.1837 | 33.5594 |
| 1996 | 48.3160 | 36.1309 |
| 1997 | 50.8313 | 38.3153 |
| 1998 | 47.5973 | 36.4080 |
| 1999 | 48.7652 | 36.5262 |
| 2000 | 46.5193 | 35.4632 |
| 2001 | 23.9770 | 23.9096 |
| 2002 | 23.5974 | 23.7074 |
| 2003 | 22.1422 | 22.6645 |
| 2004 | | 23.6776 |
| 2005 | | 23.3091 |

### 7.5.2 $CH_4$ emissions from Industrial Wastewater Treatment (CRF 6.B.1)

There are two recalculations in the 'Methane emission from Industrial Wastewater Treatment' in the 2007 submission. Activity data on production output were updated and the degradable organic component used was other than in the previous submissions (Figure 7.5_2 and Table 7.5_2).

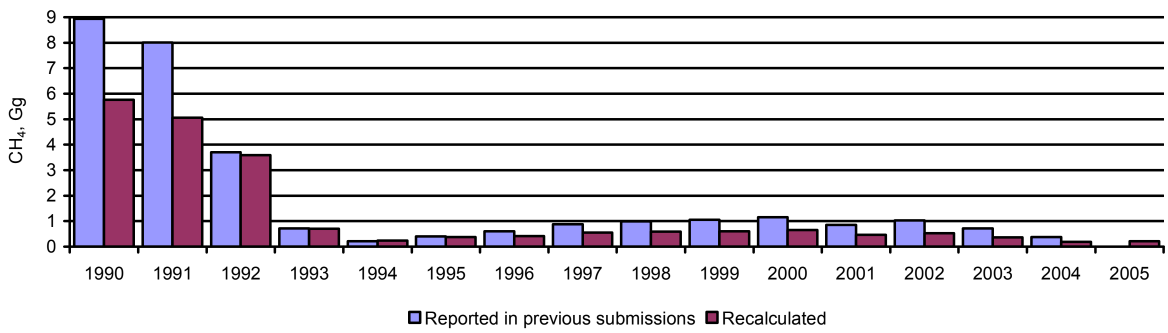



Figure 7.5_2: $CH_4$ emissions from industrial wastewater treatment in Estonia, Gg

**Table 7.5_2. $CH_4$ emissions from industrial wastewater treatment in 1990 – 2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emission of $CH_4$ |
|---|---|---|
| 1990 | 8.94 | 5.7632 |
| 1991 | 8.01 | 5.0618 |
| 1992 | 3.7 | 3.5928 |
| 1993 | 0.72 | 0.7032 |
| 1994 | 0.21 | 0.2420 |
| 1995 | 0.4 | 0.3732 |
| 1996 | 0.6 | 0.4198 |
| 1997 | 0.88 | 0.5545 |
| 1998 | 0.99 | 0.5937 |
| 1999 | 1.05 | 0.6076 |
| 2000 | 1.16 | 0.6487 |
| 2001 | 0.85 | 0.4692 |
| 2002 | 1.03 | 0.5238 |
| 2003 | 0.72 | 0.3676 |
| 2004 | 0.38 | 0.1870 |
| 2005 | | 0.2098 |

### 7.5.3 CH4 emissions from Domestic and Commercial Wastewater Treatment (CRF 6.B.2)

The recalculations on 'Methane emissions from domestic and commercial wastewater treatment' were carried out in the 2006 submissions. The reason for the recalculations was the improvement in activity data (Figure 7.5_3 and Table 7.5_3).

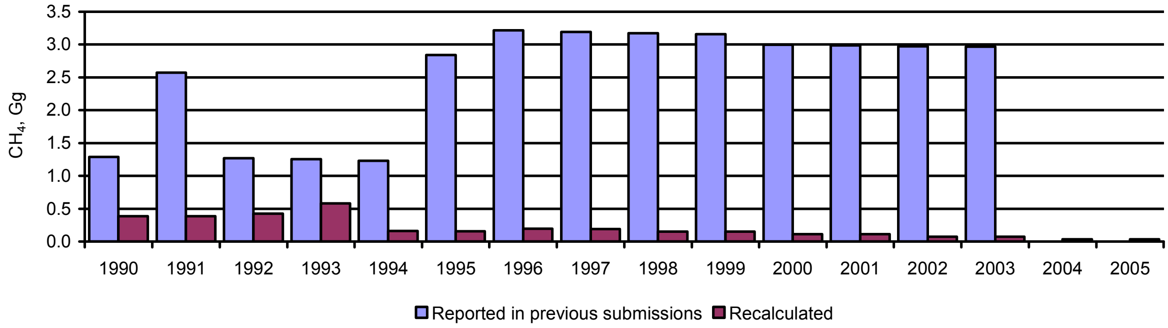



Figure 7.5_3: $CH_4$ emissions from domestic and commercial wastewater treatment in Estonia, Gg

**Table 7.5_3. $CH_4$ emissions from domestic and commercial wastewater treatment in 1990 – 2005, Gg**

| | Reported emissions of $CH_4$ in 1990 – 2004 | Recalculated emissions of $CH_4$ |
|---|---|---|
| 1990 | 1.2902 | 0.3870 |
| 1991 | 2.5727 | 0.3860 |
| 1992 | 1.2681 | 0.4260 |
| 1993 | 1.2534 | 0.5790 |
| 1994 | 1.2313 | 0.1620 |
| 1995 | 2.8436 | 0.1590 |
| 1996 | 3.2176 | 0.1950 |
| 1997 | 3.1930 | 0.1920 |
| 1998 | 3.1749 | 0.1530 |
| 1999 | 3.1588 | 0.1510 |
| 2000 | 2.9987 | 0.1130 |
| 2001 | 2.9874 | 0.1120 |
| 2002 | 2.9754 | 0.0750 |
| 2003 | 2.9697 | 0.0740 |

| | | |
|---|---|---|
| 2004 | | 0.0370 |
| 2005 | | 0.0370 |

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# ANNEX 1. Emission Factors of non- $CO_2$ Gases from Fuel Combustion

The $CH_4$, $N_2O$, CO and NMVOC emission factors used in the Estonian inventory are mainly taken from the Revised 1996 IPCC Guidelines, but some emission factors and new data from national research were used.

***$CH_4$ from fuel combustion (kg/TJ)***

| | Coal | Natural Gas | Oil | Wood | Peat/ Briquette |
|---|---|---|---|---|---|
| Energy Industries | 1 | 1 | 3 | 30 | 30 |
| Manufacturing | 10 | 5 | 2 | 30 | 30 |
| Transport | | | | | |
| *Domestic Aviation* | | | 2 | | |
| *Road* | | 50 | 20/5* | | |
| *Railways* | 10 | | 5 | | |
| *National Navigation* | 10 | | 5 | | |
| Commercial | 10 | 5 | 10 | 300 | 300 |
| Residential | 300 | 5 | 10 | 300 | 300 |
| Agriculture | | | | | |
| *Stationary* | 300 | 5 | 10 | 300 | 300 |
| *Mobile* | | 5 | 5 | | |

**Gasoline/Diesel*
*Source: IPCC96 Default value*

***$N_2O$ from fuel combustion (kg/TJ)***

| | Coal | Natural Gas | Oil | Wood | Peat/ Briquette |
|---|---|---|---|---|---|
| Energy Industries | 1.0 | 0.1 | 0.6 | 4 | 4 |
| Manufacturing | 1.4 | 0.1 | 0.6 | 4 | 4 |
| Transport | | | | | |
| *Domestic Aviation* | | | 2 | | |
| *Road* | | 0.1 | 0.6/0.6* | | |
| *Railways* | 1.4 | | 0.6 | | |
| *National Navigation* | 1.4 | | 0.6 | | |
| Commercial | 1.4 | 0.1 | 0.6 | 4 | 4 |
| Residential | 1.4 | 0.1 | 0.6 | 4 | 4 |
| Agriculture | | | | | |
| *Stationary* | 1.4 | 0.1 | 0.6 | 4 | 4 |
| *Mobile* | | 0.1 | 0.6 | | |

**Gasoline/Diesel*
*Source: IPCC96 Default value*

***NOx from fuel combustion (kg/TJ)***

| | ***Coal*** | ***Natural Gas*** | ***Oil*** | ***Wood*** | ***Oil Shale***** | ***Peat/ Briquette*** |
|---|---|---|---|---|---|---|
| Energy Industries | 300 | 150 | 200 | 100 | 110 | 100 |
| Manufacturing and Construction | 300 | 150 | 200 | 100 | 110 | 100 |
| Transport | | | | | | |
| *Domestic Aviation* | | | 300 | | | |
| *Road* | | 600 | 600/800* | | | |
| *Railways* | 300 | | 1200 | | | |
| *National Navigation* | 300 | | 1500 | | | |
| Commercial | 100 | 50 | 100 | 100 | 110 | 100 |
| Residential | 100 | 50 | 100 | 100 | 110 | 100 |
| Agriculture | 100 | 50 | 100 | 100 | 110 | 100 |
| *Stationary* | | | | | | |
| *Mobile* | | 1000 | 1200 | | | |

**Gasoline/Diesel*
*Source: IPCC96 Default value and*
*** Country specific*

***CO from fuel combustion (kg/TJ)***

| | ***Coal*** | ***Natural Gas*** | ***Oil*** | ***Wood*** | ***Oil Shale***** | ***Peat/ Briquette*** |
|---|---|---|---|---|---|---|
| Energy Industries | 20 | 20 | 15 | 1000 | 26 | 1000 |
| Manufacturing and Construction | 150 | 30 | 10 | 2000 | 87 | 4000 |
| Transport | | | | | | |
| *Domestic Aviation* | | | 100 | | | |
| *Road* | | 400 | 800/1000* | | | |
| *Railways* | 150 | | 1000 | | | |
| *National Navigation* | | | | | | |
| Commercial | 2000 | 50 | 20 | 5000 | 87 | 5000 |
| Residential | 2000 | 50 | 20 | 5000 | 87 | 5000 |
| Agriculture | | | | | | |
| *Stationary* | 2000 | 50 | 20 | 5000 | 87 | 5000 |
| *Mobile* | | 400 | 1000 | | | |

**Gasoline/Diesel*
*Source: IPCC96 Default value*
*** Country specific*

***NMVOC from fuel combustion (kg/TJ)***

| | ***Coal*** | ***Natural Gas*** | ***Oil*** | ***Wood*** | ***Oil Shale*** | ***Peat/ Briquette*** |
|---|---|---|---|---|---|---|
| Energy Industries | 5 | 5 | 5 | 50 | 60 | 50 |
| Manufacturing and Construction | 20 | 5 | 5 | 50 | 50 | 50 |
| Transport | | | | | | |
| *Domestic Aviation* | | | 50 | | | |
| *Road* | | 5 | 1500/200* | | | |
| *Railways* | 20 | | 200 | | | |
| *National Navigation* | 20 | | 200 | | | |
| Commercial | 200 | 5 | 5 | 600 | | 600 |
| Residential | 200 | 5 | 5 | 600 | | 600 |
| Agriculture | | | | | | |
| *Stationary* | 200 | 5 | 5 | 600 | | 600 |
| *Mobile* | | 5 | 200 | | | |

**Gasoline/Diesel*
*Source: IPCC96 Default value*

# ANNEX 2. Description of the Individual Source Category Checklists of the sectors Energy, Industrial processes, Agriculture, LULUCF and Waste

## Table A. Tier 1: Individual Source Category Checklist – $CO_2$, $N_2O$ and $CH_4$ emissions from Fuel Combustion

**Inventory Report:** 1990 - 2005
**Source/Sink Category:** **Fuel Combustion Activities**
**Estimates prepared by:** Inge Roos (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | I. Roos | 10.03.2007 | Check that the description of activity data, emission factors is properly recorded and archived. | The description of activity data, emissions factors and methodology used is recorded in the internal documentation and archived. | none |
| Check for transcription errors in data input and reference | Confirm that bibliographical data references are properly cited in the internal documentation. | I. Roos | 10.03.2007 | Check that all bibliographical data references are cited and documented. | Activity data and emission factors are cited to references and documented in the internal documentation and the Reporter. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | I. Roos | 10.03.2007 | Check for transcription errors. | No transcription errors were noted. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | I. Roos | 10.03.2007 | $CO_2$ emission from combustion of fuels for Public electricity and heat has been calculated using figures of 2005. | The value calculated was 11451.969 Gg; the value of $CO_2$ emission from Public electricity and heat reported in the Reporter was 11451.969 Gg. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | I. Roos | 10.03.2007 | The check was not undertaken. | | |
| Check that parameter and emission units are correctly recorded and that | Check that units are properly labeled in calculation sheets. | I. Roos | 10.03.2007 | Check that units correctly used and properly reported. | There are correct units used in tables. | none |
| | Check that units are correctly carried through from beginning to end of calculations. | I. Roos | 10.03.2007 | Check that units are used properly. | Correct SI units used to estimate $CO_2$, $CH_4$ and $N_2O$ emissions from Energy are reported correctly. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| appropriate conversion factors are used. | Check that conversion factors are correct. | I. Roos | 10.03.2007 | Check that conversion factors used are correct. | Conversion factors used for the estimation of $CO_2$ emissions are correct. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | I. Roos | 10.03.2007 | Check that all required data processing steps are properly represented. | All steps needed for data processing are represented properly and documented. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | I. Roos | 10.03.2007 | Check that data fields are properly labeled. | The data fields are correctly labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | I. Roos | 10.03.2007 | Check that documentation of database is archived. | All required documentation of database has been archived by the expert. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | I. Roos | 10.03.2007 | Check for consistency in dataset related to the estimation of $CO_2$, $CH_4$ and $N_2O$ emissions from Energy sector are reported correctly | Emission factors are consistent. | none |
| Check that the movement of inventory data among processing | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | I. Roos | 10.03.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| steps is correct. | Check that emissions data are correctly transcribed between different intermediate products. | I. Roos | 10.03.2007 | The check was not undertaken. | | |
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | I. Roos | 10.03.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and is archived. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | I. Roos | 10.03.2007 | Check that all data required to estimate $N_2O$ emissions from human sewage are documented and archived. | Activity and supporting data, emission factors are documented and archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | I. Roos | 10.03.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | I. Roos | 10.03.2007 | Check for consistency in input data by looking at graphs in the Reporter. | Input data and $N_2O$ emissions are consistent for years 1990 – 2005. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | I. Roos | 10.03.2007 | Check for consistency in the algorithm used. | The method used to estimate $N_2O$ emissions from human sewage has been taken from the IPCC Guidelines. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | I. Roos | 10.03.2007 | Run completeness check. | The test passed. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | I. Roos | 10.03.2007 | N/A | N/A | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | I. Roos | 10.03.2007 | Inventories/$N_2O$ emissions from human sewage were compared in order to trace for significant changes in 1990 – 2005. | No significant changes in $N_2O$ emissions from human sewage for years 1990 – 2005 were noted. | none |

# Table B. Tier 1: Individual Source Category Checklist – $CO_2$, and $CH_4$ emissions from Industrial Processes Sector

**Inventory Report:** 1990 - 2005
**Source/Sink Category:** **Industrial Processes**
**Estimates prepared by:** Inge Roos (Tallinn University of Technology) with the data from Estonian Statistical Office and from the ammonia production factory AS Nitrofert; cement production factory AS Kunda Nordic Cement and Lime production factory AS Nordkalk

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | I. Roos | 10.03.2007 | Check that the description of activity data, emission factors is properly recorded and archived. | The description of activity data, emissions factors and methodology used is recorded in the internal documentation and archived. | none |
| Check for transcription errors in data input and reference | Confirm that bibliographical data references are properly cited in the internal documentation. | I. Roos | 10.03.2007 | Check that all bibliographical data references are cited and documented. | Activity data and emission factors are cited to references and documented in the internal documentation and the Reporter. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | I. Roos | 10.03.2007 | Check for transcription errors. | No transcription errors were noted. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | I. Roos | 10.03.2007 | $CO_2$ emission from cement production has been calculated using figures of 2005. | The value calculated was 372.827Gg; the value of $CO_2$ emission from cement production (2.A.1) in the Reporter was 372.827Gg. The test passed. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | I. Roos | 10.03.2007 | The check was not undertaken. | | |
| Check that parameter and emission units are correctly recorded and that | Check that units are properly labeled in calculation sheets. | I. Roos | 10.03.2007 | Check that units correctly used and properly reported. | There are correct units used in tables. | none |
| | Check that units are correctly carried through from beginning to end of calculations. | I. Roos | 10.03.2007 | Check that units are used properly. | Correct SI units used to estimate $CO_2$, and $CH_4$ emissions from Industrial Processes sector are reported correctly. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| appropriate conversion factors are used. | Check that conversion factors are correct. | I. Roos | 10.03.2007 | Check that conversion factors used are correct. | Conversion factors used for the estimation of $CO_2$ emissions are correct. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | I. Roos | 10.03.2007 | Check that all required data processing steps are properly represented. | All steps needed for data processing are represented properly and documented. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | I. Roos | 10.03.2007 | Check that data fields are properly labeled. | The data fields are correctly labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | I. Roos | 10.03.2007 | Check that documentation of database is archived. | All required documentation of database has been archived by the expert. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | I. Roos | 10.03.2007 | Check for consistency in dataset related to the estimation of $CO_2$ and $CH_4$ emissions from Industrial Processes sector are reported correctly | Emission factors are consistent. | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | I. Roos | 10.03.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | I. Roos | 10.03.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | I. Roos | 10.03.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and is archived. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | I. Roos | 10.03.2007 | Check that all data required to estimate $N_2O$ emissions from human sewage are documented and archived. | Activity and supporting data, emission factors are documented and archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | I. Roos | 10.03.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | I. Roos | 10.03.2007 | Check for consistency in input data by looking at graphs in the Reporter. | Input data and $N_2O$ emissions are consistent for years 1990 – 2005. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | I. Roos | 10.03.2007 | Check for consistency in the algorithm used. | The method used to estimate $N_2O$ emissions from human sewage has been taken from the IPCC Guidelines. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | I. Roos | 10.03.2007 | Run completeness check. | The test passed. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | I. Roos | 10.03.2007 | N/A | N/A | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | I. Roos | 10.03.2007 | Inventories/$N_2O$ emissions from human sewage were compared in order to trace for significant changes in 1990 – 2005. | No significant changes in $N_2O$ emissions from human sewage for years 1990 – 2005 were noted. | none |

# Table C. Tier 1: Individual Source Category Checklist – Forest Land

**Inventory Report:** 1990 – 2005
**Source/Sink Category:** **5.A.1 – Forest Land Remaining Forest Land and Biomass Burning**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO and CFPS

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 20.01.2007 | Check for description of activity data, emission factors applied and methodology used. | The appropriateness of activity data, emission factors and methodology used is documented and archived. | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 20.01.2007 | Check that all references are cited in the appropriate source chapter. | All bibliographical data references are cited in the Reporter and in the internal documentation. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 20.01.2007 | Check that no transcription errors were made in the Reporter (in 1990 – 2005). | No transcription errors were made, the data reported in the Reporter are similar to those presented in statistical databases. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 20.01.2007 | Using figures of worksheet (1994) and activity data of this year, the calculation was carried out to estimate $CO_2$ sequestration and emissions. | The value (net) calculated was 2,474 Gg of carbon; the value reported in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 20.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 20.01.2007 | Inspection that units are correctly labeled. | Units are labeled correctly. | none |
| emission units are correctly recorded and that appropriate | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 20.01.2007 | Check that units are appropriate. | Correct SI units have been used in the estimates. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 20.01.2007 | Check that correct conversion factors have been used to estimate sequestration / removals of carbon. | Correct conversion factors have been used and accounted properly. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 20.01.2007 | Confirmation that all required data processing steps were carried out. | All appropriate data processing steps were carried out in the estimates in 1990 – 2005 (conversion from stem value to total tree biomass, from fresh matter to dry matter, etc). | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 20.01.2007 | Confirm that data fields are properly labeled. | The data fields are labeled correctly. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 20.01.2007 | Confirm that the documentation of databases on forest areas and biomass is documented and archived. | All appropriate documentation exists and is archived. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 20.01.2007 | Check for consistency in forest dataset in 1990 – 2005. | Forest area is consistent in 1990 (1857 ha) and in 2005 (2122 ha). The average biomass increment is consistent in 1990 (3.98 tdm/ha) and in 2005 (5 tdm/ha). | none |
| Check that the movement of inventory data among processing | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 20.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| steps is correct. | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 20.01.2007 | The check was not undertaken. | | |
| Check that uncertainties in emissions and | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| removals are estimated or calculated correctly. | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 20.01.2007 | Check for the detailed internal documentation to support the estimates. | The detailed internal documentation has been archived by the expert. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 20.01.2007 | Check that inventory and supporting data are archived. | All inventory data (forest areas, biomass increment and harvest, conversion factors, etc) are recorded and archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 20.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 20.01.2007 | Check for consistency in time by looking at graphs in the Reporter. | No inconsistencies in time-series. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| resulting in recalculations. | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 20.01.2007 | Check for consistency in algorithm used. | Tier 1 method has been used in the estimates in 1990 – 2005. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 20.01.2007 | Run completeness check. | All passed. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 20.01.2007 | N/A | N/A | N/A |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 20.01.2007 | All inventories (years 1990 – 2005) were compared in order to trace changes in $CO_2$ emissions or removals. | No significant changes were noted. | none |

# Table D. Tier 1: Individual Source Category Checklist – $CH_4$ emissions from Enteric Fermentation of Cattle

**Inventory Report:** 1990 – 2005
**Source/Sink Category:** **4.A. – Enteric Fermentation (Cattle: Dairy and Non-Dairy Cattle)**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 15.01.2007 | Check of criteria for the selection and descriptions of activity data, emission factors and methodology used. | Descriptions of activity data, emission factors and approach used are documented and archived. | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 15.01.2007 | Confirmation that references are cited in the internal documentation. | All bibliographical data sources are cited to references in the Reporter and in the internal documentation. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 15.01.2007 | Check for transcription errors. | No errors were made in transcription of the data on cattle population in 1990 - 2005. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 15.01.2007 | $CH_4$ emission from Dairy Cattle Enteric Fermentation was calculated using figures of 1993. | The value calculated was 20.66 Gg of $CH_4$; the value of $CH_4$ reported in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 15.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and emission units are correctly recorded and that appropriate conversion factors are used. | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 15.01.2007 | Check that recorded units are appropriate. | Correct units are labeled. | none |
| | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 15.01.2007 | Check that units are properly reported (used) through inventories. | Correct SI units are reported from inventories from 1990 to 2005. | none |
| | Check that conversion factors are correct. | O. Gavrilova | 15.01.2007 | Check that conversion factors are properly used. | Conversion factors have been used correctly in 1990 – 2005. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 15.01.2007 | Confirmation that required data processing steps are correctly represented in the database. | All appropriate data processing steps are represented correctly (required for Tier 2 method) and are archived in the internal documentation. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 15.01.2007 | Check that data fields are properly labeled. | Data fields are properly labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 15.01.2007 | Check that corresponding documentations of databases are archived. | Corresponding documentations relating to the estimation of methane emission from enteric fermentation of cattle are archived by the expert. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 15.01.2007 | Check for consistency in activity data and emission factors used in the estimation of $CH_4$ emissions. | Cattle population is not consistent in 1990 (757 th. head) and in 2005 (250 th. heads), the decrease in number of cattle has been noted. Emission factors are consistent in 1990 (66.6 kg $CH_4$/head/yr) and in 2005 (81.5 kg $CH_4$/head/yr), the small increase in EF is explained by the increase of milk production per cow. | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 15.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 15.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 15.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and has been archived by the expert. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 15.01.2007 | Check that activity data and supporting data are archived. | All activity data, supporting data (emission factors, conversion factors, etc.) have been archived by the expert. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 15.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 15.01.2007 | Check for consistency of input data in time by looking at graphs in the Reporter. | No inconsistency in time-series. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 15.01.2007 | Check for consistency of approach used to estimate $CH_4$ emissions from enteric fermentation. | Tier 2 method (Dairy Cattle) and Tier 1 (Non-Dairy Cattle) have been used to estimate $CH_4$ emission from enteric fermentation of cattle in 1990 – 2005. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 15.01.2007 | Run completeness check. | The test passed. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 15.01.2007 | Check that unknown data are documented. | All known data gaps are documented. | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 15.01.2007 | Inventories/$CH_4$ emissions in for years 1990 – 2005 were compared in order to trace significant changes in $CH_4$ emissions. | No significant changes are noted. Recalculations of $CH_4$ emission from cattle enteric fermentation have been carried out in the submission of 2007. | none |

# Table E. Tier 1: Individual Source Category Checklist – $CH_4$ Emissions from Enteric Fermentation of 'Other Animals' (Sheep, Goats, Horses)

**Inventory Report:** 1990 - 2005
**Source/Sink Category:** **4.A. – Enteric Fermentation (Sheep, Goats and Horses)**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 16.01.2007 | Check of the description of activity data, emission factors and methodology used. | The description of activity data (1990 – 2005), emission factors are properly documented and archived. | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 16.01.2007 | Confirmation that bibliographical data are cited in the internal documentation. | All bibliographical data references are cited in the internal documentation and in the Reporter. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 16.01.2007 | Check that no transcription errors were made. | Activity data on livestock population reported in the Reporter are similar to those, presented in ESO. Thus, no transcription errors were made. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 16.01.2007 | $CH_4$ emission from Enteric Fermentation of Horses was estimated using figures of 1992. | The value of $CH_4$ emission from horse enteric fermentation calculated is 0.1188 Gg. The value reported in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 16.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 16.01.2007 | Check that units are labeled properly. | Correct units have been used. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| emission units are correctly recorded and that | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 16.01.2007 | Check that units have been used accurately since 1990 until 2005. | Correct SI units have been used correctly. | none |
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 16.01.2007 | Check that conversion factors have been used properly. | Correction factors are correct and reported properly. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 16.01.2007 | Confirmation that all required data processing steps are documented and archived. | All appropriate data processing steps are documented and archived. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 16.01.2007 | Check that data fields are labeled. | The data fields are properly labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 16.01.2007 | Check that documentation of databases is archived. | All adequate documentation of database is archived. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 16.01.2007 | Check for consistency in 'other livestock' dataset in 1990 – 2005. | 'Other livestock' population decreased smoothly from 1990 to 2005. Emission factors are consistent, have been used from the IPCC Guidelines. | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 16.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 16.01.2007 | The check was not undertaken. | | |
| Check that uncertainties in emissions and removals are | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| estimated or calculated correctly. | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 16.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and is archived. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 16.01.2007 | Check that activity and supporting data are archived. | All activity and supporting data used in estimates are archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 16.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 16.01.2007 | Check for consistency of input data in time by looking at graphs in the Reporter. | No inconsistencies in time-series. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 16.01.2007 | Check for consistency of algorithm used. | Tier 1 approach (for Sheep, Goats and Horses) has been used to estimate $CH_4$ emission from Enteric Fermentation in 1990 – 2005. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 16.01.2007 | Run completeness check. | The test passed. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 16.01.2007 | N/A | N/A | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 16.01.2007 | Inventories / $CH_4$ emissions were compared in order to trace for significant changes in emissions of 1990 – 2005. | No significant changes were noted in inventories from 1990 to 2005. | none |

# Table F. Tier 1: Individual Source Category Checklist – $CH_4$ Emissions from Enteric Fermentation of Swine

**Inventory Report:** 1990 - 2005
**Source/Sink Category:** **4.A. – Enteric Fermentation (Swine)**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 16.01.2007 | Check for descriptions of activity data, emission factors and methodology used in the internal documentation. | Activity data on swine population, emission factors and algorithm used are documented. | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 16.01.2007 | Confirmation that the data are cited to references in the internal documentation and in the Reporter. | All bibliographical data references are cited for years 1990 – 2005. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 16.01.2007 | Check for transcription errors. | No transcription errors were made, the data on swine population are similar to those presented in data sources. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 16.01.2007 | $CH_4$ emission from Enteric Fermentation of Swine was estimated using figures of 1993. | The value calculated is 0.525 Gg of $CH_4$; the value reported in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 16.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and emission units are correctly recorded and that | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 16.01.2007 | Check that units are properly labeled. | Correct units have been used in tables. | none |
| | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 16.01.2007 | Check that units have been used properly. | Correct SI units have been used for the estimation from 1990 – 2005. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 16.01.2007 | Check that correct conversion factors have been used. | Conversion factors used are correct. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 16.01.2007 | Confirmation that all required data processing steps are correctly represented. | Required data processing steps (for Tier 2) are represented accurately and documented by the expert. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 16.01.2007 | Check that data fields are correctly labeled. | All data fields are properly reported. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 16.01.2007 | Check that documentation on database is achieved. | All required documentation of database (swine population, supporting data) is archived by the expert. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 16.01.2007 | Check for consistency in dataset related to pigs in Estonia. | The data on swine population (by sub-categories) are not really consistent in the period 1998 – 1999, as ESO changed the methodology of data collection. | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 16.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 16.01.2007 | The check was not undertaken. | | |

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|---|---|---|---|---|---|---|
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 16.01.2007 | Check that the detailed internal documentation is archived. | The detailed internal documentation exists and has been archived by the expert. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 16.01.2007 | Check that inventory data and supporting data are archived. | Activity data (1990 – 2005) and all supporting data required to estimate $CH_4$ emission from swine enteric fermentation are archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 16.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 16.01.2007 | Check for consistency of input data in time. | No inconsistencies in time-series. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 16.01.2007 | Check for temporal consistency of method used to estimate $CH_4$ emissions. | Tier 2 approach has been used to estimate $CH_4$ emission from swine enteric fermentation in 1990–2005. | none |

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|---|---|---|---|---|---|---|
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 16.01.2007 | Run completeness check. | The test passed. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 16.01.2007 | N/A | N/A | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 16.01.2007 | Inventories / emissions were compared in order to trace significant changes in $CH_4$ emissions. | Significant change in $CH_4$ emissions was noted in years 1999 – 2000. However, the main reason for this, the change in methodology of data collection by ESO, has been noted. Thus, since 1999, $CH_4$ emission is considered to be more accurate and comprehensive. | none |

# Table G. Tier 1: Individual Source Category Checklist – Indirect Emissions of $N_2O$ from Agriculture

**Inventory Report:** 1990 – 2005
**Source/Sink Category:** **4.B. – Indirect Emissions: Atmospheric Deposition, Nitrogen Leaching and Run-off**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 19.01.2007 | Check that descriptions of activity data and emission factors are documented and archived. | The data sources and the description of activity data, emission factors are recorded and archived. | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 19.01.2007 | Ensure that the input data are cited to references. | All input data are cited to references in the internal documentation and in the Reporter. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 19.01.2007 | Check for transcription errors. | No transcription errors were made. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 19.01.2007 | The calculation of $N_2O$ emission from atmospheric deposition using figures of 1991 was carried out. | The value calculated is 0.2950 Gg of $N_2O$. The value reported in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |
| Check that parameter and | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 19.01.2007 | Check that units are labeled. | Units are properly labeled. | none |

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|---|---|---|---|---|---|---|
| emission units are correctly recorded and that | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 19.01.2007 | Check that units are used correctly in calculations. | Correct SI units have been properly used from beginning to end of the calculation in years 1990 – 2005. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 19.01.2007 | Check that correct conversion factors have been used. | Correct conversion factors have been used in the estimations. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 19.01.2007 | Confirmation that all necessary data processing steps have been carried out. | All required data processing steps have been carried out (estimations of manure generation, synthetic fertilizers applied to soils etc.) and documented. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 19.01.2007 | Check that data fields have been properly labeled. | All data fields were labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 19.01.2007 | Confirm that the required documentation of databases are documented and archived. | The documentation of databases on manure generation, synthetic fertilizers applied etc. for years 1990 – 2005, are documented and archived. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 19.01.2007 | Check for consistency in dataset associated with estimates of $N_2O$ indirect emission. | Emission factors used are consistent. As emissions depend on manure generation by livestock, synthetic fertilizers applied to soils, then $N_2O$ emissions change with changing of nitrogen used on soils. | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 19.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation for years 1990 – 2005 exists and is archived. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 19.01.2007 | Check that activity and supporting data used are recorded and archived. | All input data for years 1990 – 2005 are archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 19.01.2007 | Check that input data are consistent in time by looking at graphs presented in the Reporter. | No inconsistencies in time-series were noted. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 19.01.2007 | Check that methodology used is consistent in time. | The IPCC algorithm has been used in the estimates in years 1990 – 2005. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 19.01.2007 | Run completeness check. | The test passed. | none |

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|---|---|---|---|---|---|---|
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 19.01.2007 | Check that unknown data are documented. | There are no unknown data. | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 19.01.2007 | Inventories/$N_2O$ indirect emissions were compared in order to trace emission trend. | No significant changes were noted. However, as since 2003 Estonia has been using Western Europe's manure management system (instead of Eastern Europe's), a smooth drop was noted in $N_2O$ emission from atmospheric deposition in 2003. | none |

# Table H. Tier 1: Individual Source Category Checklist – $CH_4$ and $N_2O$ emissions from Cattle Manure Management

**Inventory Report:** 1990 – 2005
**Source/Sink Category:** **4.B. – Cattle Manure Management (Dairy and Non-Dairy Cattle)**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 17.01.2007 | Check for descriptions of activity data, emission factors and methodology used in the estimates. | The descriptions of activity data, emission factors and methodology using are documented and archived. | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 17.01.2007 | Confirmation that references on activity data are cited in the internal documentation. | References on activity data and emission factors are cited in the Reporter and the internal documentation. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 17.01.2007 | Check that no transcription errors were made. | No transcription errors were made; activity data (on cattle population) are the same as in data sources (for the period 1990–2005). | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 17.01.2007 | $CH_4$ emission from Dairy Cattle Manure Management was estimated using figures of 1997. | The value calculated of $CH_4$ emission from dairy cattle manure management is 2.327 Gg. The value reported in the Reporter is the same. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 17.01.2007 | The check was not undertaken. | | |

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|---|---|---|---|---|---|---|
| Check that parameter and | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 17.01.2007 | Check that units are appropriate. | There are correct units used in tables. | none |
| emission units are correctly recorded and that | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 17.01.2007 | Check that units have been used properly from beginning to end of calculations. | Proper SI units have been used. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 17.01.2007 | Check that conversion factors have been used correctly. | Appropriate conversion factors have been used. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 17.01.2007 | Confirmation that all required data processing steps are represented and documented. | All appropriate data processing steps have been carried out (in the estimates of $CH_4$ and $N_2O$ emissions) and documented. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 17.01.2007 | Check that data fields are labeled. | Data fields are labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 17.01.2007 | Check that required documentation is archived. | All adequate documentation of database is documented. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 17.01.2007 | Check for consistency in the values (activity data and emission factors) used in the calculations. | The reduction in the total population of cattle is smooth from one year to another - in 1990 (757 th. heads) and 2005 (246 th heads). The population of cattle by sub-categories decreased inconsistently, as since 1999, ESO changed the method of data collection. It changed significantly the total emission factor – from 8.34 kg$CH_4$/head/year in 1990 to 6.18 kg$CH_4$/head/year in 2005. Since 2003, Estonia has decided to use the data of Western Europe's manure management system (instead of Eastern Europe's). It was the reason for a small drop in $N_2O$ emission in 2003. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 17.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 17.01.2007 | The check was not undertaken. | | |
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 17.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and is archived. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 17.01.2007 | Check that activity and supporting data are archived. | Activity and supporting data (cattle population, milk production, manure management systems etc.) are described and archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 17.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 17.01.2007 | Check for consistency of activity data in time by looking at graphs in the Reporter. | No inconsistencies in time-series. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| recalculations. | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 17.01.2007 | Check for consistency of method used in time. | Tier 2 approach has been used to estimate $CH_4$ emissions and Tier 1 method has been used to estimate $N_2O$ emissions from cattle manure management in 1990 – 2005. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 17.01.2007 | Run completeness check. | The test passed. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 17.01.2007 | Check that unknown data are documented. | The known data gaps are documented. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 17.01.2007 | Inventories reported in the Reporter were compared in order to trace significant changes of $CH_4$ or $N_2O$ emissions. | No significant changes in $CH_4$ emissions were noted. A small drop was noted in $N_2O$ emission in 2002-2003. As has been noted, the reason for this is the estimation of $N_2O$ emission based on Western Europe's manure management since 2003. | none |

# Table I. Tier 1: Individual Source Category Checklist – $CH_4$ and $N_2O$ Emissions from Swine Manure Management

**Inventory Report:** 1990 – 2005
**Source/Sink Category:** **4.B. – Swine Manure Management**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 17.01.2007 | Check that the description of activity data, emission factors and methodology used are recorded and archived. | The description of activity data, emission factors and methodology used are recorded and archived in the internal documentation | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 17.01.2007 | Confirmation that data references are cited. | The bibliographical data references are cited and archived in the internal documentation and in the Reporter. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 17.01.2007 | Check for transcription errors. | No transcription errors were made. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 17.01.2007 | Nitrogen excretion by swine was calculated using figures of 1999. | The calculated value of nitrogen excretion by swine is 5,771 tonnes. The value recorded in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 17.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and emission units are correctly recorded and that | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 17.01.2007 | Check that units are appropriate. | All units presented are correct. | none |
| | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 17.01.2007 | Check that units properly used from beginning to end of the estimates. | Correct SI units have been used for the estimates in 1990 – 2005. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 17.01.2007 | Check that conversion factors used in the estimates are correct. | Conversion factors were used correctly and reported. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 17.01.2007 | Confirmation that required data processing steps are described in the documentation. | All data processing steps are documented in the internal documentation. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 17.01.2007 | Check that data fields are properly labeled. | All data fields are labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 17.01.2007 | Check that documentation on database on pig population is recorded and achieved. | The documentation of databases are recorded and archived. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 17.01.2007 | Check for consistency in pig dataset in 1990 – 2005. | Activity data (pig population, manure management system) used in the estimates of $CH_4$ and $N_2O$ emissions are documented. The difference in the total $CH_4$ emission factors is noted for year of 1999. It is explained by introducing a new system of data collection in ESO. ESO began to collect data on six sub-categories of pigs, instead of three sub-categories of pigs (as was collected before).<br>Since 2003, Estonia decided to estimate nitrogen excretion based on Western Europe's manure management system (instead of Eastern Europe's). | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 17.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 17.01.2007 | The check was not undertaken. | | |
| Check that uncertainties in emissions and | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| removals are estimated or calculated correctly. | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 17.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and is archived. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 17.01.2007 | Check that activity data and supporting data are archived. | Activity data (pig population) and all supporting data are recorded and archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 17.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 17.01.2007 | Check for consistency of data used in time by looking at graphs in the Reporter. | All data used are consistent in time from 1990 until 2005. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 17.01.2007 | Check for consistency of method used. | Tier 1 ($CH_4$, $N_2O$) approach has been used in order to estimate emissions from manure management in 1990 – 2005. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 17.01.2007 | Run completeness check. | No inconsistencies in time-series. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 17.01.2007 | Check that unknown data are documented. | The known data gaps are documented. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 17.01.2007 | Inventories/$CH_4$ and $N_2O$ emissions were compared in order to find significant changes in the emissions. | No significant changes were noted in $CH_4$ emissions from swine manure management. The changes in $CH_4$ emissions reflect changes in the population of pigs.<br>A small drop was noted in nitrogen excretion ($N_2O$ emission) for year of 2003. The main reason for this is that since 2003 Estonia decided to estimate $N_2O$ emission based on Western Europe's manure management system (instead of Eastern Europe's). | none |

# Table J. Tier 1: Individual Source Category Checklist – $CH_4$ and $N_2O$ emissions from 'Other Livestock' Manure Management

**Inventory Report:** 1990 – 2005
**Source/Sink Category:** **4.B. – 'Other Livestock' Manure Management**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 19.01.2007 | Check that the description of activity data, emission factors and methodology is documented and archived. | The description of activity data, emission factors and methodology is recorded and archived. | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 19.01.2007 | Confirmation that bibliographical data references are recorded. | Data references are cited in the internal documentation and in Reporter. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 19.01.2007 | Check that no transcription errors were made. | Activity data (livestock population) are similar to those presented in source documentation; no transcription errors were made. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 19.01.2007 | The calculation of nitrogen excretion by horses was carried out using figures of 2001. | The value of nitrogen excreted by horses was 137,500 kg in 2001 (presented in the Reporter). The value calculated is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 19.01.2007 | Check that units are properly labeled. | All units are labeled. | none |

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|---|---|---|---|---|---|---|
| emission units are correctly recorded and that | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 19.01.2007 | Check that units have been used correctly from beginning to end of estimates. | Correct SI units have been used properly through all calculations in 1990 – 2005. | none |
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 19.01.2007 | Check that conversion factors have been used properly. | Conversion factors used in the estimates are correct in 1990 – 2005. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 19.01.2007 | Check that all required data processing steps have been carried out and documented. | The appropriate data processing steps are documented. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 19.01.2007 | Check that data fields are labeled. | All data fields are labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 19.01.2007 | Check that appropriate documentation of databases on livestock population are documented and archived. | The adequate documentation of database is represented and archived. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 19.01.2007 | Check for consistency in activity data and emission factors. | Activity data and emission factors used in order to estimate $CH_4$ emission and nitrogen excretion are consistent; no significant changes were noted. | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 19.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and is archived. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 19.01.2007 | Check that inventory and supporting data are documented and archived. | Inventory and supporting data are documented and archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 19.01.2007 | Check for input data consistency in time by looking at graphs in the Reporter. | All input data is consistent in 1990 – 2005, no significant changes are noted. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 19.01.2007 | Check for consistency of method used. | Tier 1 approach has been used to estimate $CH_4$ and $N_2O$ emission in 1990 – 2005. | none |

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|---|---|---|---|---|---|---|
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 19.01.2007 | Run completeness check. | No inconsistencies in time-series. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 19.01.2007 | Check that unknown data are documented. | The known data gaps are documented. | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 19.01.2007 | Inventories/$CH_4$ emissions/Nitrogen excretions were compared for reported years. | No significant changes in $CH_4$ emissions were noted. Since 2003, a sharp drop has been noted in $N_2O$ from poultry manure management system. It is explained by changing the manure management systems (for all categories of animals). Since 2003 Estonia has used Western Europe's manure management system. | none |

# Table K. Tier 1: Individual Source Category Checklist – $N_2O$ emissions from growing of N-fixing crops and Crop Residues

**Inventory Report:** 1990 – 2005
**Source/Sink Category:** **4.B. – N-fixing Crops and Crop Residues**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 19.01.2007 | Check for descriptions of activity data, emission factors and methodology used. | The description of activity data and emission factors are documented and archived. | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 19.01.2007 | Confirmation that input data is cited to references. | All input data (1990 – 2005) are cited to references in the internal documentation. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 19.01.2007 | Check for transcription errors. | No transcription errors were made. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 19.01.2007 | The calculation was carried out to estimate $N_2O$ emission from N-fixing crops using figures of 1996. | The value calculated was 0.0141 of $N_2O$. The value reported in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and emission units are correctly recorded and that | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 19.01.2007 | Check that all units are correctly labeled. | Units are properly labeled. | none |
| | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 19.01.2007 | Check that units have been used correctly in the estimates. | Correct SI units have been used properly. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 19.01.2007 | Check that conversion factors have been used correctly. | Correct conversion factors have been used in the estimates (from fresh matter to dry matter, crop/residue ratio, nitrogen content etc). | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 19.01.2007 | Confirmation that all required data processing steps are documented in the internal documentation. | All appropriate data processing steps (conversion from fresh to dry matter, estimations of nitrogen content etc.) are documented and archived. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 19.01.2007 | Check that data fields are labeled. | Data fields are labeled properly. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 19.01.2007 | Check that adequate documentation of database is represented and archived. | Adequate documentation of database is represented and archived. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 19.01.2007 | Check for consistency in activity data and emission factors used to estimate $N_2O$ emissions from N-fixing crops and crop residues. | Activity data and emission factors used are consistent in 1990 – 2005. | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |

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|---|---|---|---|---|---|---|
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 19.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and is archived. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 19.01.2007 | Check that input and supporting data with appropriate documentation is documented and archived. | Inventory and supporting data, related documentation is achieved. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 19.01.2007 | Check that input data are consistent in time by looking at graphs in the Reporter. | No inconsistencies in time-series. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 19.01.2007 | Check that method used is consistent in time. | The IPCC method has been used to estimate $N_2O$ emissions from N-fixing crops and crop residues for years 1990 – 2005. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 19.01.2007 | Run completeness check. | The test passed. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 19.01.2007 | N/A | N/A | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 19.01.2007 | Inventories/$N_2O$ emissions from N-fixing crop growing and crop residues were compared in order to trace for significant changes in emissions of 1990 – 2005. | $N_2O$ emissions in years 1990 – 2005 changed significantly from one year to another. However, it is explained by drops in crop production in Estonia in 1990 – 2005. | none |

# Table L. Tier 1: Individual Source Category Checklist – $N_2O$ Emissions from Synthetic Fertilizers applied to agricultural soils

**Inventory Report:** 1990 – 2005
**Source/Sink Category:** **4.B. – Synthetic Fertilizers**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 19.01.2007 | Check that description of activity data and emission factors are documented and archived. | The data sources and activity data description are documented and archived. | none |
| Check for transcription errors in data input and reference. | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 19.01.2007 | Confirm that the data are linked to references. | Data references are cited. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 19.01.2007 | Check input data for transcription errors. | No transcription errors were made in the process of copying data from sources to worksheets. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 19.01.2007 | The calculation was carried out using figures of 2003. | The value of $N_2O$ emissions from synthetic fertilizers calculated is 0.4626 Gg. The value of emission presented in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |

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|---|---|---|---|---|---|---|
| Check that parameter and | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 19.01.2007 | Check that units are correctly labeled. | All units are properly labeled in 1990 – 2005. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| emission units are correctly recorded and that appropriate conversion factors are used. | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 19.01.2007 | Check that units correctly used from beginning to end of the estimates. | The correct SI units have been used in the estimates for 1990 – 2005. | none |
| | Check that conversion factors are correct. | O. Gavrilova | 19.01.2007 | Check that conversion factors have been used properly. | Conversion factors used in the estimates are correct. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 19.01.2007 | Confirmation that all required data processing steps are documented. | Appropriate data processing steps were carried out correctly and were documented. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 19.01.2007 | Check that data fields are labeled. | Data fields are labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 19.01.2007 | Check for documentation of databases on synthetic fertilizers applied to soils. | The appropriate documentation is archived. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 19.01.2007 | Check for consistency in dataset associated with synthetic fertilizers applied to soils. | Application of synthetic fertilizers to soils significantly decreased from 1990 (64,530 th. tonnes) to 2005 (20,083 th. tonnes). Emission factors used are consistent. | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 19.01.2007 | Check for detailed internal documentation. | The detailed internal documentation exists and is documented. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 19.01.2007 | Check that inventory data and supporting data are documented and archived. | All inventory data and supporting data (1990 – 2005) are documented and archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 19.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 19.01.2007 | Check that input data are consistent in time by looking at graphs in the Reporter. | No inconsistencies in time-series. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 19.01.2007 | Check that method used for the calculations is consistent in time. | Tier 1 approach has been used to estimate $N_2O$ emissions from synthetic fertilizers applied to soils. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 19.01.2007 | Run completeness check. | The test passed. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 19.01.2007 | N/A | N/A | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 19.01.2007 | Inventories/$N_2O$ emissions from synthetic fertilizers applied to soils (1990 – 2005) were compared in order to trace for significant changes. | No significant changes were noted in $N_2O$ emissions. | none |

# Table M. Tier 1: Individual Source Category Checklist – $CH_4$ Emissions from Solid Waste Disposal on Land

**Inventory Report:** 1990 – 2005
**Source/Sink Category:** **6.A.1 - Solid Waste Disposal on Land (Managed Waste Disposal on Land)**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from EEIC and ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 09.01.2007 | Check that the description of activity data, emission factors and methodology used have been documented and archived. | The description of activity data, emission factors, methodology used have been documented and archived. | none |
| Check for transcription errors in data input and reference | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 09.01.2007 | Confirmation that bibliographical data references are cited in the internal documentation. | All input data are cited to references in the internal documentation and the Reporter. There is an exception for years 1990 – 1992, where references for activity data are not presented. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 09.01.2007 | Check for transcription errors made. | No transcription errors made. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 09.01.2007 | $CH_4$ emission from waste disposal using figures of 1998 was calculated. | The value of $CH_4$ emitted from waste disposal on landfills calculated was 36.408 Gg. The value reported in the Reporter is the same. Test passed. | none |

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|---|---|---|---|---|---|---|
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 09.01.2007 | The check was not undertaken. | | |
| Check that parameter and emission units are correctly recorded and that | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 09.01.2007 | Check that units are appropriate. | The correct units have been used in tables. | none |
| | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 09.01.2007 | Check that units correctly used through calculations. | Correct SI units have been used in tables. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 09.01.2007 | Ensure that conversion factors used in the estimates are correct. | Conversion factors are correct and have been reported properly. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 09.01.2007 | Check that all steps needed are represented. | All appropriate data processing steps are correctly represented. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 09.01.2007 | Check data fields. | Data fields are properly labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 09.01.2007 | Check adequate documentation of waste database. | All adequate documentation is archived. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 09.01.2007 | Check for consistency in waste generation (disposal) from 1990 to 2005, and emission factors used in estimations. | Emissions factors are consistent. Amounts of waste disposal to landfills are consistent: 361.2 Gg in 1990 and 371.7 Gg in 2005. | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 09.01.2007 | The check was not undertaken | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 09.01.2007 | The check was not undertaken | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that uncertainties in emissions and removals are estimated or calculated correctly. | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 09.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation is archived. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 09.01.2007 | Check that supporting data and calculations carried out are archived. | All calculations associated with the estimation of $CH_4$ emission from waste landfills are archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 09.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 09.01.2007 | Check for consistency in time by looking at graphs in the Reporter. | No inconsistencies in time-series. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 09.01.2007 | Check for consistency in algorithm/method used for calculations. | Tier 1 method has been used for calculations $CH_4$ emissions from landfills in 1990 – 2005. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 09.01.2007 | Run completeness check. | The test passed. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 09.01.2007 | Check that unknown data are documented. | The known data gaps are documented. | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 9.01.2007 | Inventories/$CH_4$ emissions from waste disposal were compared in order to trace significant changes. | No significant changes in $CH_4$ emissions from municipal waste landfills were noted. | none |

# Table N. Tier 1: Individual Source Category Checklist – $CH_4$ emissions from Domestic Wastewater: Wastewater and Sludge

**Inventory Report:** 1990 - 2005
**Source/Sink Category:** **6.B.1 – Domestic and Commercial Wastewater: Wastewater**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from EEIC and ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 11.01.2007 | Check of the description of activity data, emission factors and methodology used. | The description of activity data, emission factors and methodology used to estimate $CH_4$ emissions from domestic wastewater treatment is documented and archived. | none |
| Check for transcription errors in data input and reference | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 11.01.2007 | Confirmation that bibliographical data are cited. | Activity data and emissions factor are cited to references in the Reporter and in the internal documentation. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 11.01.2007 | Check that no transcription errors were made. | Activity data (population of Estonia, amounts of wastewater generated and treated) were transcribed correctly. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 11.01.2007 | $CH_4$ emission from domestic and commercial wastewater treatment using figures of 1995 was calculated. | The value calculated of $CH_4$ emission is 0.1583 Gg, the value reported in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 11.01.2007 | The check was not undertaken | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 11.01.2007 | Check that units are appropriate. | There are correct units in tables. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| emission units are correctly recorded and that appropriate conversion factors are used. | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 11.01.2007 | Check that units correctly used in calculations. | Correct SI units have been used in 1990 – 2005. | none |
| | Check that conversion factors are correct. | O. Gavrilova | 11.01.2007 | Check that conversion factors were used correctly. | Conversion factors are correct and reported properly. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 11.01.2007 | Confirmation that all required steps represented correctly in the internal documentation. | All appropriate data processing steps are represented correctly in the internal documentation. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 11.01.2007 | Check that data fields are properly labeled. | Data fields are properly labeled. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 11.01.2007 | Check for consistency in wastewater set in 1990 – 2005. | Wastewater generated and treated is consistent, a notable decrease in wastewater generation was observed (from 112 mln $m^3$ in 1990 to 52 mln $m^3$ in 2005). | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 11.01.2007 | The check was not undertaken | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 11.01.2007 | The check was not undertaken | | |
| Check that uncertainties in emissions and removals are | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| estimated or calculated correctly. | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 11.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and has been archived by an expert. | none |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 11.01.2007 | Check that activity and supporting data are archived. | All activity and supporting data (for years 1990 – 2005) are archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 11.01.2007 | The check was not undertaken | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 11.01.2007 | Check for consistency of input data in time by looking at graphs in the Reporter. | No inconsistencies in time-series. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 11.01.2007 | Check for consistency in the method used. | The approach used to estimate $CH_4$ from domestic and commercial wastewater treatment is consistent. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 11.01.2007 | Run completeness check. | The test passed. | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 11.01.2007 | N/A | N/A | none |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 11.01.2007 | Inventories/$CH_4$ emissions from wastewater treatment in years 1990 – 2005 were compared in order to trace for significant changes in emissions. | No significant changes in $CH_4$ emission trend (in 1990-2005) are noted. | none |

# Table O. Tier 1: Individual Source Category Checklist – $N_2O$ emissions from Domestic Water: Human Sewage

**Inventory Report:** 1990 - 2005
**Source/Sink Category:** **6.B.2.2 – Human Sewage**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from EEIC and ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 11.01.2007 | Check that the description of activity data, emission factors is properly recorded and archived. | The description of activity data, emissions factors and methodology used is recorded in the internal documentation and archived. | none |
| Check for transcription errors in data input and reference | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 11.01.2007 | Check that all bibliographical data references are cited and documented. | Activity data and emission factors are cited to references and documented in the internal documentation and the Reporter. | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 11.01.2007 | Check for transcription errors. | No transcription errors were noted. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 11.01.2007 | $N_2O$ emission from human sewage has been calculated using figures of 2005. | The value calculated was 0.116 Gg; the value of $N_2O$ emission from human sewage reported in the Reporter was 0.1158 Gg. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 11.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and emission units are correctly recorded and that | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 11.01.2007 | Check that units correctly used and properly reported. | There are correct units used in tables. | none |
| | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 11.01.2007 | Check that units are used properly. | Correct SI units used to estimate $N_2O$ emissions from human sewage are reported correctly. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 11.01.2007 | Check that conversion factors used are correct. | Conversion factors used for the estimation of $N_2O$ emissions are correct. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 11.01.2007 | Check that all required data processing steps are properly represented. | All steps needed for data processing are represented properly and documented. | none |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 11.01.2007 | Check that data fields are properly labeled. | The data fields are correctly labeled. | none |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 11.01.2007 | Check that documentation of database is archived. | All required documentation of database has been archived by the expert. | none |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 11.01.2007 | Check for consistency in dataset related to the estimation of $N_2O$ from human sewage. | Emission factors are consistent. Population of Estonia is consistent in 1990 (1,570 th. people) and in 2005 (1,347 th. people). | none |
| Check that the movement of inventory data among processing steps is correct. | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 11.01.2007 | The check was not undertaken. | | |
| | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 11.01.2007 | The check was nit undertaken. | | |
| Check that uncertainties in emissions and removals are | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| estimated or calculated correctly. | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 11.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation exists and is archived. | none |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 11.01.2007 | Check that all data required to estimate $N_2O$ emissions from human sewage are documented and archived. | Activity and supporting data, emission factors are documented and archived. | none |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 11.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes resulting in recalculations. | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 11.01.2007 | Check for consistency in input data by looking at graphs in the Reporter. | Input data and $N_2O$ emissions are consistent for years 1990 – 2005. | none |
| | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 11.01.2007 | Check for consistency in the algorithm used. | The method used to estimate $N_2O$ emissions from human sewage has been taken from the IPCC Guidelines. | none |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 11.01.2007 | Run completeness check. | The test passed. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 11.01.2007 | N/A | N/A | none |

| | | | | | | |
|---|---|---|---|---|---|---|
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 11.01.2007 | Inventories/$N_2O$ emissions from human sewage were compared in order to trace for significant changes in 1990 – 2005. | No significant changes in $N_2O$ emissions from human sewage for years 1990 – 2005 were noted. | none |

# Table P. Tier 1: Individual Source Category Checklist – $CH_4$ emissions from Industrial Wastewater: Wastewater and Sludge

**Inventory Report:** 1990 - 2005
**Source/Sink Category:** **6.B.1 – Industrial Wastewater: Wastewater**
**Estimates prepared by:** O. Gavrilova (Tallinn University of Technology) with the data from EEIC and ESO

| QC Activity | Procedures | Person responsible for quality check | Date | Brief description of check applied | Results of check | Corrective Actions Taken |
|---|---|---|---|---|---|---|
| Check that assumptions and criteria for the selection of activity data and emission factors are documented. | Cross-check descriptions of activity data and emission factors with information on source categories and ensure that these are properly recorded and archived. | O. Gavrilova | 10.01.2007 | Check for description of activity data, emission factors and approaches used in 1990 – 2005. | The description of activity data used, emission factors applied is documented in the internal documentation. | none |
| Check for transcription errors in data input and reference | Confirm that bibliographical data references are properly cited in the internal documentation. | O. Gavrilova | 10.01.2007 | Ensure that references are cited in the Reporter and in the internal documentation. | All bibliographical data references are cited in the Reporter (in 'year specific documentation') | none |
| | Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors. | O. Gavrilova | 10.01.2007 | Confirm that no transcription errors were made in activity data. | No transcription errors were made. | none |
| Check that emissions are calculated correctly. | Reproduce a representative sample of emissions calculations. | O. Gavrilova | 10.01.2007 | The calculation of $CH_4$ emission from industrial wastewater treatment was carried out using figures of 1992. | The calculated value of $CH_4$ emitted is 3.59 Gg; the value reported in the Reporter is the same. The test passed. | none |
| | Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy. | O. Gavrilova | 10.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Check that parameter and emission units are correctly recorded and that | Check that units are properly labeled in calculation sheets. | O. Gavrilova | 10.01.2007 | Check that units are properly labeled. | Correct units are labeled in h all estimates – from 1990 to 2005. | none |
| | Check that units are correctly carried through from beginning to end of calculations. | O. Gavrilova | 10.01.2007 | Check that units are appropriate. | Correct SI units have been used. | none |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| appropriate conversion factors are used. | Check that conversion factors are correct. | O. Gavrilova | 10.01.2007 | Check for conversion factors used in the estimates. | Correct conversion factors (from the IPCC Guidelines) have been used to estimate $CH_4$ emission from industrial wastewater treatment. | none |
| Check the integrity of database files. | Confirm that the appropriate data processing steps are correctly represented in the database. | O. Gavrilova | 10.01.2007 | Confirmation that all required data processing steps have been carried out. | All appropriate data processing steps have been carried out in the inventories of 1990 – 2005 (the estimation of total organic output by economic sectors of Estonia, $CH_4$ emissions) | |
| | Ensure that data fields are properly labeled and have the correct design specifications. | O. Gavrilova | 10.01.2007 | Check that data fields are properly labeled. | The data fields are labeled in 1990 – 2005. | |
| | Ensure that adequate documentation of database and model structure and operation are archived. | O. Gavrilova | 10.01.2007 | Ensure that adequate documentation of wastewater database has been documented. | All appropriate documentation exists and is archived. | |
| Check for consistency in data between source categories. | Identify parameters (e.g. activity data, constants) that are common to multiple source categories and confirm that there is consistency in the values used for these parameters in the emissions calculations. | O. Gavrilova | 10.01.2007 | Check for consistency in wastewater treatment set in 1990 – 2005. | The fraction of wastewater treated using the anaerobic method is not consistent in 1990 (18%) and 2005 (1%). Since 1994, in Estonia decreasing amounts of wastewater have been treated using the anaerobic method. | none |
| Check that the movement of inventory data among processing | Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries. | O. Gavrilova | 10.01.2007 | The check was not undertaken. | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| steps is correct. | Check that emissions data are correctly transcribed between different intermediate products. | O. Gavrilova | 10.01.2007 | The check was not undertaken. | | |
| Check that uncertainties in emissions and | Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate. | | | | | |
| removals are estimated or calculated correctly. | Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly. | | | | | |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| | If necessary, duplicate error calculations or a small sample of the probability distributions used by Monte Carlo analyses. | | | | | |
| Undertake review of internal documentation. | Check that there is detailed internal documentation to support the estimates and enable duplication of the emission and uncertainty estimates. | O. Gavrilova | 10.01.2007 | Check for the detailed internal documentation. | The detailed internal documentation is archived. | |
| | Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. | O. Gavrilova | 10.01.2007 | Ensure that inventory and supporting data are archived. | All inventory and supporting data are documented in the internal documentation and archived. | |
| | Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation. | O. Gavrilova | 10.01.2007 | The check was not undertaken. | | |
| Check methodological and data changes | Check for temporal consistency in time series input data for each source category. | O. Gavrilova | 10.01.2007 | Check for consistency in time by looking at graphs in the Reporter. | No inconsistencies in time-series. | |

| | | | | | | |
|---|---|---|---|---|---|---|
| resulting in recalculations. | Check for consistency in the algorithm/method used for calculations throughout the time series. | O. Gavrilova | 10.01.2007 | Check for consistency in algorithm used. | The algorithm presented in the IPCC Guidelines has been used in the estimates. | |
| Undertake completeness checks. | Confirm that estimates are reported for all source categories and for all years from the appropriate base year to the period of the current inventory. | O. Gavrilova | 10.01.2007 | Run completeness check. | All passed. | none |
| | Check that known data gaps that result in incomplete source category emissions estimates are documented. | O. Gavrilova | 10.01.2007 | N/A | N/A | |
| Compare estimates to previous estimates. | For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. | O. Gavrilova | 10.01.2007 | Check for inconsistencies in inventories. | Significant changes in ‘total organic product’ are noted. However, as activity data have been obtained from ESO and no transcription errors were made, the changes are explained by different product output by the Estonian economy. | none |

# ANNEX 3. Assessment of completeness and sources and sinks of greenhouse gas emissions and removals excluded.

Completeness of the Estonia's inventory submissions is evaluated here by sectors in tables below. The completeness is estimated by the gases ($CO_2$, $N_2O$ $CH_4$, F-gases and also NOx, CO, NMVOC and $SO_2$) and emission sources according to the detailed CRF Reporter classification. The CRF Reporter tool *Completeness* under the menu Submission has been used.

**Abbreviations used in tables:**

X - Included in to the inventory
NO - Not occurring in Estonia
NA - Not available
NE - Not estimated
IE - Included elsewhere.

***Notes,**
if category reporting includes some national specific emission source, which is not required in IPCC guidelines
other relevant issues.

## Energy, Fuel combustion (CRF Reporter 1.A)

| Greenhouse gas source and sink categories | $CO_2$ | $CH_4$ | $N_2O$ | NOx | CO | NMVOC | $SO_2$ | Notes* |
|---|---|---|---|---|---|---|---|---|
| **1. A. Fuel combustion activities** | | | | | | | | |
| **1.A.A. Sectoral Approach** | | | | | | | | |
| **1.AA.1.A. Energy industries** | | | | | | | | |
| **1.AA.1.A.** Public Electricity and Heat Production | X | X | X | X | X | X | X | |
| **1.AA.1.B.** Petroleum Refining* | X | X | X | X | X | X | X | Shale Oil production in Estonia |
| **1.AA.1.C.** Manufacture of Solid Fuels and Other Energy Industries* | X | X | X | X | X | X | X | Peat Briquette production |
| **1.AA.2. Manufacturing Industries and Construction** | | | | | | | | |
| 1.AA.2.A. Iron and Steel* | X | X | X | X | X | X | X | In 1991, 1992 and 1993 there was no iron and steel production in Estonia |
| 1.AA.2.B. Non-Ferrous Metals* | X | X | X | X | X | X | NA | There was no production of non-ferrous metals products in 1990-1999 and 2001 |
| 1.AA.2.C. Chemicals | X | X | X | X | X | X | X | |
| 1.AA.2.D. Pulp, Paper and Print* | X | X | X | X | X | X | X | There was no production of pulp and paper in 1990, 1991 and 1996 |
| 1.AA.2.E. Food Processing, Beverages and Tobacco | X | X | X | X | X | X | X | |
| 1.AA.2.F. Other (please specify) Other manu-facturing sectors and construction | X | X | X | X | X | X | X | |

| Greenhouse gas source and sink categories | $CO_2$ | $CH_4$ | $N_2O$ | NOx | CO | NMVOC | $SO_2$ | Notes* |
|---|---|---|---|---|---|---|---|---|
| **1.AA.3. Transport** | | | | | | | | |
| 1.AA.3.A. Civil Aviation | **X** | **X** | **X** | **X** | **X** | **X** | **X** | |
| 1.AA.3.B. Road Transportation | **X** | **X** | **X** | **X** | **X** | **X** | **X** | |
| 1.AA.3.C. Railways | **X** | **X** | **X** | **X** | **X** | **X** | **X** | |
| 1.AA.3.D. Navigation | **X** | **X** | **X** | **X** | **X** | **X** | **X** | |
| 1.AA.3.E. Other Transportation *(please specify* - other fuels from the Civil Aviation sub-sector | **X** | **X** | **X** | **X** | **X** | **X** | **X** | No fuel consumption in 1998, 2000, 2001, 2004, 2005 |
| **1.AA.4. Other Sectors** | | | | | | | | |
| 1.AA.4.A. Commercial/ Institutional | **X** | **X** | **X** | **X** | **X** | **X** | **X** | |
| 1.AA.4.B. Residential | **X** | **X** | **X** | **X** | **X** | **X** | **X** | |
| 1.AA.4.C. Agriculture/Forestry/ Fisheries | **X** | **X** | **X** | **X** | **X** | **X** | **X** | |
| **1.AA.5. Other *(please specify)*** | | | | | | | | |
| **1.AA.5. A**. Stationary | NO | NO | NO | NO | NO | NO | NO | |
| **B.** Mobile | NO | NO | NO | NO | NO | NO | NO | |

## Energy, Fugitive emissions (CRF REPORTER 1.B)

| Greenhouse gas source and sink categories | $CO_2$ | $CH_4$ | $N_2O$ | NOx | CO | NMVOC | $SO_2$ | Notes* |
|---|---|---|---|---|---|---|---|---|
| **1.B Fugitive emissions from fuels** | | | | | | | | |
| **1.B.1. Solid fuels** | | | | | | | | |
| 1.B.1.A. Coal Mining | NO | **X** | NO | NO | NO | NO | NO | Oil Shale mining in Estonia |
| 1.B.1.B. Solid Fuel Transform-ation | NO | NO | NO | NO | NO | NO | NO | |
| 1.B.1.C. Other (please specify) | NO | NO | NO | NO | NO | NO | NO | |
| **1.B.2. Oil and Natural Gas** | | | | | | | | |
| 1.B.2.A. Oil | NO | **X** | NO | X | X | X | X | $CO_2$ emissions from Shale Oil production are included in Category **1.AA.1.B.** Petroleum Refining |
| 1.B.2.B. Natural Gas | NO | **X** | NO | NO | NO | NO | NO | . |
| 1.B.2.C. Venting and Flaring | NO | **X** | NO | NO | NO | NO | NO | |
| 1.B.2.D. Other (please specify) | NO | NO | NO | NO | NO | NO | NO | |

## Industrial Processes (CRF Reporter 2)

| Greenhouse gas source and sink categories | $CO_2$ | $CH_4$ | $N_2O$ | NOx | CO | NMVOC | $SO_2$ | Notes* |
|---|---|---|---|---|---|---|---|---|
| **2. Industrial processes** | | | | | | | | |
| **2. A. Mineral products** | | | | | | | | |
| 2.A.1. Cement Production | **X** | NO | NO | NO | NO | NO | **X** | |
| 2.A.2. Lime Production | **X** | NO | NO | NO | NO | NO | NO | |
| 2.A.3. Limestone and Dolomite Use | NO | NO | NO | NO | NO | NO | NO | |
| 2.A.4. Soda Ash Production and Use | NO | NO | NO | NO | NO | NO | NO | |
| 2.A.5. Asphalt Roofing | NO | NO | NO | NO | NO | NO | NO | |
| 2.A.6. Road Paving with Asphalt | NO | NO | NO | NO | NO | NO | NO | . |
| 2.A.6. Other (please specify) | NO | NO | NO | NO | NO | NO | NO | |
| **2. B. Chemical Industry** | | | | | | | | |
| 2.B.1. Ammonia Production | **X** | NO | NO | NO | X | **X** | **X** | |
| 2.B.2. Nitric Acid Production | NO | NO | NO | NO | NO | NO | NO | |
| 2.B.3. Adipic Acid Production | NO | NO | NO | NO | NO | NO | NO | |

| Greenhouse gas source and sink categories | $CO_2$ | $CH_4$ | $N_2O$ | NOx | CO | NMVOC | $SO_2$ | Notes* |
|---|---|---|---|---|---|---|---|---|
| 2.B.4. Carbide Production | NO | NO | NO | NO | NO | NO | NO | |
| 2.B.5. Other Production | NO | NO | NO | NO | NO | NO | NO | |
| **2.C. Metal Production** | NO | NO | NO | NO | NO | NO | NO | |
| 1. Iron and Steel Production | NO | NO | NO | NO | NO | NO | NO | |
| 2. Ferroalloys Production | NO | NO | NO | NO | NO | NO | NO | |
| 3. Aluminium Production | NO | NO | NO | NO | NO | NO | NO | |
| 4. SF6 Used in Aluminium and Magnesium Foundries | NO | NO | NO | NO | NO | NO | NO | |
| 5. Other *(please specify)* | NO | NO | NO | NO | NO | NO | NO | |
| **2.D. Other Production** | | | | | | | | |
| 1. Pulp and Paper | NO | NO | NO | NO | NO | NO | NO | |
| 2. Food and Drink | NO | NO | NO | NO | NO | NO | NO | |
| **G. Other (please specify)** | | | | | | | | |
| | NO | NO | NO | NO | NO | NO | NO | |

## F-gases (CRF 2.F)

| Greenhouse gas source and sink categories | HFC$_s$ | PFC$_s$ | SF6 | Explanation notes |
|---|---|---|---|---|
| **2. Industrial processes** | | | | |
| **2.E. Production of Halocarbons and $SF_6$** | | | | |
| 1. By-product Emissions | NO | NO | NO | There is no production of Halocarbons and $SF_6$ in Estonia |
| Production of HCFC-22 | NO | NO | NO | |
| Other | NO | NO | NO | |
| **2.F. Consumption of Halocarbons and $SF_6$** | | | | |
| 2.F.1. Refrigeration and Air Conditioning Equipment | **X** | NO | **X** | Experts estimations from 1995 |
| 2.F.2. Foam Blowing | NA | NO | NO | |
| 2.F.3. Fire Extinguishers | NA | NO | NO | |
| 4. Aerosols/ Metered Dose Inhalers | NA | NO | NO | |
| **2.F.P. Consumption of Halocarbons and $SF_6$** | **NO** | **NO** | **X** | HFCs and PFCs data on 2001-2005;<br>SF6 – data on 2005 only |
| | | | | |

## Agriculture (CRF 4)

| Greenhouse gas source and sink categories | $CH_4$ | $N_2O$ | NOx | CO | NMVOC | $SO_2$ | Notes* |
|---|---|---|---|---|---|---|---|
| **4.A. Enteric Fermentation** | **X** | **NO** | **NO** | **NO** | **NO** | **NO** | |
| **4.B. Manure Management** | **X** | **X** | **NO** | **NO** | **NO** | **NO** | |
| **4.C. Rice Cultivation** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | |
| **4.D. Agricultural soils** | | | | | | | |
| 4.D.1. Direct Soil Emissions | | | | | | | |
| 4.D.1.1. Synthetic Fertilizers | NO | X | NO | NO | NO | NO | |
| 4.D.1.2. Animal Manure Applied to Soils | NO | X | NO | NO | NO | NO | |
| 4.D.1.3. N-fixing Crops | NO | X | NO | NO | NO | NO | |
| 4.D.1.4. Crop Residue | NO | X | NO | NO | NO | NO | |
| 4.D.1.5. Cultivation of Histosols | NO | NE | NO | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 4.D.1.6. Other emissions | NO | NO | NO | NO | NO | NO | |
| 4.D.2. Pasture, Range and Paddock Manure | NO | X | NO | NO | NO | NO | |
| 4.D.3. Indirect Emissions | | | | | | | |
| 4.D.3.1. Atmospheric Deposition | NO | X | NO | NO | NO | NO | |
| 4.D.3.2. Nitrogen Leaching and Run-off | NO | X | NO | NO | NO | NO | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4.D.4. Other | NO | NO | NO | NO | NO | NO | |
| **4.E. Prescribed Burning of Savannas** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | |
| **4.F. Field Burning of Agricultural Residues** | **NE** | **NE** | **NE** | **NO** | **NO** | **NO** | Not all data requested were available to perform a complete GHG inventory in this sub-section |

## LULUCF (CRF 5)

| Greenhouse gas source and sink categories | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | Notes* |
|---|---|---|---|---|---|---|---|
| **5.A. Forest Land** | | | | | | | |
| Carbon stock change | | | | | | | |
| 5(I) Direct $N_2O$ emissions from N fertilization | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | |
| 5(II) Non-$CO_2$ emissions from drainage of soils and wetlands | **NE** | **NE** | **NE** | **NO** | **NO** | **NO** | |
| 5(V) Biomass burning | **X** | **X** | **X** | **NO** | **NO** | **NO** | |
| 5.A.1. Forest Land remaining Forest Land | | | | | | | |
| Carbon stock change | **X** | **NO** | **NO** | **NO** | **NO** | **NO** | |
| 5(I) Direct $N_2O$ emissions from N fertilization | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | |
| 5(II) Non-$CO_2$ emissions from drainage of soils and wetlands | **NO** | **NE** | **NE** | **NO** | **NO** | **NO** | |
| 5(V) Biomass burning | **X** | **X** | **X** | **NO** | **NO** | **NO** | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.A.2. Land converted to Forest Land | | | | | | | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.A.2.1. Cropland converted to Forest Land | NE | NO | NO | NO | NO | NO | |
| 5.A.2.2. Grassland converted to Forest Land | NE | NO | NO | NO | NO | NO | |
| 5.A.2.3. Wetlands converted to Forest Land | NE | NO | NO | NO | NO | NO | |
| 5.A.2.4. Settlements converted to Forest Land | NE | NO | NO | NO | NO | NO | |
| 5.A.2.5. Other Land converted to Forest Land | NE | NO | NO | NO | NO | NO | |
| **5.B. Cropland** | | | | | | | |
| Carbon stock change | NE | NO | NO | NO | NO | NO | |
| 5(III) $N_2O$ emissions from disturbances associated with land-use conversion to cropland | NO | NO | NE | NO | NO | NO | |
| 5(IV) $CO_2$ emissions from agricultural lime application | NE | NO | NO | NO | NO | NO | |
| 5(V) Biomass burning | NE | NE | NE | NO | NO | NO | |
| 5.B.1. Cropland remaining Cropland | | | | | | | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| Carbon Stock Change | NE | NO | NO | NO | NO | NO | |
| Biomass Burning | NE | NE | NE | NO | NO | NO | |
| 5.B.2. Land converted to Cropland | | | | | | | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.B.2.1. Forest Land Converted to Cropland | NE | NO | NO | NO | NO | NO | |
| 5.B.2.2. Grassland converted to Cropland | NE | NO | NO | NO | NO | NO | |
| 5.B.2.3. Wetlands converted to Cropland | NE | NO | NO | NO | NO | NO | |
| 5.B.2.3. Settlements converted to Cropland | NE | NO | NO | NO | NO | NO | |
| 5.B.2.4. Other land converted to Cropland | NE | NO | NO | NO | NO | NO | |
| 5(III) $N_2O$ emissions from disturbances associated with land-use conversion to cropland | | | | | | | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.B.2.1. Forest Land Converted to Cropland | NO | NO | NE | NO | NO | NO | |
| 5.B.2.2. Grassland converted to Cropland | NO | NO | NE | NO | NO | NO | |
| 5.B.2.3. Wetlands converted to Cropland | NO | NO | NE | NO | NO | NO | |
| 5.B.2.4. Settlements converted to Cropland | NO | NO | NE | NO | NO | NO | |
| 5.B.2.3. Other land converted to Cropland | NO | NO | NE | NO | NO | NO | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Biomass Burning | NE | NE | NE | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.B.2.1. Forest land converted to Cropland | NE | NE | NE | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| **5.C. Grassland** | | | | | | | |
| Carbon Stock Change | NE | NO | NO | NO | NO | NO | |
| 5(IV) Carbon emissions from agricultural lime application | NE | NO | NO | NO | NO | NO | |
| 5(V) Biomass Burning | NE | NE | NE | NO | NO | NO | |
| 5.C.1. Grassland remaining Grassland | NE | NO | NO | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5(IV) $CO_2$ emissions from agricultural lime application | NE | NO | NO | NO | NO | NO | |
| 5 (V) Biomass Burning | NE | NE | NE | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.C.2. Land converted to Grassland | | | | | | | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.C.2.1. Forest Land Converted to Grassland | NE | NO | NO | NO | NO | NO | |
| 5.C.2.2. Grassland converted to Grassland | NE | NO | NO | NO | NO | NO | |
| 5.C.2.3. Wetlands converted to Grassland | NE | NO | NO | NO | NO | NO | |
| 5.C.2.4. Settlements converted to Grassland | NE | NO | NO | NO | NO | NO | |
| 5.C.2.5. Other land converted to Grassland | NE | NO | NO | NO | NO | NO | |
| 5(V) Biomass Burning | NE | NE | NE | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.C.2.1. Forest land converted to Grassland | NE | NE | NE | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| **5.D. Wetlands** | | | | | | | |
| Carbon Stock Change | NE | NO | NO | NO | NO | NO | |
| 5(II) $N_2O$ emissions from drainage of soils and wetlands | NO | NE | NE | NO | NO | NO | |
| 5(V) Biomass Burning | NE | NE | NE | NO | NO | NO | |
| 5.D.1. Wetlands remaining Wetlands | | | | | | | |
| Carbon Stock Change | NE | NO | NO | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| Biomass Burning | NE | NE | NE | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.D.2. Land converted to Wetlands | | | | | | | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.D.2.1. Forest Land Converted to Wetlands | NE | NO | NO | NO | NO | NO | |
| 5.D.2.2. Grassland converted to Wetlands | NE | NO | NO | NO | NO | NO | |
| 5.D.2.3. Wetlands converted to Wetlands | NE | NO | NO | NO | NO | NO | |
| 5.D.2.4. Settlements converted to Wetlands | NE | NO | NO | NO | NO | NO | |
| 5.D.2.5. Other land converted to Wetlands | NE | NO | NO | NO | NO | NO | |
| 5(II) Non-$CO_2$ emissions from drainage of soils and wetlands | NO | NE | NE | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5(V) Biomass Burning | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5.D.2.1. Forest land converted to Wetlands | NE | NE | NE | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| **5.E. Settlements** | | | | | | | |
| 5.E.1. Settlements remaining Settlements | NE | NO | NO | NO | NO | NO | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.E.2. Land converted to Settlements | | | | | | | Not all data requested were available to perform a complete GHG inventory in this sub-section |
| 5.E.2.1. Forest Land Converted to Settlements | NE | NO | NO | NO | NO | NO | |
| 5.E.2.2. Cropland converted to Settlements | NE | NO | NO | NO | NO | NO | |
| 5.E.2.3. Grassland converted to Settlements | NE | NO | NO | NO | NO | NO | |
| 5.E.2.4. Wetlands converted to Settlements | NE | NO | NO | NO | NO | NO | |
| 5.E.2.5. Other land converted to Settlements | NE | NO | NO | NO | NO | NO | |
| **5.F. Other Land** | **NE** | **NE** | **NE** | **NO** | **NO** | **NO** | |
| **5.G. Other Land (please specify)** | | | | | | | |
| Harvested Wood Products | IE | IE | NE | NO | NO | NO | Estonian inventory on LULUCF considers the total biomass associated with the volume of the extracted roundwood as an immediate emission Emission from Harvested Wood Products was added to the total amount of CH4 emission from waste transferred to landfill |

## Waste (CRF 6)

| Greenhouse gas source and sink categories | $CO_2$ | $CH_4$ | $N_2O$ | $NO_x$ | CO | NMVOC | Notes* |
|---|---|---|---|---|---|---|---|
| **6.A. Solid Waste Disposal on Land** | | | | | | | |
| 6.A.1. Managed Waste Disposal on Land | **NE** | **X** | **NO** | **NE** | **NO** | **NO** | |
| 6.A.2. Unmanaged Waste Disposal Sites | | | | | | | |
| 6.A.2.1. deep (>5 m) | NO | NO | NO | NO | NO | NO | |
| 6.A.2.2. shallow (< 5m) | NO | NO | NO | NO | NO | NO | |
| 6.A.3. Other | NO | NO | NO | NO | NO | NO | |
| **6.B. Wastewater handing** | | | | | | | |
| 6.B.1. Industrial Wastewater | | | | | | | |
| Wastewater | NO | X | NE | NO | NO | NO | |
| Sludge | NO | IE | NE | NO | NO | NO | The emission of $CH_4$ from sludge was not carried out as the amount of sludge was added to the total amount of waste transferred to landfill. |
| 6.B.2. Domestic and Commercial Wastewater | | | | | | | |
| 6.B.2.1. Domestic and Commercial Wastewater | | | | | | | |
| Wastewater | NO | X | NE | NO | NO | NO | |
| Sludge | NO | IE | NE | NO | NO | NO | The emission of $CH_4$ from sludge was not carried out as the amount of sludge was added to the total amount of waste transferred to landfill. |
| 6.B.2.2. Human Sewage | NO | NO | X | NO | NO | NO | |
| **6.C. Waste Incineration** | | | | | | | |
| 6.C.1. Biogenic | NE | NE | NE | NO | NO | NO | |
| 6.C.2. Other | NO | NO | NO | NO | NO | NO | |
| **6.D. Other** | **NO** | **NO** | **NO** | **NO** | **NO** | **NO** | |

# ANNEX 4. Reasoning and impact of the recalculations for the years 1990-2004 for the sectors Energy and Industrial Processes.

**TABLE 8(a) RECALCULATION - RECALCULATED DATA** **Estonia**

**Recalculated year: 1990** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference[1] | Previous submission | Latest submission | Difference[1] | Previous submission | Latest submission | Difference[1] |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **37 493.66** | **37 496.75** | **0.01** | **1 287.52** | **1 286.88** | **-0.05** | **47.34** | **50.70** | **7.09** |
| 1.A. | Fuel Combustion Activities | 37 493.66 | 37 496.75 | 0.01 | 86.66 | 86.02 | -0.74 | 47.34 | 50.70 | 7.09 |
| 1.A.1. | Energy Industries | 29 753.46 | 30 741.77 | 3.32 | 7.87 | 8.84 | 12.32 | 19.99 | 22.42 | 12.16 |
| 1.A.2. | Manufacturing Industries and Construction | 2 654.88 | 1 785.56 | -32.74 | 1.49 | 1.53 | 3.08 | 2.91 | 3.32 | 14.22 |
| 1.A.3. | Transport | 2 693.06 | 3 024.29 | 12.30 | 6.91 | 11.35 | 64.33 | 7.54 | 8.60 | 14.05 |
| 1.A.4. | Other Sectors | 2 392.27 | 1 945.14 | -18.69 | 70.39 | 64.29 | -8.67 | 16.91 | 16.36 | -3.24 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 1 200.86 | 1 200.86 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 407.69 | 407.69 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 793.17 | 793.17 | 0.00 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **613.74** | **945.59** | **54.07** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 613.74 | 628.43 | 2.39 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 317.16 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NA | 0.00 | | NA | 0.00 |

**TABLE 8(a) RECALCULATION - RECALCULATED DATA**
**Recalculated year: 1991**

**Estonia 2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **35 300.24** | **35 027.37** | **-0.77** | **1 260.55** | **1 240.32** | **-1.60** | **45.13** | **47.84** | **6.02** |
| 1.A. | Fuel Combustion Activities | 35 300.24 | 35 027.37 | -0.77 | 101.45 | 80.63 | -20.51 | 45.13 | 47.84 | 6.02 |
| 1.A.1. | Energy Industries | 28 655.85 | 28 529.74 | -0.44 | 7.69 | 8.60 | 11.86 | 18.97 | 20.77 | 9.45 |
| 1.A.2. | Manufacturing Industries and Construction | 1 902.58 | 1 746.41 | -8.21 | 1.57 | 1.46 | -6.98 | 3.34 | 3.30 | -1.31 |
| 1.A.3. | Transport | 3 077.55 | 2 919.45 | -5.14 | 8.96 | 10.25 | 14.47 | 7.85 | 8.30 | 5.81 |
| 1.A.4. | Other Sectors | 1 664.25 | 1 831.76 | 10.07 | 83.23 | 60.33 | -27.52 | 14.96 | 15.47 | 3.41 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 1 159.10 | 1 159.68 | 0.05 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 368.63 | 368.63 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 790.47 | 791.05 | 0.07 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **614.67** | **925.73** | **50.61** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 614.67 | 633.86 | 3.12 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 291.87 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |

**TABLE 8(a) RECALCULATION - RECALCULATED DATA** **Estonia**
**Recalculated year: 1992** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **25 828.35** | **25 986.76** | **0.61** | **873.04** | **867.72** | **-0.61** | **33.13** | **34.36** | **3.70** |
| 1.A. | Fuel Combustion Activities | 25 828.35 | 25 986.76 | 0.61 | 70.72 | 65.06 | -8.00 | 33.13 | 34.36 | 3.70 |
| 1.A.1. | Energy Industries | 22 066.13 | 22 313.40 | 1.12 | 6.02 | 6.58 | 9.35 | 14.97 | 16.06 | 7.30 |
| 1.A.2. | Manufacturing Industries and Construction | 1 230.70 | 1 140.32 | -7.34 | 0.93 | 0.87 | -6.41 | 2.10 | 2.02 | -3.65 |
| 1.A.3. | Transport | 1 497.89 | 1 539.87 | 2.80 | 3.51 | 5.09 | 44.80 | 4.17 | 4.24 | 1.75 |
| 1.A.4. | Other Sectors | 1 033.62 | 993.16 | -3.91 | 60.25 | 52.51 | -12.84 | 11.90 | 12.04 | 1.15 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 802.33 | 802.66 | 0.04 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 341.34 | 341.34 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 460.99 | 461.32 | 0.07 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **313.46** | **538.11** | **71.67** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 313.46 | 387.65 | 23.67 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 150.45 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |

**TABLE 8(a) RECALCULATION - RECALCULATED DATA** **Estonia**
**Recalculated year: 1993** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **20 360.35** | **20 967.58** | **2.98** | **568.18** | **566.71** | **-100.00** | **29.16** | **31.11** | **6.69** |
| 1.A. | Fuel Combustion Activities | 20 360.35 | 20 967.58 | 2.98 | 60.75 | 58.93 | -100.00 | 29.16 | 31.11 | 6.69 |
| 1.A.1. | Energy Industries | 17 007.43 | 17 723.17 | 4.21 | 4.93 | 5.86 | -100.00 | 12.51 | 14.34 | 14.61 |
| 1.A.2. | Manufacturing Industries and Construction | 652.66 | 538.53 | -17.49 | 0.39 | 0.31 | -100.00 | 1.07 | 0.84 | -21.72 |
| 1.A.3. | Transport | 1 712.89 | 1 893.81 | 10.56 | 3.91 | 5.76 | -100.00 | 4.73 | 5.23 | 10.50 |
| 1.A.4. | Other Sectors | 987.37 | 812.08 | -17.75 | 51.52 | 46.99 | -100.00 | 10.85 | 10.71 | -1.31 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 507.43 | 507.78 | -100.00 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 281.40 | 281.40 | -100.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 226.03 | 226.38 | -100.00 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **193.06** | **304.58** | **57.77** | **0.00** | | **NA,NO** | **0.00** | **NA,NO** | **NA,NO** |
| 2.A. | Mineral Products | 193.06 | 244.62 | 26.71 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 59.96 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

## TABLE 8(a) RECALCULATION – RECALCULATED DATA Estonia
## Recalculated year: 1994 2007

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **21 163.21** | **21 717.73** | **2.62** | **676.47** | **677.81** | **0.20** | **34.30** | **35.42** | **3.26** |
| 1.A. | Fuel Combustion Activities | 21 163.21 | 21 717.73 | 2.62 | 73.45 | 74.36 | 1.25 | 34.30 | 35.42 | 3.26 |
| 1.A.1. | Energy Industries | 17 764.75 | 18 375.66 | 3.44 | 6.38 | 6.87 | 7.76 | 14.92 | 15.89 | 6.52 |
| 1.A.2. | Manufacturing Industries and Construction | 907.41 | 848.11 | -6.54 | 0.57 | 0.50 | -11.43 | 1.48 | 1.36 | -7.69 |
| 1.A.3. | Transport | 1 521.60 | 1 988.00 | 30.65 | 4.13 | 6.77 | 63.80 | 4.34 | 5.45 | 25.60 |
| 1.A.4. | Other Sectors | 969.44 | 505.95 | -47.81 | 62.37 | 60.22 | -3.45 | 13.57 | 12.72 | -6.27 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 603.03 | 603.44 | 0.07 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 276.62 | 276.62 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 326.41 | 326.83 | 0.13 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **214.87** | **546.53** | **154.36** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 214.87 | 344.22 | 60.20 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 202.31 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

**TABLE 8(a) RECALCULATION – RECALCULATED DATA** **Estonia**
**Recalculated year: 1995** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference[1] | Previous submission | Latest submission | Difference[1] | Previous submission | Latest submission | Difference[1] |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **19 093.53** | **19 536.18** | **2.32** | **755.18** | **752.88** | **-0.30** | **42.75** | **44.76** | **4.71** |
| 1.A. | Fuel Combustion Activities | 19 093.53 | 19 536.18 | 2.32 | 124.23 | 122.38 | -1.50 | 42.75 | 44.76 | 4.71 |
| 1.A.1. | Energy Industries | 16 363.43 | 16 884.51 | 3.18 | 7.00 | 7.92 | 13.06 | 15.62 | 17.41 | 11.45 |
| 1.A.2. | Manufacturing Industries and Construction | 633.29 | 556.61 | -12.11 | 0.46 | 0.36 | -21.73 | 0.76 | 0.65 | -13.88 |
| 1.A.3. | Transport | 1 102.94 | 1 564.92 | 41.89 | 3.02 | 5.62 | 85.91 | 3.17 | 4.48 | 41.09 |
| 1.A.4. | Other Sectors | 993.87 | 530.14 | -46.66 | 113.75 | 108.48 | -4.63 | 23.20 | 22.23 | -4.19 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 630.94 | 630.50 | -0.07 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 254.67 | 254.67 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 376.28 | 375.84 | -0.12 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **221.65** | **568.54** | **156.50** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 221.45 | 361.08 | 63.05 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.21 | 207.47 | 100 126.09 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

**TABLE 8(a) RECALCULATION – RECALCULATED DATA** **Estonia**
**Recalculated year: 1996** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **20 056.75** | **20 523.81** | **2.33** | **842.85** | **838.50** | **-0.52** | **48.20** | **49.81** | **3.35** |
| 1.A. | Fuel Combustion Activities | 20 056.75 | 20 523.81 | 2.33 | 143.85 | 139.66 | -2.91 | 48.20 | 49.81 | 3.35 |
| 1.A.1. | Energy Industries | 17 126.88 | 17 631.47 | 2.95 | 7.77 | 8.48 | 9.21 | 17.00 | 18.40 | 8.24 |
| 1.A.2. | Manufacturing Industries and Construction | 729.59 | 692.62 | -5.07 | 0.62 | 0.59 | -5.00 | 1.25 | 1.23 | -1.05 |
| 1.A.3. | Transport | 1 047.22 | 1 621.15 | 54.81 | 2.50 | 6.06 | 142.26 | 3.03 | 4.63 | 52.44 |
| 1.A.4. | Other Sectors | 1 153.05 | 578.57 | -49.82 | 132.97 | 124.53 | -6.34 | 26.91 | 25.55 | -5.07 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 699.01 | 698.84 | -0.02 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 282.81 | 282.81 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 416.20 | 416.03 | -0.04 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **207.01** | **586.42** | **183.27** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 207.01 | 375.17 | 81.23 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 211.25 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

## TABLE 8(a) RECALCULATION – RECALCULATED DATA
## Recalculated year: 1997

Estonia
2007

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **19 998.59** | **19 949.54** | **-0.25** | **824.53** | **818.01** | **-0.79** | **50.00** | **48.20** | **-3.61** |
| 1.A. | Fuel Combustion Activities | 19 998.59 | 19 949.54 | -0.25 | 145.73 | 139.27 | -4.44 | 50.00 | 48.20 | -3.61 |
| 1.A.1. | Energy Industries | 16 850.39 | 17 181.32 | 1.96 | 8.43 | 8.04 | -4.63 | 17.96 | 17.19 | -4.29 |
| 1.A.2. | Manufacturing Industries and Construction | 655.49 | 605.33 | -7.65 | 0.52 | 0.48 | -7.99 | 1.08 | 1.02 | -4.95 |
| 1.A.3. | Transport | 1 211.78 | 1 681.55 | 38.77 | 3.23 | 6.61 | 104.59 | 3.55 | 4.54 | 27.80 |
| 1.A.4. | Other Sectors | 1 280.93 | 481.34 | -62.42 | 133.55 | 124.14 | -7.05 | 27.42 | 25.45 | -7.17 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 678.80 | 678.74 | -0.01 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 273.52 | 273.52 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 405.28 | 405.22 | -0.01 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **226.02** | **633.80** | **180.42** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 226.02 | 411.43 | 82.03 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 222.37 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

**TABLE 8(a) RECALCULATION – RECALCULATED DATA** **Estonia**
**Recalculated year: 1998** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **17 950.08** | **17 606.22** | **-1.92** | **723.34** | **718.57** | **-0.66** | **43.20** | **41.72** | **-3.43** |
| 1.A. | Fuel Combustion Activities | 17 950.08 | 17 606.22 | -1.92 | 114.65 | 110.09 | -3.98 | 43.20 | 41.72 | -3.43 |
| 1.A.1. | Energy Industries | 14 791.02 | 14 788.68 | -0.02 | 8.09 | 7.75 | -4.31 | 17.22 | 16.53 | -3.99 |
| 1.A.2. | Manufacturing Industries and Construction | 666.38 | 636.69 | -4.46 | 0.46 | 0.51 | 10.21 | 0.78 | 0.75 | -3.41 |
| 1.A.3. | Transport | 1 352.27 | 1 736.97 | 28.45 | 3.56 | 6.52 | 83.30 | 3.79 | 4.68 | 23.41 |
| 1.A.4. | Other Sectors | 1 140.41 | 443.88 | -61.08 | 102.55 | 95.32 | -7.05 | 21.41 | 19.76 | -7.72 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 608.69 | 608.48 | -0.03 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 225.88 | 225.88 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 382.81 | 382.60 | -0.05 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **367.63** | **670.32** | **82.34** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 367.63 | 428.80 | 16.64 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 241.52 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

**TABLE 8(a) RECALCULATION – RECALCULATED DATA** **Estonia**
**Recalculated year: 1999** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **16 424.10** | **16 148.13** | **-1.68** | **689.33** | **683.35** | **-0.87** | **41.41** | **40.12** | **-3.12** |
| 1.A. | Fuel Combustion Activities | 16 424.10 | 16 148.13 | -1.68 | 111.93 | 106.48 | -4.87 | 41.41 | 40.12 | -3.12 |
| 1.A.1. | Energy Industries | 13 477.90 | 13 758.85 | 2.08 | 7.84 | 7.57 | -3.54 | 16.62 | 16.06 | -3.37 |
| 1.A.2. | Manufacturing Industries and Construction | 660.01 | 373.55 | -43.40 | 0.30 | 0.37 | 25.64 | 0.54 | 0.57 | 4.63 |
| 1.A.3. | Transport | 1 203.19 | 1 622.76 | 34.87 | 3.35 | 6.14 | 83.38 | 3.52 | 4.36 | 23.79 |
| 1.A.4. | Other Sectors | 1 083.00 | 392.97 | -63.71 | 100.44 | 92.40 | -8.01 | 20.72 | 19.13 | -7.71 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 577.41 | 576.87 | -0.09 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 204.50 | 204.50 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 372.90 | 372.37 | -0.14 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **346.79** | **603.30** | **73.97** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 346.79 | 386.30 | 11.39 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 217.01 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

**TABLE 8(a) RECALCULATION – RECALCULATED DATA** **Estonia**
**Recalculated year: 2000** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **16 018.51** | **16 369.92** | **2.19** | **771.57** | **770.43** | **-0.15** | **37.95** | **40.19** | **5.91** |
| 1.A. | Fuel Combustion Activities | 16 018.51 | 16 369.92 | 2.19 | 107.46 | 107.07 | -0.36 | 37.95 | 40.19 | 5.91 |
| 1.A.1. | Energy Industries | 13 945.36 | 13 888.15 | -0.41 | 7.35 | 7.64 | 3.96 | 15.29 | 15.86 | 3.74 |
| 1.A.2. | Manufacturing Industries and Construction | 482.94 | 484.27 | 0.28 | 0.49 | 0.58 | 19.18 | 0.91 | 0.93 | 1.89 |
| 1.A.3. | Transport | 554.25 | 1 604.64 | 189.51 | 0.30 | 6.16 | 1 933.72 | 1.09 | 4.24 | 289.57 |
| 1.A.4. | Other Sectors | 1 035.96 | 392.86 | -62.08 | 99.32 | 92.69 | -6.67 | 20.66 | 19.15 | -7.27 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 664.11 | 663.36 | -0.11 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 236.21 | 236.21 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 427.91 | 427.16 | -0.18 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **354.33** | **582.18** | **64.30** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 354.33 | 394.35 | 11.29 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 187.83 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

**TABLE 8(a) RECALCULATION – RECALCULATED DATA** **Estonia**
**Recalculated year: 2001** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **16 721.75** | **16 650.40** | **-0.43** | **801.00** | **797.03** | **-0.50** | **41.58** | **41.70** | **0.30** |
| 1.A. | Fuel Combustion Activities | 16 721.75 | 16 650.40 | -0.43 | 109.72 | 106.33 | -3.09 | 41.58 | 41.70 | 0.30 |
| 1.A.1. | Energy Industries | 13 912.22 | 13 816.88 | -0.69 | 8.21 | 8.21 | -0.02 | 16.75 | 16.74 | -0.02 |
| 1.A.2. | Manufacturing Industries and Construction | 588.17 | 589.93 | 0.30 | 0.74 | 0.83 | 12.19 | 1.38 | 1.43 | 3.97 |
| 1.A.3. | Transport | 1 914.96 | 1 904.05 | -0.57 | 6.93 | 7.34 | 5.91 | 5.29 | 5.00 | -5.48 |
| 1.A.4. | Other Sectors | 306.40 | 339.55 | 10.82 | 93.85 | 89.96 | -4.14 | 18.16 | 18.53 | 2.01 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 691.28 | 690.70 | -0.08 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 231.47 | 231.47 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 459.81 | 459.22 | -0.13 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **355.58** | **605.08** | **70.17** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 355.58 | 402.49 | 13.19 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 202.59 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

## TABLE 8(a) RECALCULATION – RECALCULATED DATA
**Recalculated year: 2002**

**Estonia 2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] | Previous submission | Latest submission | Difference[(1)] |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **16 971.38** | **16 536.79** | **-2.56** | **719.84** | **714.55** | **-0.74** | **42.49** | **42.31** | **-0.44** |
| 1.A. | Fuel Combustion Activities | 16 971.38 | 16 536.79 | -2.56 | 110.70 | 106.27 | -4.00 | 42.49 | 42.31 | -0.44 |
| 1.A.1. | Energy Industries | 13 911.44 | 13 562.01 | -2.51 | 8.44 | 8.43 | -0.01 | 17.09 | 17.09 | -0.01 |
| 1.A.2. | Manufacturing Industries and Construction | 421.68 | 424.52 | 0.67 | 0.44 | 0.56 | 28.53 | 0.87 | 0.87 | 0.34 |
| 1.A.3. | Transport | 2 174.71 | 1 988.21 | -8.58 | 7.28 | 7.08 | -2.75 | 6.03 | 5.23 | -13.27 |
| 1.A.4. | Other Sectors | 463.54 | 562.05 | 21.25 | 94.55 | 90.20 | -4.61 | 18.50 | 19.11 | 3.32 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 609.14 | 608.28 | -0.14 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | 0.00 | NA,NO | 0.00 | 223.26 | 223.26 | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | 0.00 | NA,NO | 0.00 | 385.87 | 385.01 | -0.22 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **340.48** | **413.99** | **21.59** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 340.48 | 385.59 | 13.25 | 0.00 | NA | 0.00 | 0.00 | NA | 0.00 |
| 2.B. | Chemical Industry | 0.00 | 28.40 | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 2.C. | Metal Production | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA | 0.00 |
| 2.D. | Other Production | 0.00 | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

**TABLE 8(a) RECALCULATION – RECALCULATED DATA** **Estonia**
**Recalculated year: 2003** **2007**

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) | Previous submission | Latest submission | Difference(1) |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **18 830.01** | **18 608.32** | **-1.18** | **770.53** | **765.67** | **-0.63** | **44.77** | **44.53** | **-0.54** |
| 1.A. | Fuel Combustion Activities | 18 830.01 | 18 608.32 | -1.18 | 115.48 | 111.50 | -3.45 | 44.77 | 44.53 | -0.54 |
| 1.A.1. | Energy Industries | 15 854.75 | 15 625.37 | -1.45 | 8.18 | 8.20 | 0.31 | 16.53 | 16.58 | 0.29 |
| 1.A.2. | Manufacturing Industries and Construction | 419.92 | 475.53 | 13.24 | 1.50 | 1.71 | 13.90 | 2.86 | 2.87 | 0.29 |
| 1.A.3. | Transport | 2 146.56 | 1 946.46 | -9.32 | 7.05 | 6.85 | -2.97 | 5.93 | 5.11 | -13.81 |
| 1.A.4. | Other Sectors | 408.78 | 560.95 | 37.23 | 98.74 | 94.74 | -4.05 | 19.44 | 19.96 | 2.68 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 655.05 | 654.17 | -0.13 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | NO | NO | 0.00 | 229.37 | 229.37 | 0.00 | 0.00 | NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | NO | NA,NO | 0.00 | 425.68 | 424.80 | -0.21 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **276.43** | **456.31** | **65.07** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 276.43 | 363.48 | 31.49 | NO | NA | 0.00 | NO | NA | 0.00 |
| 2.B. | Chemical Industry | NO | 92.82 | 0.00 | NO | NA,NO | 0.00 | NO | NA,NO | 0.00 |
| 2.C. | Metal Production | NO | NA,NO | 0.00 | NO | NA,NO | 0.00 | NO | NA | 0.00 |
| 2.D. | Other Production | NE | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 | 0.00 | NO | 0.00 |

## TABLE 8(a) RECALCULATION – RECALCULATED DATA Estonia
## Recalculated year: 2004 2007

| GREENHOUSE GAS SOURCE AND SINK CATEGORIES | | $CO_2$ | | | $CH_4$ | | | $N_2O$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Previous submission | Latest submission | Difference[1] | Previous submission | Latest submission | Difference[1] | Previous submission | Latest submission | Difference[1] |
| | | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) | $CO_2$ equivalent (Gg) | | (%) |
| **Total National Emissions and Removals** | | | | **0.00** | | | **0.00** | | | **0.00** |
| **1. Energy** | | **18 531.64** | **17 953.33** | **-3.12** | **744.34** | **850.01** | **14.20** | **44.10** | **44.39** | **0.66** |
| 1.A. | Fuel Combustion Activities | 18 531.64 | 17 953.33 | -3.12 | 116.98 | 112.06 | -4.21 | 44.10 | 44.39 | 0.66 |
| 1.A.1. | Energy Industries | 15 552.67 | 14 938.53 | -3.95 | 8.01 | 7.99 | -0.22 | 16.16 | 16.06 | -0.59 |
| 1.A.2. | Manufacturing Industries and Construction | 447.06 | 471.46 | 5.46 | 1.50 | 1.64 | 9.56 | 2.91 | 2.93 | 0.76 |
| 1.A.3. | Transport | 2 144.87 | 1 997.82 | -6.86 | 6.97 | 6.77 | -2.92 | 5.58 | 5.23 | -6.31 |
| 1.A.4. | Other Sectors | 387.04 | 545.52 | 40.95 | 100.49 | 95.65 | -4.82 | 19.45 | 20.16 | 3.69 |
| 1.A.5. | Other | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 | 0.00 | NA,NO | 0.00 |
| 1.B. | Fugitive Emissions from Fuels | 0.00 | NA,NO | 0.00 | 627.36 | 737.95 | 17.63 | 0.00 | NA,NO | 0.00 |
| 1.B.1. | Solid fuel | NO | NO | 0.00 | 236.43 | 236.43 | 0.00 | 0.00 | NO | 0.00 |
| 1.B.2. | Oil and Natural Gas | NO | NA,NO | 0.00 | 390.93 | 501.52 | 28.29 | 0.00 | NA,NO | 0.00 |
| **2. Industrial Processes** | | **700.59** | **567.46** | **-19.00** | **0.00** | **NA,NO** | **0.00** | **0.00** | **NA,NO** | **0.00** |
| 2.A. | Mineral Products | 399.09 | 396.04 | -0.77 | NO | NA | 0.00 | NO | NA | 0.00 |
| 2.B. | Chemical Industry | 301.50 | 171.42 | -43.14 | NO | NA,NO | 0.00 | NO | NA,NO | 0.00 |
| 2.C. | Metal Production | NO | NA,NO | 0.00 | NO | NA,NO | 0.00 | NO | NA | 0.00 |
| 2.D. | Other Production | NE | NO | 0.00 | | | | | | |
| 2.G. | Other | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |