GREENHOUSE GAS EMISSIONS IN ESTONIA 1990-2011

NATIONAL INVENTORY REPORT
under the UNFCCC and the Kyoto Protocol

Submission to the UNFCCC secretariat

Common Reporting Formats (CRF)
1990–2011

Tallinn 2013

PREFACE

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

Part I. Description of the greenhouse gas emission inventory according to the updated UNFCCC reporting guidelines (FCCC/SBSTA/2006/9) containing description of the organization of the national greenhouse gas inventory, IPCC and other methods applied in calculation of the year 2011 emissions and exemptions to the previous inventories. A summarizing table of the emissions data for the years 1990–2011 is included as well as description of the current emission trends.

Part II. Supplementary information required under Article 7, paragraph 1 of the Kyoto Protocol.

Estonian Environmental Research Centre (Ms Kristina Kaar, Ms Katri Saare, Ms Kaili Tuulik and Mr Tanel Laasma), Estonian Environment Information Centre (Ms Kaie Kriiska and Mr Veiko Adermann) and Department of Chemistry at Tallinn University of Technology (Ms Olga Gavrilova), have made the inventory calculations, the description of the methodologies and other information included in the National Inventory Report.

Climate Department of Estonian Environmental Research Centre (Ms Kristina Kaar) and Climate and Radiation Department of the Ministry of the Environment (Ms Anne Mändmets) co-ordinated the process of the inventory preparation.

The Ministry of the Environment has responsibility of the preparation and finalization of inventory reports and their submission to the UNFCCC Secretariat and the European Commission.

Report co-financed by the Environmental Investment Centre.

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ES.1.1 Background information on climate change

Estonia has not carried out exhaustive study on impacts of climate change. According to available information the impacts of climate change in Estonia are expected to be relatively small compared to the southern and northern regions of Europe. Therefore no significant consequences are expected for biodiversity or public health. Some species may disappear and some new species will probably emerge, but these changes are quite negligible.

The rise in temperature and precipitation will have a positive rather than negative effect on Estonian economy. For example, it will probably be favourable for agriculture, especially grassland husbandry. The total growing season will lengthen and a greater number of harvests will become possible. In the case of higher temperatures and higher rainfall, the growth and development of herbaceous plants will quicken and harvesting times will shift to an earlier period. Livestock will be better provided with fodder in summer and winter.

The main hazards and economic losses in Estonia will result from the rise of sea level which will cause flooding in coastal areas, the erosion of sandy beaches and the destruction of harbour constructions.

ES.1.2 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 UNFCCC and in 2002, the Kyoto Protocol. Under the Protocol Estonia is obliged to reduce during the period 2008–2012 the emissions of air polluting greenhouse gases from its territory by 8% as compared with the 1990 level.

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

ES.1.3 Background information on supplementary information required under Article 7, paragraph 1, on the Kyoto Protocol

Estonia, as an Annex I Party that is also part of the Kyoto Protocol is required to report supplementary information in accordance with Article 7, paragraph 1, of the Kyoto Protocol. The required information is specified in the Annex of Decision 15/CMP.1.

Part II of this report includes information related to Article 3, paragraph 3 (Afforestation, Reforestation, Deforestation) in Chapter 11 and information related to Article 3, paragraph 14 (information on minimization of adverse impacts of climate change) in Chapter 15. Estonia has not selected activities under Article 3, paragraph 4 during the first commitment period.

A summary of information on accounting of Kyoto units is presented in Chapter 12 and more detailed information is presented in Standard Electronic Tables (SEF) which are part of Estonia's inventory submission. Information related to changes in national system and in the national registry are provided in Chapter 13 and Chapter 14 accordingly.

ES2. Summary of national emission and removal related trends, and emission and removals from KP-LULUCF activities

ES.2.1 GHG inventory

In 2011 the total emissions of GHGs, measured as CO_2 equivalents, were 16 692.77 Gg, and without net CO_2 from LULUCF 20 955.58 Gg. From 1990 to 2011 the emissions decreased by 48.31%. Table ES.1. shows the trends in the total emissions during the period 1990–2011. Figure ES.1. shows greenhouse gas emissions trends in CO_2 equivalents.

In 2011, the most important GHG in Estonia was carbon dioxide (CO_2), contributing 89.87% to total national GHG emissions expressed in CO_2 equivalents, followed by nitrous oxide (N_2O), 4.79%, and methane (CH_4), 4.57%. Fluorocarbons (so-called "F-gases") account for about 0.77% of total emissions. The Energy sector accounted for 89.05% of total GHG emissions, followed by Agriculture (6.06%), Industrial Processes (2.93%), Waste (1.86%) and Solvent and Other Product Use (0.09%).

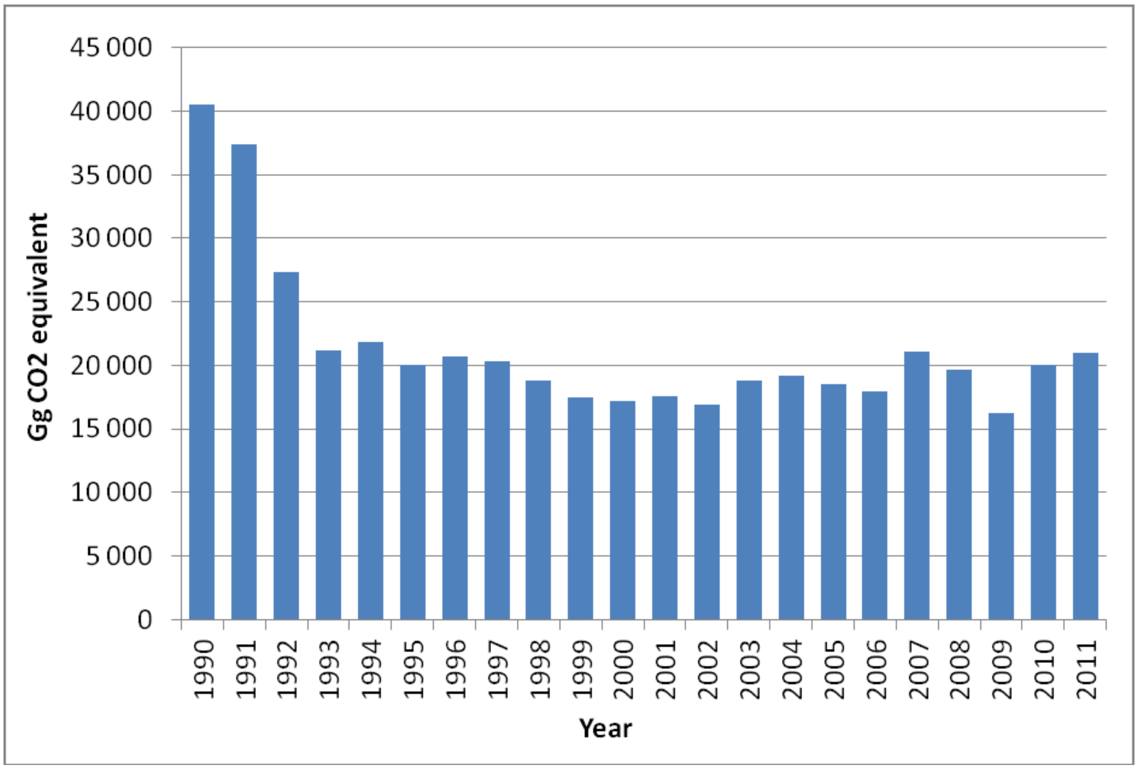


Figure ES.1. Overall development of greenhouse gases in Estonia, in CO_2 equivalents (without net CO_2 from LULUCF)

Table ES.1. Greenhouse gas emissions in Estonia. Emission trends

GREENHOUSE GAS EMISSIONS	**Base year (1990)**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
	CO2 equivalent (Gg)													
CO_2 emissions including net CO_2 from LULUCF	27 784.35	7 383.03	16 239.54	20 072.21	18 339.99	17 487.43	14 691.96	11 378.41	8 838.86	10 755.46	9 224.65	6 808.82	11 852.77	14 563.07
CO_2 emissions excluding net CO_2 from LULUCF	36 635.00	17 981.46	15 143.30	15 497.77	15 004.26	16 832.39	17 082.08	16 419.49	15 842.60	18 873.36	17 357.71	14 157.89	17 801.49	18 832.99
CH_4 emissions including CH_4 from LULUCF	1 673.58	982.05	1 026.63	1 056.87	1 007.86	1 038.68	1 073.03	1 044.24	1 062.85	1 063.05	1 055.08	984.69	1 016.97	957.54
CH_4 emissions excluding CH_4 from LULUCF	1 673.18	981.63	1 024.95	1 056.64	1 004.31	1 038.20	1 072.00	1 043.93	1 054.57	1 062.77	1 053.77	984.50	1 016.84	957.42
N_2O emissions including N_2O from LULUCF	2 235.50	1 048.10	903.44	890.45	841.19	877.18	919.32	898.33	900.83	966.23	1 079.94	986.35	1 023.01	1 010.97
N_2O emissions excluding N_2O from LULUCF	2 233.95	1 046.55	901.65	888.93	838.92	875.22	916.72	894.98	894.95	960.83	1 073.49	979.61	1 016.05	1 003.97
HFCs	NA,NE,NO	25.37	69.54	85.47	86.52	91.92	104.61	118.16	135.31	148.98	131.31	138.15	152.56	159.38
PFCs	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.07	0.06	0.04	NA,NE,NO	NA,NE,NO	NA,NE,NO
SF_6	NA,NE,NO	3.22	2.73	1.74	1.44	1.33	1.08	1.08	1.15	0.97	1.35	1.44	1.81	1.82
Total (including LULUCF)	**31 693.44**	**9 441.77**	**18 241.88**	**22 106.75**	**20 276.99**	**19 496.53**	**16 790.00**	**13 440.22**	**10 939.07**	**12 934.75**	**11 492.37**	**8 919.45**	**14 047.13**	**16 692.77**
Total (excluding LULUCF)	**40 542.14**	**20 038.23**	**17 142.17**	**17 530.56**	**16 935.43**	**18 839.07**	**19 176.50**	**18 477.64**	**17 928.66**	**21 046.97**	**19 617.67**	**16 261.58**	**19 988.77**	**20 955.58**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**Base year (1990)**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
	CO2 equivalent (Gg)													
1. Energy	35 956.90	17 596.48	14 770.96	15 129.28	14 824.75	16 594.37	16 722.18	16 020.66	15 385.39	18 270.54	16 745.77	14 129.73	17 767.99	18 661.63
2. Industrial Processes	1 048.23	675.54	705.92	746.39	545.35	605.39	764.67	807.11	871.47	1 059.00	1 051.13	451.04	493.86	613.82
3. Solvent and Other Product Use	26.44	26.02	26.76	24.47	24.84	24.69	25.07	26.16	26.35	24.43	21.96	18.49	17.39	18.86
4. Agriculture	3 166.84	1 483.71	1 203.70	1 188.80	1 112.73	1 163.64	1 196.40	1 170.78	1 166.40	1 209.27	1 329.85	1 230.60	1 256.59	1 270.52
5. Land Use, Land-Use Change and Forestry	-8 848.70	-10 596.46	1 099.71	4 576.19	3 341.56	657.47	-2 386.49	-5 037.42	-6 989.58	-8 112.22	-8 125.30	-7 342.13	-5 941.64	-4 262.81
6. Waste	343.72	256.49	434.83	441.62	427.76	450.98	468.18	452.93	479.04	483.74	468.96	431.72	452.94	390.76

Table ES.2. Greenhouse gas emissions in Estonia – annual contributions of the various greenhouse gases

GHG EMISSIONS [CO2 equivalent (Gg)]	1990		1995		2000		2005		2007		2008		2009		2010		2011	
	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]	[Gg]	[%]
CO_2 emissions excluding net CO_2 from LULUCF	**36 635.00**	90.36	**17 981.46**	89.74	**15 143.30**	88.34	**16 419.49**	88.86	**18 873.36**	89.67	**17 357.71**	88.48	**14 157.89**	87.06	**17 801.49**	89.06	**18 832.99**	89.87
CH_4 emissions excluding CH_4 from LULUCF	**1 673.18**	4.13	**981.63**	4.90	**1 024.95**	5.98	**1 043.93**	5.65	**1 062.77**	5.05	**1 053.77**	5.37	**984.50**	6.05	**1 016.84**	5.09	**957.42**	4.57
N_2O emissions excluding N_2O from LULUCF	**2 233.95**	5.51	**1 046.55**	5.22	**901.65**	5.26	**894.98**	4.84	**960.83**	4.57	**1 073.49**	5.47	**979.61**	6.02	**1 016.05**	5.08	**1 003.97**	4.79
HFCs	**NA,NE,NO**		**25.37**	0.127	**69.54**	0.406	**118.16**	0.639	**148.98**	0.708	**131.31**	0.669	**138.15**	0.850	**152.56**	0.763	**159.38**	0.761
PFCs	**NA,NE,NO**		**NA,NE,NO**		**NA,NE,NO**		**NA,NE,NO**		**0.06**	0.000	**0.04**	0.000	**NA,NE,NO**		**NA,NE,NO**		**NA,NE,NO**	
SF_6	**NA,NE,NO**		**3.22**	0.016	**2.73**	0.016	**1.08**	0.006	**0.97**	0.005	**1.35**	0.007	**1.44**	0.009	**1.81**	0.009	**1.82**	0.009
Total (excluding LULUCF)	**40 542.14**		**20 038.23**		**17 142.17**		**18 477.64**		**21 046.97**		**19 617.67**		**16 261.58**		**19 988.77**		**20 955.58**	

ES.2.2 KP-LULUCF activities

Under Article 3, paragraph 3 of the Kyoto Protocol (KP), Estonia reports emissions and removals from afforestation (A), reforestation (R) and deforestation (D).

Estimates of emissions and removals from Article 3.3 activities are presented in Table ES.3. In 2011, net emissions from Article 3.3 activities were 232.11 Gg CO_2 eq. Uptake from afforestation and reforestation activities including emissions from biomass burning was estimated at -145.01 Gg CO_2 eq., whereas deforestation resulted in a net emission of 377.12 Gg CO_2 eq. Areas subject to AR and D were 27 295 and 19 135 ha, respectively by the end of 2011. Annual rates of afforestation and deforestation have declined continuously from 0.6 kha to 0.4 kha per year for AR and from 2.2 kha to 0.8 kha per year for D during the period 2008–2011.

Table ES.3. Net CO_2 emissions/removals in the KP LULUCF sector, Gg CO_2 equivalent

Greenhouse gas sources and sink activities	**Net CO_2 eq. emissions/removals, Gg**				
	2008	**2009**	**2010**	**2011**	**Total**
A. Article 3.3 activities	**623.64**	**517.17**	**344.66**	**232.11**	**1 717.59**
A.1. Afforestation and Reforestation	-97.88	-121.26	-131.07	-145.01	-495.23
A.1.1. Units of land not harvested since the beginning of the commitment period	-97.88	-121.26	-131.07	-145.01	
A.1.1. Biomass burning	1.5E-05	1.6E-05	1.8E-05	2.0E-05	
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA	
A.2. Deforestation	721.53	638.44	475.74	377.12	2 212.82
A.2.1 Biomass burning	NO	NO	NO	NO	NO
B. Article 3.4 activities	**NA**	**NA**	**NA**	**NA**	**NA**

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

ES.3.1. GHG inventory

The greenhouse gas emissions and removals are divided into the following sectors according to the updated UNFCCC reporting guidelines on annual inventories (FCCC/SBSTA/2006/9): 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 ES.2 shows the contributions of individual source and sink categories to total greenhouse gas emissions.

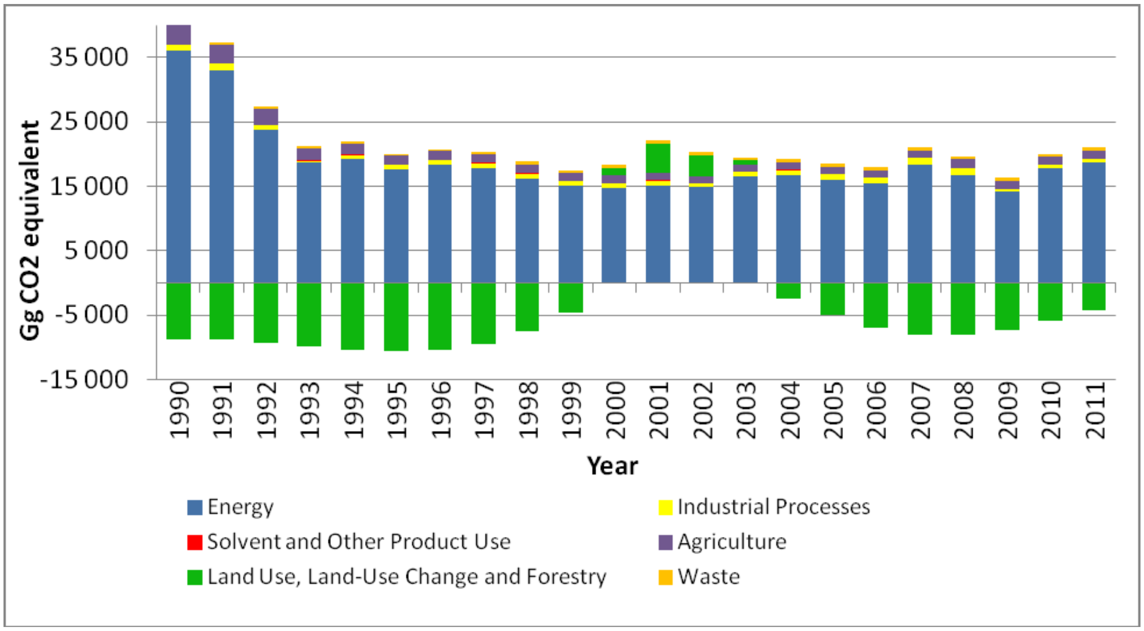


Figure ES.2. Greenhouse-gas emissions trends, by source groups, in CO_2 equivalents

The energy sector is the most significant source of greenhouse gas emissions in Estonia with 89.05% share of the total emissions in 2011. Since the base year, emissions have decreased by 48.10%. The key driver for the fall in emissions is the transition from a planned economy to a market economy.

Agriculture is the second most significant source of greenhouse gas emissions in Estonia. In 2011 the agriculture sector contributed 6.06% of the total emissions. Since the base year emissions have decreased by 59.88%, mostly due to the decreasing livestock population and quantities of synthetic fertilizers and manure applied to agricultural fields.

In 2011 industrial processes greenhouse gas emissions contributed 2.93% of the total greenhouse gas emissions in Estonia. Emissions have decreased by 41.44% between 1990 and 2011. Industrial CO_2 emissions have fluctuated strongly since 1990, reaching the lowest level in 1993. The decrease in the emissions during the early 1990s was caused by the transition from planned economy to market economy after 1991 when Estonia became independent.

The Waste sector contributed 1.86% of the total greenhouse gas emissions in 2011. The total emissions in CO_2 equivalents from the Waste sector increased by 13.69% compared to the base year: the emissions from solid waste landfilled increased by 41.5% and emissions from waste composting processes increased about hundred fold – from 1.26 Gg in 1990 to 96.1 Gg in 2011.

In 2011, the LULUCF sector acted as a CO_2 sink, totalling 4 262.81 Gg CO_2 equivalent. Since 1990, net removals have decreased by 51.83%. The key driver for the decrease in removals is the increased harvest rate in forest land remaining forest land. Due to the comparatively intensive use of forest resources, carbon flows derived from forest land category have a major influence on the LULUCF sector's total carbon balance. LULUCF sector is a net source of emissions in some years (2000–2003) and a net sink of carbon in other years.

ES.3.2. KP-LULUCF activities

Estonia reports activities under Article 3, paragraph 3, of the Kyoto Protocol and has not elected any activities under Article 3, paragraph 4, of the Kyoto Protocol. Estonia has chosen to account for the KP-LULUCF activities at the end of commitment period.

The total emissions related to afforestation/reforestation and deforestation activities were estimated at 232.11 Gg CO_2 eq. in 2011. Afforestation/reforestation amounted a net uptake of -145.01 Gg CO_2 eq. and deforestation a net emission of 377.12 Gg CO_2 eq. Areas of AR and D were 27 295 ha and 19 135 ha, respectively.

PART 1: ANNUAL INVENTORY SUBMISSION

1. INTRODUCTION

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

1.1.1. Background information on climate change

According to the Intergovernmental Panel on Climate Change (IPCC) the territory of Estonia lies within the region where the most significant increase in air temperature has been observed over the past few decades. The annual mean air temperature in Estonia increased by 1.0–1.7 °C during the second half of the 20th century. Seasonality plays an important part in climate warming in Estonia. A statistically significant increase in the monthly mean temperature is present only during the period from January to May, with the greatest increase in March (up to 4 °C). For the rest of the year, practically no change in the annual mean air temperature has been identified.

Precipitation is the most variable climatic characteristic in Estonia. Its extreme values cause severe droughts and floods which have a significant influence on human activity. Since 1966 precipitation series in Estonia have been homogeneous. They indicate an increase during the cold half-year and also in June. A significant increase in precipitation has occurred in winter period (29%).

The duration of snow cover and sea ice decreased significantly during the second half of the 20th century. Over this period, the date by which sea ice appears has been very consistent, but the date by which it disappears at the end of winter has become earlier. The end of winter and the start of spring occur much earlier than before (by 19–39 days). The earlier melting of the snow cover causes changes in the hydrological regime. For instance, rivers reach their point of maximum runoff earlier and the magnitude of such runoff is generally smaller. The water content of the soil is comparatively smaller and drought conditions appear earlier. Drier climatic conditions in spring and in the first half of summer are projected for Estonia in the future.

The impacts of climate change in Estonia are relatively small compared to the southern and northern regions of Europe. Therefore no significant consequences are expected for biodiversity or public health. Some species may disappear and some new species will probably emerge, but these changes are quite negligible.

The rise in temperature and precipitation will have a positive rather than negative effect on Estonian economy. For example, it will probably be favourable for agriculture, especially grassland husbandry. The total growing season will lengthen and a greater number of harvests will become possible. In the case of higher temperatures and higher rainfall, the growth and development of herbaceous plants will quicken and harvesting times will shift to an earlier period. Livestock will be better provided with fodder in summer and winter.

The main hazards and economic losses in Estonia will result from the rise of sea level which will cause flooding in coastal areas, the erosion of sandy beaches and the destruction of harbour constructions (Estonia's Fifth National Communication, 2009).

1.1.2. 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 UNFCCC and in 2002, the Kyoto Protocol. In response to the UNFCCC and the Kyoto Protocol requirements Estonia has prepared the present emission National Inventory Report (NIR).

Single national entity with overall responsibility for the Estonian greenhouse gas inventory is the Estonian Ministry of the Environment (MoE). Financial resources are partly planned in the State Budget and partly applied from Environmental Investment Centre. Practical work is done mostly on the basis of contracts. The Institute of Ecology at Tallinn University was responsible for the inventories under contract to the Ministry of the Environment in Estonia until summer 2006. The 2008–2012 inventories were produced in collaboration between the MoE, Estonian Environment Information Centre (EEIC), Tallinn University of Technology (TUT) and Estonian Environmental Research Centre (EERC). The 2013 inventory was produced also in collaboration between MoE, EEIC, TUT and EERC, responsiblitites between different institutions are shown in Figure 1.1.

This report presents the national inventory of greenhouse gas emissions and removals from 1990 to 2011. The components covered are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and F-gases - hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). 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.

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 3.6.2). The methodology used in calculations of emissions is harmonized 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 structure of this NIR follows the UNFCCC reporting guidelines on annual inventories (UNFCCC 2006). The annotated outline of the NIR developed by the UNFCCC secretariat in 2009 has been followed. Chapter 1 gives an introduction to the background of greenhouse gas inventories and the arrangement for inventory preparation. Chapter 2 presents the overall emission trend in Estonia from the year 1990 to the year 2011. Chapters 3–8 give information of GHG emission trends from the base year 1990 to year 2011 for the following sectors: energy, industrial processes, solvent and other product use, agriculture, land use, land-use change and forestry, waste. In Chapter 10 improvements and recalculations since the previous submission are summarised. Chapter 11 provides description of KP LULUCF, Chapter 12 information on accounting of Kyoto units, Chapter 13 information on changes in national system and Chapter 14 information on changes in national registry. Chapter 15 gives information on minimisation of adverse impacts in accordance with Article 3, paragraph 14 of KP. Annex 1 contains key category reporting tables and Annex 2 the detailed discussion of methodology and data for estimating CO_2 emissions from fossil fuel combustion. Annex 3 gives information on other detailed methodological descriptions for individual source or sink categories. Annex 4 contains information on CO_2 reference approach and comparison with sectoral approach, and relevant information on the national energy balance. Assessment of completeness and (potential) sources and sinks of greenhouse gas emissions and removals excluded is included in Annex 5. Annex 6 contains the Standard Independent Assessment Report and Annex 7 the mandatory uncertainty reporting table (table 6.1 of Good Practice Guidance 2000).

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

Estonia, as an Annex I Party that is also part of the Kyoto Protocol is required to report supplementary information in accordance with Article 7, paragraph 1, of the Kyoto Protocol. The required information is specified in the Annex of Decision 15/CMP.1.

Part II of this report includes information related to Article 3, paragraph 3 (Afforestation, Reforestation, Deforestation) in Chapter 11 and information related to Article 3, paragraph 14 (information on minimization of adverse impacts of climate change) in Chapter 15. A summary of information on accounting of Kyoto units is presented in Chapter 12 and more detailed information in Standard Electronic Tables (SEF) which are part of Estonia's inventory submission. Information related to changes in national system and in the national registry are provided in Chapter 13 and Chapter 14 accordingly.

Estonia has chosen to report greenhouse gas emission removals from activities under Article 3.3 (i.e. afforestation, reforestation and deforestation) for the first commitment period (CP). Estonia did not choose to account greenhouse gas emissions/removals from activities under Article 3.4 for the first commitment period. For the LULUCF activities under Article 3.3 of Kyoto Protocol Estonia has chosen commitment period accounting. Thus the accounting quantity will be reported only in the annual report submitted for the last year of the CP (in 2014) and calculated over the entire CP.

1.2. A description of the institutional arrangements for inventory preparation

1.2.1. Overview of institutional arrangements for compiling GHG inventory

Single national entity with overall responsibility for the Estonian greenhouse gas inventory is MoE. The inventory is produced in collaboration between the MoE, EERC, EEIC and TUT.

The MoE is responsible for:

- Coordinating the overall inventory preparation process;
- Approving the inventory before official submission to the UNFCCC;
- Reporting the greenhouse gas inventory to the UNFCCC, including the National Inventory Report and CRF tables;
- Concluding the formal agreements with inventory compiler (EERC);
- Coordinating the cooperative work between the inventory compilers and UNFCCC Secretariat;
- Informing the inventory compilers about the requirements of the national system and ensuring that existing information in national institutions is considered and used in the inventory where appropriate;
- Informing the inventory compilers about new or revised guidelines;
- Coordinating the UNFCCC inventory reviews.

Climate Department in EERC is responsible for:

- Compiling the National Inventory Report according to the parts submitted by the inventory compilers;
- Coordinating of the implementation of the QA/QC plan;
- Coordinating the inventory process;
- Preparation of the UNFCCC inventory reviews and coordinating the communication with the expert review team, including responses to the review findings;
- Overall archiving system.

The EERC is responsible for preparing the estimates of Energy, Industrial Processes, Solvents and Other Product Use, Agriculture and Waste sectors. EERC has signed a contract agreement with the Department of Chemistry at TUT for preparing the estimates of Agriculture sector. Department of the National Forest Inventory at EEIC is responsible for the LULUCF and KP LULUCF sectors. All experts collect activity data, calculate emissions, prepare relevant QC, fill in the sectoral data to the CRF Reporter and prepare sectoral parts of the NIR. They also have archiving system for the sectors that they are working with.

1.2.1.1. Legal basis

In accordance with §117 of the Ambient Air Protection Act (RT I 2004, 43,298), activities for the reduction of climate change are organised by the Ministry of the Environment on the basis of the requirements for the restriction of the limit values of emissions of greenhouse gases provided by the UNFCCC and the Kyoto Protocol to the UNFCCC.

In accordance with §6 of the Statute of the Ministry of the Environment (RT I 2009, 63, 412), the Ministry is responsible for climate change related tasks and according to §23 section 8, the Climate and Radiation Department task is to organize, develop and implement climate change mitigation and adaptation policies.

In accordance with the Statute of the Climate and Radiation Department the department is responsible for organizing and coordinating the GHG emission reporting activities under the UNFCCC, the Kyoto Protocol and the European Union legislation.

In accordance with §6 section 3 and 4 of the Statute of the Estonian Environment Information Centre EEIC performs the following tasks: forest and forest sector data collection, analysis and assessments; National Forest Inventory compilation.

Contract agreements with EERC for inventory preparation in Industrial Processes, Solvent and Other Product Use and Waste sectors were concluded for 3 years (2011, 2012 and 2013 inventory). The 3 years contracts were concluded for the first time and MoE is planning to use this approach for other sectoral contracts as well in the upcoming years in order to secure the continuousness of the inventory preparation.

Contract agreement with EERC for inventory preparation in Energy and Agriculture sector was concluded for the first time in 2012 (previously these sectors were complied by experts from TUT) and was done for 1 year. EERC signed a contract agreement with the Department of Chemistry at TUT for preparation of Agriculture sector estimates in 2013 submission.

Contract agreement with EERC for inventory coordination was concluded for the first time in 2010 and was done for 1 year. New contract agreement with EERC for inventory coordination were done in 2011 and 2012. MoE is planning to use external coordinator for the coordination of the inventory also in the future.

The Statistics Estonia collects statistical data on the basis of the Official Statistics Act § 3(2), taking into consideration the official statistical surveys approved by the Government of the Republic.

1.2.1.2. Institutional cooperation

The four core institutions: MoE, EERC, EEIC and TUT work together to fulfill the requirements for the national system. The overview of the allocation of responsibilities is shown in Figure 1.1.

The EERC is a state hold joint stock company whose all shares belong to the Republic of Estonia. The EERC belongs to the government area of the Ministry of the Environment. The manager of this capital is the Ministry of the Environment and the Minister of the Environment is the sole representative of shareholders on the general meeting of shareholders.

The EEIC is a state organisation administered by MoE. The functions of the EEIC are covered with a Statute of Estonian Environment Information Centre.

The MoE has signed agreements with EERC for inventory preparation. Through these agreements, the institution is committed to calculate emissions, to implement the QA/QC and archiving procedures, documentation, making information available for review, and delivering data and information in a timely manner to meet the deadline for reporting to EC and the UNFCCC. EERC has signed agreement with the Department of Chemistry at TUT for preparation of Agriculture sector. Also an agreement for inventory coordination has been signed between MoE and EERC.

All four institutions are in close contact with each other. Several cooperation meetings are held to discuss and agree on the methodological issues, problems that have arisen and improvements that need to be implemented. As Estonia is a small country there is close contact between inventory experts (EERC, EEIC and TUT) and inventory compiler (EERC) and as a result different problems and misunderstandings are also solved on a daily basis.

During the cooperation meetings the following subjects are addressed:

- Preparation of the annual review;
- Discussion on the comments received from the expert review and agreeing on possible changes that have to be made;
- Discussion on the different problems that came up during the last inventory preparation and find solutions to improve the overall system;
- Discussion on methodologies and possible changes in the future;
- Discussion on QA/QC plan, available resources and possible improvements;
- Discussion on data collection and agreeing on possible institutions that could be also involved;
- Agreement on recalculations;
- Archiving system, updating and possible improvements;
- Exchange of relevant information;
- Reporting the conclusions from the meetings and dividing the responsibilities.

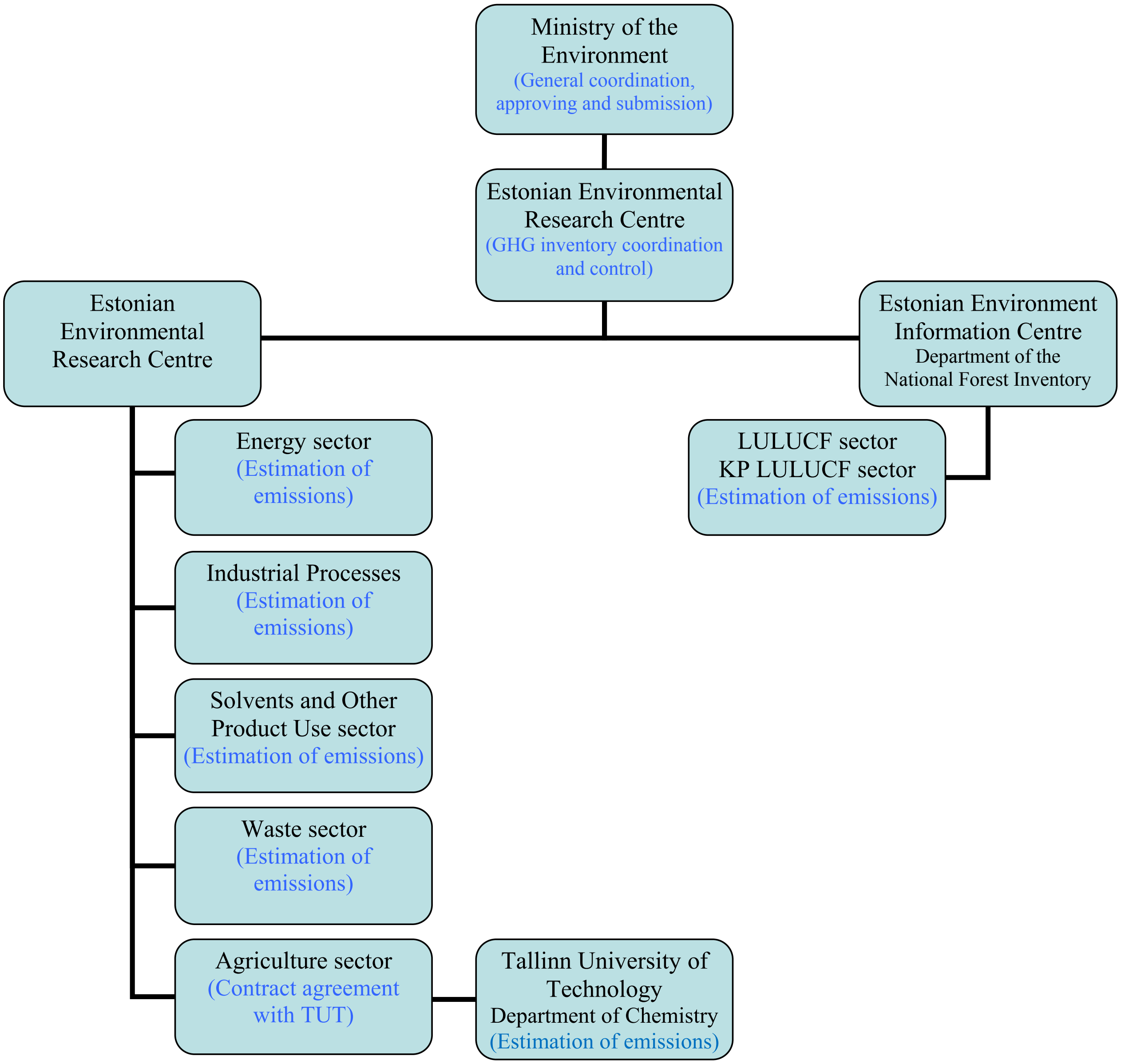


Figure 1.1 National System for GHG inventory in Estonia
Source: National Greenhouse Gas Inventory System in Estonia.

1.2.2. Overview of inventory planning

Estonia's 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/CP.7) to ensure the transparency, consistency, comparability, completeness and accuracy of inventories. Inventory activities include planning, preparation and management of the inventories.

EERC and MoE have worked out an inventory production plan that sets out the schedule for the inventory preparation. The schedule is a part of the Estonia's QA/QC plan and has to be followed by all the core institutions (MoE, EERC, EEIC and TUT). The inventory production plan is presented in the Table 1.1. More detailed information about Estonia's QA/QC plan is presented in the section 1.3.3.

Table 1.1. Inventory production plan

Activity	Responsible	Deadline
Annual meeting: Will be discussed how the previous inventory cycle has been, what should be improved/changed; new contracts, etc	*All*	*April 15*
Agreement on the changes and adjustments to be made for the next year's reporting	All	July 1
Sectoral experts notify the EERC and MoE of the planned methodological changes, reasons for changes and how they plan to incorporate the UNFCCC review results to the next report	Sectoral experts	Oct. 15
Annual meeting: Sectoral experts notify the EERC and MoE of the planned methodological changes, reasons for changes, overview of the planning of the new inventory cycle and how they plan to incorporate the UNFCCC review results to the next report. MoE and EERC give an overview of the new requirements, plans, etc	*All*	*Oct. 30*
Sectoral experts provide the XML files to the EERC and MoE	EERC, EEIC, TUT	Dec. 1
Sectoral experts send the necessary data for uncertainty analysis to EERC and MoE	EERC, EEIC, TUT	Dec. 5
QC checks are carried out (XML files) and documented by inventory coordinator (MoE and EERC) and sent to the sectoral experts	EERC, MoE	Dec. 1-6
MoE compiles the CRF tables and sends them to the sectoral experts for approval. CRF tables are also sent to the independent experts	MoE	Dec. 7
EERC performs the key category analysis and uncertainty analysis and sends the results to the sectoral experts and independent experts	EERC	Dec. 10
Sectoral experts provide the draft NIR to the EERC and MoE. Prior to this the QC checks should be carried out and documented	EERC, EEIC, TUT	Dec. 15
EERC compiles the draft NIR according to the submitted sectoral parts and sends it to the sectoral	EERC	Dec. 21

Activity	**Responsible**	**Deadline**
experts, independent experts, MoE and other institutes for approval		
Independent experts will carry out the QA for the CRF tables and submit the documented results to the sectoral experts	Independent experts	Dec. 21
EERC and MoE perform QC of the NIR and send the comments to the sectoral experts and independent expert for review	EERC, MoE	Jan. 4
Sectoral experts send their comments and possible changes on the CRF tables according to the QA/QC (performed by independent experts, MoE and EERC) to EERC, MoE. EERC sends comments to independent experts	EERC, EEIC, TUT	Jan. 8
Reporting to the EU (CRF tables and draft NIR)	MoE	Jan. 15
The draft NIR along with the CRF tables is uploaded to the MoE webpage for public review	MoE	Jan. 18
Independent experts carry out QA of the NIR and submit the results to EERC and MoE. EERC submits the results to sectoral experts	Independent experts	Febr. 8
MoE different departments carry out QA of the CRF tables and NIR and submit the results to the EERC	MoE	Febr. 15
EERC submits the results of the MoE QA to the sectoral experts and independent experts	EERC	Febr. 15
Sectoral experts send their comments and possible changes according to the QA/QC (performed by the MoE and independent experts) to EERC, MoE. EERC sends comments to independent experts	EERC, EEIC, TUT	Febr. 22
Annual meeting: The independent experts will meet with the sectoral experts in order to discuss the results of the QA checks	*EERC, EEIC, TUT*	*Febr. 22*
Annual meeting: The comments given during the inventory preparation and the last UNFCCC review report will be looked through. Also questions/problems that have been raised will be discussed before the submission to the EU	*All*	*Before March 15*
Reporting to the EU (CRF tables and NIR)	MoE	March 15
Answers to the EU initial check and if possible then corrections are made to the inventory	All	Febr 28-April 15
MoE approves the final inventory	MoE	April 10
Reporting to the UNFCCC	MoE	April 15
NIR and CRF tables are uploaded to the MoE webpage	MoE	April 19

1.2.3. Overview of inventory preparation and management, including for supplementary information required under Article 7, paragraph 1, of the Kyoto Protocol

The inventory preparation is an annual process and is divided into three stages: planning, preparation and management. The specific functions are described below.

Inventory planning

- Designate a single national entity with overall responsibility for the national inventory;
- Make available the postal and electronic addresses of the national entity responsible for the inventory;
- Define and allocate specific responsibilities in the inventory development process, including those relating to choice of methods, data collection, particularly activity data and emission factors from statistical services and other entities, processing and archiving, and QA/QC. This definition shall specify the roles of, and cooperation between, government agencies and other entities involved in the preparation of the inventory, as well as the institutional, legal and procedural arrangements made to prepare the inventory;
- Elaborate an inventory QA/QC plan which describes specific QC procedures to be implemented during the inventory development process, facilitate the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establish quality objectives;
- Establish processes for the official consideration and approval of the inventory, including any recalculations, prior to its submission and to respond to any issues raised by the inventory review process.

Inventory preparation

- Identify key source categories;
- Prepare estimates in accordance with the methods described in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and the IPCC Good Practice Guidance;
- Collect sufficient activity data, process information and emission factors as are necessary to support the methods selected for estimating anthropogenic GHG emissions by sources and removals by sinks;
- Make a quantitative estimate of inventory uncertainty for each source category and for the inventory in total, following the IPCC Good Practice Guidance;
- Ensure that any recalculations of previously submitted estimates of anthropogenic GHG emissions by sources and removals by sinks are prepared in accordance with the IPCC Good Practice Guidance and relevant decisions;
- Compile the national inventory;
- Implement general inventory QC procedures (tier 1) in accordance with its QA/QC plan following the IPCC Good Practice Guidance;
- Consider source-specific QC procedures and provide for a basic review of the inventory of personnel that have not been included in the inventory development.

Inventory Management

- Archive information for each year in accordance with relevant decisions;
- Provide a review team with access to archived information used by the Party to prepare the inventory;
- Respond to requests for clarifying inventory information resulting from different stages of the review process of the inventory information, and information on the national system, in a timely manner.

All information required pursuant to Article 7 of the Kyoto Protocol has been integrated within the reporting processes.

1.3. Inventory preparation

1.3.1. GHG inventory and KP-LULUCF inventory

The UNFCCC, the Kyoto Protocol and the Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol require Estonia to submit annually NIR and CRF tables. The annual submission contains emission estimates for the years between 1990 and the year before last year. So the 2013 submission contains estimates for the years 1990–2011.

The organization of the preparation and reporting of Estonia's greenhouse gas inventory and the duties of its different parties are detailed in the previous section (1.2.1). Single national entity with overall responsibility for the Estonian greenhouse gas inventory is MoE. The inventory is produced in collaboration between the MoE, EERC, EEIC and TUT.

Under the EU monitoring mechanism the annual inventory is submitted to the Commission by 15 January. The Member States may complement and update their submission by 15 March. The final greenhouse gas inventory is submitted to the UNFCCC Secretariat by 15 April.

1.3.2. Data collection, processing and storage

The inventory process for the next year starts with examination of previous years and by analyzing the available datasets in order to improve the inventory due to new knowledge and activity data developed.

The sectoral experts from EERC, EEIC and TUT are collecting data and prepare the estimates for the national inventory. The main sources of data are from official Estonian statistics (Statistics Estonia, Estonian Animal Recording Center) and from company's annual emission reports.

MoE has a bilateral agreement with Statistics Estonia (SE). SE collects statistical data on the basis of the Official Statistics Act §3(2), taking into consideration the official statistical surveys approved by the Government of the Republic.

The data collected from other institutions and private companies is done by sectoral experts that have personal contacts in order to receive the data.

The data sources for each sector are described below.

Energy

Activity data used in the estimates is obtained mainly from SE.

SE publishes:

1. Energy related data in the statistical database of the homepage of SE (Energy Balance Sheets in natural units (in thousand tons, thousand cubic meters) and in energy units (TJ-s)). The data received from SE covers all fuels used in 6 main end-use sectors (Energy Industries, Manufacturing Industries, Transport, Agriculture, Residential and Commercial/Institutional) but also in sub-sectors of the main end-use sectors.

2. Additionally, EERC asks also more detailed energy balance from SE (some data is not published on the homepage of SE).

3. Other information sources used in estimates of GHG emissions from energy sector are:

Eesti Energia AS (Estonian Energy Ltd.) – data on oil shale consumption for pulverized combustion and for circulating fluidized bed combustion, data on use of oil shale semi–coke gas in the Eesti Power Plant.

Narva Oil Plant AS (at the Eesti Power Plant) – Oil shale consumption for shale oil production, shale oil and semi-coke gas production data.

Viru Keemia Grupp AS (Viru Chemistry Group Ltd. in Kohtla-Järve) – Oil shale consumption for shale oil production, shale oil, semi-coke gas and generator gas production data.

Kiviõli Keemiatööstuse OÜ (Kiviõli Oil Shale Processing and Chemicals Plant Ltd.) – Oil shale consumption for shale oil production, shale oil, semi-coke gas and generator gas production data.

EEIC – GHG emission estimations from civil aviation and road transport sector. EEIC has a special model Copert IV for calculation of emissions from transport, incinerated waste fuel data. Also data on fuel use for national and international aviation separately.

EEIC – activity data on combustible waste amounts.

EEIC – activity data on transport biofuel amounts used in Estonia.

Industrial Processes

Activity data used in the estimates are obtained from SE, plants and in case of F-gases from national and international companies, associations, public institutions etc. CO_2 emissions from mineral industries are reported in six sub-sectors: cement, lime, glass, bricks and tiles production as well as lightweight gravel production and soda ash use.

Data on clinker production (raw material in cement production) were received directly from the cement factory Kunda Nordic Cement AS. Activity data on lime production were collected mainly from the industry (Nordkalk AS and Limex AS) and taken partly from industrial statistics. Data on flat glass production were received from SE and data on container glass production from factory O-I Production Estonia AS. Data on bricks and roof tiles production were collected from production plants and taken partly from industrial statistics. Activity data on lightweight gravel production and soda ash use were received from industry. Data on soda ash use were collected from plants.

In chemical industry sector only CO_2 emissions from ammonia production are calculated. Activity data were received directly from the ammonia factory Nitrofert AS.

Consumption of Halocarbons and SF_6 covers HFC, PFC and SF_6 emissions from refrigeration and air-conditioning, foam blowing, aerosols and electrical equipment, as well as emissions from some smaller sources, such as fire extinguishers and other (other electrical equipment). In these sub-sectors data were collected from national and international companies, associations, public institutions etc.

Solvent and Other Product Use

The collection of NMVOC emission data from the solvent and other product use sector is performed at the EEIC. The NMVOC inventory is carried out to meet the obligations of the United Nations Economic Commission for Europe's Convention on Long-Range Transboundary Air Pollution (UNECE CLRTAP). Activity data used in the estimates are obtained from SE and from web-interface air emissions data system for the point sources (OSIS), that contains data reported by the facilities having pollution permit. In some sectors, also expert judgements have been used.

Activity data used to estimate N_2O emissions from the solvent and other product use was collected directly from the companies importing N_2O for medical use and other applications to Estonia.

Agriculture

Activity data used in the estimates were obtained mainly from SE. The data received from SE (see Table 6.3):

- number of livestock (by livestock category and sub-category);
- data on milk production per cow;
- crop yields and sown areas of filed crops (by crop type);
- volume of N fertilizers applied on agricultural soils;
- location of animal waste management systems.

SE opens the data annually by July–August.

Other information sources used in the estimates of GHG emissions from agriculture sector are:

- Estonian Animal Recording Centre (fat content of milk, percentage of cows that give birth);
- Scientific publications (model of gross intake by pigs, feed digestibility of cattle and swine, nitrogen content of feed, etc.);
- Activity data on organic soils cultivated, which were obtained in the framework of National Forest Inventory (NFI).

LULUCF

Activity data used in preparing the estimates is obtained mainly from NFI. Data gained from NFI comprises:

- area (including distribution of organic and mineral soil) of forest land, cropland, grassland, wetlands, settlements and other land;

- dynamics of land-use changes;
- volume of woody biomass (including living biomass and dead wood) on different land use and land-use change categories.

Area estimates of wildfires on forest land, grassland and wetlands are based on compiled data obtained from Estonian Rescue Service, the State Forest Management Centre and Environmental Board.

Information regarding liming is received from the Ministry of Agriculture and Statistics Estonia.

Waste

Activity data on solid waste generation and disposal are collected from EEIC. The data on the population of Estonia is obtained from the dataset of SE.

A staff of Waste Bureau of the EEIC and an expert of waste sector (from EERC) negotiate on further collaboration, which allows to the expert to receive activity data directly from EEIC waste datasets.

The data on methane recovery is obtained from EEIC Air bureau, as the landfills with the system of methane collection; report their quantities of recovered methane directly to the Air bureau.

The quantities of domestic and industrial wastewater generation and treatment are obtained from the datasets of the EEIC Water Bureau. The data on the population of Estonia and the amount of products produced are used in calculating emissions are taken from SE.

Calculating N_2O emissions from human sewage, the data on population of Estonia is obtained from the dataset of SE and the amount of protein consumption per capita per year is derived from FAO statistical databases.

Activity data on waste incineration and biological treatment are collected from EEIC.

Activity data on biogas burnt in a flare is derived from EEIC Air bureau.

Archiving

All institutions are responsible for archiving the data they collect and the estimates they calculate. But it is necessary to have a central archiving system located at a single location. EERC bears the responsibility of archiving and Estonia's central inventory archive is located there. More detailed information about the archiving system can be found in the section 1.6.1.3.

1.3.3. Quality assurance/quality control (QA/QC) procedures and extensive review of GHG inventory

It is important that the national GHG inventories would be readily assessed in terms of quality. It is good practice to implement QA/QC procedure in the development of national greenhouse gas inventories.

Quality Control (QC) is a system of routine technical activities to assess and maintain the quality of the inventory as it is being compiled. It is performed by personnel compiling the inventory. The QC system is designed to:

- Provide routine and consistent checks to ensure data integrity, correctness, and completeness;
- Identify and address errors and omissions;
- Document and archive inventory material and record all QC activities.

QC activities include general methods such as accuracy checks on data acquisition and calculations, and the use of approved standardised procedures for emission and removal calculations, measurements, estimating uncertainties, archiving information and reporting. QC activities also include technical reviews of categories, activity data, emission factors, other estimation parameters and methods.

Quality Assurance (QA) is a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Reviews, preferably by independent third parties, are performed upon a completed inventory following the implementation of QC procedures. Reviews verify that measurable objectives were met, ensure that the inventory represents the best possible estimates of emissions and removals given the current state of scientific knowledge and data availability, and support the effectiveness of the QC programme.

All institutions involved in the inventory process (MoE, EERC, EEIC and TUT) are responsible for implementing the QC procedures to meet the data quality objectives. MoE as a national entity is responsible for overall QC and is in charge of checking on an annual basis that the appropriate QC procedures are implemented internally in EERC, EEIC and TUT. EERC as the quality coordinator has an overall responsibility for coordinating and implementing the QA/QC plan. EERC checks the QC reports of EERC, EEIC and TUT performed by sectoral experts, and the QA report performed by independent experts. Also a public review is carried out annually. The draft NIR is uploaded to the MoE website www.envir.ee where all interested parties have an opportunity to comment on it.

One part of QA is the UNFCCC reviews. The reviews are performed by a team of experts (sectoral experts and a generalist) from other countries. They examine the data and methods used in Estonia, check the documentation, archiving system and the national system.

In addition, the GHG inventories submitted in 2012 from all Member States were subject to a technical review of GHG emission estimates with a particular focus on the years 2005, 2008, 2009 and 2010. The technical review process for GHG inventories included three stages: initial checks of the completeness, initial consistency and comparability checks and a detailed technical review.

Estonia also had a Twinning Light project EE06-IB-TWP-ENV-06 "Improving the quality of Estonia's National Greenhouse Gas Inventory" with Finland in 2009. The project was directed at improving the implementation of article 3.1 of Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring European Community GHG emissions and for implementing the Kyoto Protocol.

More detailed information about Estonia's QA/QC plan is presented in Chapter 1.6.

1.4. Brief general description of methodologies and data source used

1.4.1. GHG inventory

The methodologies used for the Estonia's greenhouse gas inventory are consistent with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and IPCC Good Practice Guidance (IPCC 2000), IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (IPCC 2003) and 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006). Detailed descriptions of the methodologies used can be found in the sectoral Chapters 3 to 8.

The main methodologies and data sources used in current inventory are given in Table 1.2.

Table 1.2. Methodology, activity data and emission factor sources used

IPCC category	Methodology	Emission factor	Activity data
1. Energy	Revised 1996 IPCC, IPCC 2000, IPCC 2006	Revised 1996 IPCC, IPCC 2006	Statistics Estonia and energy companies (Eesti Energia AS, VKG AS, Kiviõli Keemiatööstuse OÜ), The Estonian Environment Information Centre (EEIC)
A. Fuel Combustion	T_1, T_2, T_3	D, CS, PS	National Energy Balances and Annual Yearbooks and the statistical data base of Statistics Estonia; data of energy companies, waste fuel data from the EEIC
A.1 Energy Industries	T_1, T_2, T_3	D, CS, PS	National Energy Balances and Annual Yearbooks and the statistical data base of Statistics Estonia; data of energy companies
A.2 Manufacturing Industries and Construction	T_1, T_2, T_3 (T_3 since 2000)	D, CS, PS (PS since 2000)	National Energy Balances and Annual Yearbooks and the statistical data base of Statistics Estonia; data on waste fuels from EEIC

IPCC category	Methodology	Emission factor	Activity data
A.3 Transport	T_1, T_2, T_3	D, CS	National Energy Balances and Annual Yearbooks and the statistical data base of Statistics Estonia; data on aviation and road transport fuels and corresponding GHG emission estimations from the EEIC
A.4 Other Sectors	T_1, T_2	D, CS	National Energy Balances from the statistical data base of Statistics Estonia
A.5 Other	T_1, T_2	D, CS	National Energy Balances from the statistical data base of Statistics Estonia
B. Fugitive Emissions	T_1	D	National Energy Balances from the statistical data base of Statistics Estonia
2. Industrial Processes	Revised 1996 IPCC, IPCC 2000, IPCC 2006	Revised 1996 IPCC, IPCC 2000, IPCC 2006	Statistics Estonia; plant specific data; national and international companies; associations; public institutions
A. Mineral Products	T_1, T_2	D, PS	Statistics Estonia; plant specific data
B. Chemical Industry	T_{1a}	PS	Plant specific data
F. Consumption of Halocarbons and SF_6	T_2, T_3	CS	National and international companies; associations; public institutions
3. Solvent and Other Product Use	IPCC 2006	IPCC 2006	Estonian Environment Information Centre; national companies
A. Paint Application	T_1	D	Estonian Environment Information Centre
B. Degreasing and Dry Cleaning	T_1	D	Estonian Environment Information Centre

IPCC category	Methodology	Emission factor	Activity data
C. Chemical Products, Manufacture and Processing	T_1	D	Estonian Environment Information Centre
D. Other	T_1, T_2	D, CS	Estonian Environment Information Centre; national companies
4. Agriculture	Revised 1996 IPCC, IPCC 2000	Revised 1996 IPCC, IPCC 2000	Statistics Estonia; IPCC default parameters
A. Enteric Fermentation	T_1, T_2	CS, D	Statistics Estonia; IPCC default parameters
B. Manure Management	T_1, T_2	CS, D	Statistics Estonia; IPCC default parameters
D. Agricultural Soils	T_1, $T1_b$, T_2	D	Statistics Estonia; IPCC default parameters
5. LULUCF	IPCC 2003, IPCC 2006	IPCC 2003, IPCC 2006	National Forest Inventory; Statistics Estonia; Estonian Rescue Service; the State Forest Management Centre; Environmental Board; Ministry of Agriculture
A. Forest land	T_1, T_2	OTH	National Forest Inventory; Estonian Rescue Service; the State Forest Management Centre; Environmental Board
B. Cropland	T_1, T_2	D	National Forest Inventory; Ministry of Agriculture; Statistics Estonia
C. Grassland	T_1, T_2	D, OTH	National Forest Inventory; Estonian Rescue Service; the State Forest Management Centre; Environmental Board
D. Wetlands Peatland	T_2	CS	National Forest Inventory; Estonian

IPCC category	Methodology	Emission factor	Activity data
			Rescue Service; the State Forest Management Centre; Environmental Board
E. Settlements	T_2	OTH	National Forest Inventory
F. Other Land	T_2	OTH	National Forest Inventory
6. Waste	Revised 1996 IPCC, IPCC 2000, IPCC 2006	Revised 1996 IPCC, IPCC 2000, IPCC 2006	Estonian Environment Information Centre; Statistics Estonia
A. Solid Waste Disposal on Land	T_2 (the FOD method)	D	Estonian Environment Information Centre; Statistics Estonia
B. Wastewater Handling	T_1	D	Estonian Environment Information Centre; Statistics Estonia
C. Waste Incineration	T_1	D	Estonian Environment Information Centre
D. Other	T_1	D	Estonian Environment Information Centre

T_1 – IPCC Tier 1; T_2 – IPCC Tier 2; T_3 – IPCC Tier 3; CS – Country specific; D – IPCC default value, PS – Plant specific

1.4.2. KP-LULUCF inventory

Estonia implements *Reporting Method 1, approach 2* based on National Forest Inventory sampling grid for tracking land use changes and land subject to activities under Article 3.3. The area of Estonia is not divided into regions.

Information on the IPCC land use and land-use change categories for each sample plot is presented in the forest inventory database. The annual land-use change areas were calculated for 1990–2011. Land-use matrix was developed by adding and subtracting the transition areas to and from land-use category areas.

In the 2013 submission, area and the volume of growing stock of afforestation/reforestation activities was obtained from NFI, in previous submissions the data was acquired from Statistics Estonia. The area of deforestation is also based on NFI data and is equivalent to the area of Forest Land converted to other land uses under the UNFCCC reporting. CO_2 emissions due to biomass loss related to deforestation is estimated assuming that the volume of growing stock on deforested area is the same as under Forest Land land remaining Forest Land category in the UNFCCC reporting.

1.5. Brief description of key categories

1.5.1. GHG inventory

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 2011), the trend of emissions (change between 1990 and 2011) or both. There are two alternative methods for identifying key categories: Tier 1 and Tier 2. In this report Tier 2 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 90% of inventory level or trend (Table 1.3).

Detailed reporting tables can be found in Annex 1.

Table 1.3. Key categories identified using Tier 2 methodology

	IPCC Source Category	Gas	Key category	Criteria for identification (without LULUCF)	Criteria for identification (with LULUCF)
1.A.1.a	Energy Industries/Electricity and Heat Production – Solid Fuels	CO_2	yes	Level (1990, 2011), Trend	Level (1990, 2011), Trend
1.A.1.a	Energy Industries/ Electricity and Heat Production – Liquid Fuels	CO_2	yes	Trend	Trend
1.A.1.c	Energy Industries/Other Energy Industries – Solid Fuels	CO_2	yes	Level (2011), Trend	Level (2011), Trend
1.A.2	Manufacturing Industries and Constructions – Other Fuels	CO_2	yes	Trend	Trend
1.A.2.c	Manufacturing Industries and Constructions/Chemicals – Solid Fuels	CO_2	yes	Level (1990), Trend	Level (1990), Trend
1.A.2.f	Manufacturing Industries and Constructions/Other – Solid Fuels	CO_2	yes	Level (1990, 2011)	Level (1990, 2011)
1.A.3.b	Road Transport – Liquid Fuels	CO_2	yes	Trend	Trend
1.A.4.b	Other Sectors/Residential – Solid Fuels	CO_2	yes	Level (1990), Trend	Level (1990), Trend
1.A.4.b	Other Sectors/Residential – Biomass	CH_4	yes	Level (2011), Trend	Level (2011), Trend
1.A.4.b	Other Sectors/Residential – Biomass	N_2O	yes	Trend	Trend
2.B.1	Ammonia Production	CO_2	yes	Trend	Trend
4.A	Enteric Fermentation – Dairy Cattle	CH_4	yes	Level (1990, 2011)	Level (1990, 2011), Trend
4.A	Enteric Fermentation – Non-Dairy Cattle	CH_4	yes	Level (1990), Trend	Level (1990, 2011), Trend
4.B	Manure Management – Solid Storage and Dry Lot	N_2O	yes	Level (1990, 2011), Trend	Level (1990, 2011), Trend
4.D.1.1	Direct Soil Emissions – Synthetic Fertilizers	N_2O	yes	Level (1990, 2011), Trend	Level (1990, 2011), Trend
4.D.1.2	Direct Soil Emissions – Animal Manure Applied to Soils	N_2O	yes	Level (2011)	Level (2011), Trend
4.D.1.3	Direct Soil Emissions – N-fixing Crops	N_2O	yes	Level (1990), Trend	Level (1990), Trend
4.D.1.5	Direct Soil Emissions – Cultivation of Histosols	N_2O	yes	Trend	Level (2011), Trend
4.D.2	Pasture, Range and Paddock Manure	N_2O	yes	Level (1990, 2011), Trend	Level (1990, 2011), Trend
4.D.3.2	Indirect Emissions – Nitrogen Leaching and Run-off	N_2O	yes	Level (1990, 2011), Trend	Level (1990, 2011), Trend
5.A.1	Forest Land remaining Forest Land – living biomass	CO_2	yes		Level (1990, 2011), Trend
5.A.1	Forest Land remaining Forest Land – organic soils	CO_2	yes		Level (2011), Trend
5.A.1	Forest Land remaining Forest Land – deadwood	CO_2	yes		Level (2011), Trend
5.A.1	Forest Land remaining Forest Land – mineral soils	CO_2	yes		Level (1990, 2011), Trend
5.A.2.1	Cropland converted to Forest Land – mineral soils	CO_2	yes		Trend
5.A.2.2	Grassland converted to Forest Land – living biomass	CO_2	yes		Trend
5.B.1	Cropland remaining Cropland – organic soils	CO_2	yes		Level (1990, 2011), Trend

	IPCC Source Category	Gas	Key category	Criteria for identification (without LULUCF)	Criteria for identification (with LULUCF)
5.B.1	Cropland remaining Cropland – mineral soils	CO_2	yes		Level (2011), Trend
5.B.2.2	Grassland converted to Cropland – organic soils	CO_2	yes		Trend
5.B.2.2	Grassland converted to Cropland – mineral soils	CO_2	yes		Trend
5.C.1	Grassland remaining Grassland – living biomass	CO_2	yes		Level (2011), Trend
5.C.1	Grassland remaining Grassland – organic soils	CO_2	yes		Trend
5.C.2	Land converted to Grassland – mineral soils	CO_2	yes		Trend
5.D.1	Wetlands remaining Wetlands/Peatland – organic soils managed for peat extraction	CO_2	yes		Trend
5.E.2	Land converted to Settlements – living biomass	CO_2	yes		Level (2011), Trend
5.E.2	Land converted to Settlements - soils	CO_2	yes		Trend
5.F.2	Land converted to Other Land – living biomass	CO_2	yes		Trend
6.A	Solid Waste Disposal on Land	CH_4	yes	Level (2011), Trend	Level (2011), Trend
6.B.1	Industrial Wastewater	CH_4	yes	Trend	Trend
6.D	Biological Treatment	CH_4	yes	Trend	Trend
6.D	Biological Treatment	N_2O	yes	Trend	Trend

1.5.2. KP-LULUCF inventory

Key category analysis for KP-LULUCF was performed according to chapter 5.4.4 of the IPCC Good Practice Guidance for LULUCF (IPCC 2003). The basis for assessment of key categories under Article 3.3 of the KP is the same as the assessment made for the UNFCCC inventory. The key categories, also reported in CRF table NIR-3, are CO_2 removals due to afforestation/reforestation and CO_2 emissions from deforestation.

1.6. Information on the QA/QC plan including verification and treatment of confidentiality issues where relevant

1.6.1. QA/QC procedures

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.

All institutions involved in the inventory process (MoE, EERC, EEIC and TUT) are responsible for implementing QC procedures to meet the data quality objectives.

MoE as the national entity is responsible for overall QC and is in charge of checking on an annual basis that the appropriate QC procedures are implemented internally in EERC, EEIC and TUT. The EERC as a coordinator has an overall responsibility for QC of the data of the emission inventory. EERC checks the QC reports of EERC, EEIC and TUT. When EERC disagrees with the report then the errors are discussed and changes are made if necessary. Each institution is responsible for reporting on their completion of the QC procedures on an annual basis. This reporting is based on a checklist of general and source-specific QC checks and a textual description of possible recalculations, issues to be followed up before the next submissions, and other relevant information. MoE as the national entity is responsible for the overall QA of the national system, including the UNFCCC reviews and any national reviews undertaken.

During the Twinning Light project "Improving the quality of Estonia's National Greenhouse Gas Inventory" with Finland in 2009 Estonia updated its QA/QC plan. The Estonia's QA/QC plan consist of seven parts: (1) production plan (see Table 1.1); (2) annual meetings; (3) QA/QC checks; (4) QA results documentation form; (5) archiving structure; (6) response tables to the review process and (7) a list of planned activities and improvements.

1.6.1.1. QC procedures

The Estonian Greenhouse Gas Inventory is compiled by the EERC. The data compilation and reporting for source sectors are performed by EERC, EEIC and TUT.

The quality of the inventory is ensured in the course of the compilation and reporting, that consists of four main stages: planning, preparation, evaluation and improvement. The quality management of inventory is a continuous process.

The starting point for accomplishing a high-quality GHG inventory is the consideration of the inventory principles. The quality requirements set for the annual inventories are continuous improvement, transparency, consistency, comparability, completeness, accuracy and timeliness. The setting of concrete annual quality objectives is based on this consideration. The next step is elaboration of the QA/QC plan and implementing the appropriate quality control measures (e.g. routine checks, documentation) focused on meeting the quality objectives set and fulfilling the requirements. In addition, the QA procedures are planned and implemented. In the improvement phase of the inventory, conclusions are made on the basis of the realized QA/QC process and its results.

The QC procedures used in Estonia's GHG inventory comply with the IPCC Good Practice Guidance. General inventory QC checks (IPCC GPG 2000, Table 8.1 and IPCC GPG LULUCF 2003, Table 5.5.1) include routine checks of the integrity, correctness and completeness of the data, identification of errors and deficiencies and documentation and archiving of the inventory data and quality control actions. Once the experts have implemented the QC procedures, they complete the QA/QC form for each source/sink category, which provides a record of the procedures performed. The QA/QC forms are part of Estonia's QA/QC plan. Also assessment of completeness is evaluated.

In addition, the quality control conducted under the European Community GHG Monitoring Mechanism (e.g. completeness checks, consistency checks) produces valuable information on errors and deficiencies, and the information is taken into account before Estonia submits its final annual inventory to the UNFCCC.

The sectoral experts send their xml files to the MoE and EERC and MoE puts all the sectors together and completes the CRF tables. During that time the numbers are cross-checked in the CRF reporter to make sure that no mistakes were made during the importing process. Also the CRF completeness check and recalculation check are carried out to make sure that all the necessary data is filled. When MoE has completed the CRF tables, then all data is checked by independent experts. The results of the independent experts will be looked through in collaboration with the experts and EERC and necessary adjustments will be carried out as a result.

When the CRF tables are finalized, the experts will start preparing the sectoral chapters of the NIR. These parts are sent to the compiler (EERC) who adds the introduction part and puts the draft NIR together. The compiler arranges the different chapters into one uniform document and makes sure that the structure of the report follows the UNFCCC guidelines (annotated outline of the National Inventory Report). All figures on emissions and removals in tables and text are checked to make sure that they are consistent with those reported in the CRF. The sectoral experts and the inventory compiler also checks that all methodological changes, recalculations, trends in emission and removals are well explained.

When the draft NIR is completed it is sent to the MoE. The Climate and Radiation Department looks over the inventory report and makes sure that the submitted data is officially valid. Also the structure of the report is assessed based on the established requirements. When there are no contradictions the report is introduced for coordination to the Forestry, Waste and Water Department and Deputy Secretary General on International Co-operation and afterwards to the Secretary General. When the report is approved by the Secretary General the report can be sent to the European Commission (EC) and UNFCCC.

The inventory meetings with participants from all institutes participating in the inventory preparation are held four times a year and the bilateral quality meetings between the quality coordinator (EERC) and the expert organizations are held whenever necessary.

MoE and EERC, in collaboration with the expert organizations responsible for the inventory calculation sectors, set yearly quality objectives for the whole inventory at the inventory planning stage and designs the QC procedures needed for achieving these objectives. In addition, the expert organizations set their own, sector and/or category specified quality objectives and prepare their QC plans.

The setting of quality objectives is based on the inventory principles presented in the UNFCCC Guidelines and in EU Decision 280/2004/EC concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol, that is, transparency, consistency, comparability, completeness, accuracy and timeliness. In addition, the principle of continuous improvement is included.

1.6.1.2. QA procedures

The objective of QA implementation is to involve reviewers that can conduct an unbiased review of the inventory and who may have a different technical perspective. It is important to use QA reviewers that have not been involved in preparing the inventory. Preferably these reviewers would be independent experts from other agencies or national experts or groups not closely connected with the national inventory compilation.

From the 2009 submission to 2012 submission all data collected by institutions involved in the inventory process was checked by an independent expert from Tallinn University of Technology. In 2013 submission, the inventory is reviewed in parts. Quality assurance procedures are performed by EERC, TUT and other national experts.

Also public review is carried out. The draft NIR is uploaded to the MoE website www.envir.ee where all interested parties have an opportunity to comment on it. The public reviews of the draft document offer a broader range of researchers and practitioners in non-governmental organizations, industry and academia, as well as the general public, the opportunity to contribute to the final document. The comments received during these processes are reviewed and, as appropriate, incorporated into the NIR.

The inventory is also checked by different Ministries and institutions. The inventory is sent to the Ministry of Economic Affairs and Communications, to Forest, Waste and Water Departments in MoE, to Ministry of Agriculture and Waste Department in EEIC. During the in-country review in 2012, UNFCCC review team encouraged Estonia to strengthen its QA procedures by involving Statistics Estonia in the quality checking of the inventory. Taking into account the recommendation, starting from the 2013 submission, inventory is sent to Statistics Estonia for quality checking.

One part of QA is UNFCCC reviews. The reviews are performed by a team of experts (sectoral experts and generalist) from other countries. They are examining the data and methods that Estonia is using, checking the documentation, archiving system and national system. In conclusion they report whether Estonia's overall performance is in accordance with current guidelines. The review report indicates the specific areas where the inventory is in need of improvements.

Also, the GHG inventories submitted in 2012 from all Member States were subject to a technical review of GHG emission estimates with a particular focus on the years 2005, 2008, 2009 and 2010. The technical review process for GHG inventories included three stages: initial checks of the completeness, initial consistency and comparability checks and a detailed technical review.

Peer review

Estonia also had a Twinning Light project with Finland in 2009. Project title was "Improving the quality of Estonia's National Greenhouse Gas Inventory". The project was addressed at improving the implementation of Article 3.1 of Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004, concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol.

During the project 5 sectors (Energy, Industrial Processes (except F-gases), Agriculture, Waste and Land Use, Land-Use Change and Forestry (LULUCF)) were analyzed. Terms of reference was elaborated to develop a single national IT system to facilitate GHG emission data handling, calculation and reporting. Concept and suggestions were developed to improve the QA/QC procedures and the uncertainty management of GHG inventory.

1.6.1.3. Archiving

It is good practice for inventory compilers to maintain the documentation for every inventory produced and to provide it for review. It is good practice to maintain and archive this documentation in such a way that every inventory estimate can be fully documented and reproduced if necessary.

All institutions are responsible for archiving the data they collect and the estimates they calculate. EERC bears the responsibility of archiving and Estonia's central inventory archive is located there. When the reporting cycle ends and all inventory calculations are finalized all experts send their documentation to the compiler and it is stored in one place.

The data and information is archived for each submission year. The archiving includes all input data, all estimated emissions, corresponding letters, all partly filled-in or final CRF, recalculations of previous estimates, submissions to UNFCCC and EC and NIR-s. The archiving system is located in EERC server which undergoes a daily backup and the backups are securely saved. Also after inventory compilation the calculation results are archived on CD-ROM.

During the Twinning Light project with Finland in 2009 "Improving the quality of Estonia's National Greenhouse Gas Inventory" a new improved archiving system was developed. The archiving system consists of two parts: data related (1) to the CRF and (2) to the NIR. The first part contains information and documentation on activity data, emission factors and methodology used and the second part all the relevant documents that were used for the preparation of NIR. Also all submissions to the UNFCCC and EC are archived. Materials used in the 2010 inventory submission were archived for the first time according to the new archiving system. The archiving system was modified after the first trial to make it better and remove all the inconsistencies that came up. The materials used in the 2011 and 2012 inventory submission were archived according to the improved archiving system.

Following the recommendation of the UNFCCC review team (ARR 2012, para 35) Estonia improved its archiving system again for the 2013 inventory. The archiving structure was modified the way that all relevant materials (e.g. XML files provided by the inventory compilers to the producers of the CRF tables, also relevant materials from the ftp site) would be stored in the archive. The materials used in the 2013 inventory submission will be archived according to the improved archiving system.

In addition to the main archive, the expert organizations contributing to the sectoral calculation archive the primary data used, internal documentation of calculations and sectoral CRF tables. These organizations keep records of their work on hard disks of individual expert's desktop workstations, with copies on backed up network servers. Also electronic copies on CD-ROMs are produced.

Starting from autumn 2010 a ftp site has been set up in order to collect all important documents into one location where everybody has the opportunity to use them. The ftp site is used for sharing documents (xml files, draft NIR's, QA/QC documents, aso), also pervious submissions, review reports, answers to the reviews and guidelines are available. The ftp site is accessible by sectoral experts, inventory compiler and independent experts. The ftp site has been a success, as it compiles all the latest documents into one location and through the ftp site it can be assured that you are getting the latest version. Before all information was shared through e-mails, that was not that sufficient.

1.6.2. Verification activities

The EU emissions trading system (EU ETS) is a cornerstone of the Europeans Union's policy to combat climate change and its key tool for reducing industrial greenhouse gas emissions cost-effectively. In contrast to traditional 'command and control' regulation, emissions trading harnesses market forces to find the cheapest ways of reducing emissions.

The EU ETS works on the 'cap and trade' principle. The overall volume of greenhouse gases that can be emitted each year by the power plants, factories and other companies covered by the system is subject to a cap set at EU level. Within this Europe-wide cap, companies receive or buy emission allowances which they can trade if they wish.

Businesses must monitor and report their EU ETS emissions for each calendar year and have their emission reports checked by an accredited verifier. They must surrender enough allowances to cover their total emissions by 30 April of the following year (European Commission, 2013).

The EU ETS reports' data can be used, in aggregated form, to draw source category specific conculsions regarding the completeness and consistency of the certain parts of the GHG inventories. Comparison of EU ETS emissions with emissions reported in national GHG inventory was carried out for year 2011[1]. The results indicated that share of verified ETS emissions in stationary combustion (includes emissions of 1.A.1, 1.A.2 and 1.A.4) was about 88% in 2011. Share of verified ETS emissions in CRF category 2.A Mineral Products was about 99.9% in 2011.

[1] EU ETS data has been used for verification purposes of the 2013 inventory as the recommendation of the UNFCCC review team (ARR 2012, para 31).

Detailed information about verification activities can be found under the sectoral chapters.

1.6.3. Treatment of confidentiality issues

Nearly all of the data necessary to compile the Estonia's inventory are publicly available. The main exception relates to the reporting of emissions from Consumption of Halocarbons and SF_6 (CRF 2.F). Under the category Consumption of Halocarbons and SF_6 there are several subcategories (for example Commercial and Industrial Refrigeration, Foam Blowing, Fire Extinguishers etc) where activity data are collected directly from private companies active in this field on condition that the data remains confidential. Therefore data from companies has been summarised and presented on subcategory level.

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

1.7.1. GHG inventory

This section provides an overview of the approach to uncertainty analysis adopted for Estonia's inventory. The mandatory reporting table of the analysis is presented in Annex 7.

The uncertainty estimates of the 2013 inventory has been done according to the Tier 1 method presented by the IPCC Good Practice Guidance 2000 (IPCC 2000). Tier 1 method combines the uncertainty in activity rates and emission factors, for each source category and greenhouse gas, and then aggregates these uncertainties, for all source categories and greenhouse gases, to obtain the total uncertainty for the inventory.

In many cases uncertainty values have been assigned based on default uncertainty estimates according to IPCC guidelines or expert judgement, because there is a lack of the information. For each source, uncertainties are quantified for emission factors and activity data.

Uncertainties are estimated for direct greenhouse gases, e.g. CO_2, CH_4, N_2O and F-gases. The uncertainty analysis was done for the all sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Waste and LULUCF sector.

Table 1.4 shows the estimated uncertainties for total greenhouse gas emissions in 2011 and the trend.

Table 1.4. Inventory uncertainties in 2011

	Combined as % of total national emissions in 2011	Introduced into the trend in total national emissions
	Uncertainty [%]	
Without LULUCF	24.93	2.78
With LULUCF	33.37	3.71

1.7.2. KP-LULUCF inventory

Tier 2 was implemented for estimating uncertainty rates related to activity data and emission factors employed in the estimates under Article 3.3. activities (Chapter 11.3.1.5).

1.8. General assessment of the completeness

1.8.1. GHG inventory

Estonia has provided estimates for all significant IPCC source and sink categories according to the detailed CRF classification. Estimates are provided for the following gases: CO_2, N_2O CH_4, F-gases (HFC, PFC and SF_6), NMVOC, NOx, CO and SO_2.

Assessment of completeness is presented in Annex 5.

1.8.2. KP-LULUCF inventory

Estonia provides emission/removal estimates for the following carbon pools: above- and below-ground biomass, litter, mineral and organic soils and biomass burning (CH_4, N_2O) under AR activites, in addition to abovementioned pools, emissions from dead wood are given under deforestation.

2. TRENDS IN GREENHOUSE GAS EMISSIONS

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

This chapter provides the trends in GHG emissions and removals by sinks in Estonia for the years 1990–2011.

The GHGs covered are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gases- hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Estimates of the emissions for nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur dioxide (SO_2) are also included in the inventory.

Estonia's base year for calculating the emissions of CO_2, CH_4, N_2O and fluorinated gases is 1990.

Total emissions of the six greenhouse gases in Estonia (excl. net emissions from the LULUCF) decreased steadily from 40 542.14 Gg CO_2 equivalent in 1990 to 20 955.58 Gg CO_2 equivalent in 2011 (Figure 2.1). From 1990 to 2011 the GHG emissions decreased by 48.31%. This decrease was mainly caused by the transition from planned economy to market economy and the successful implementation of the necessary reforms.

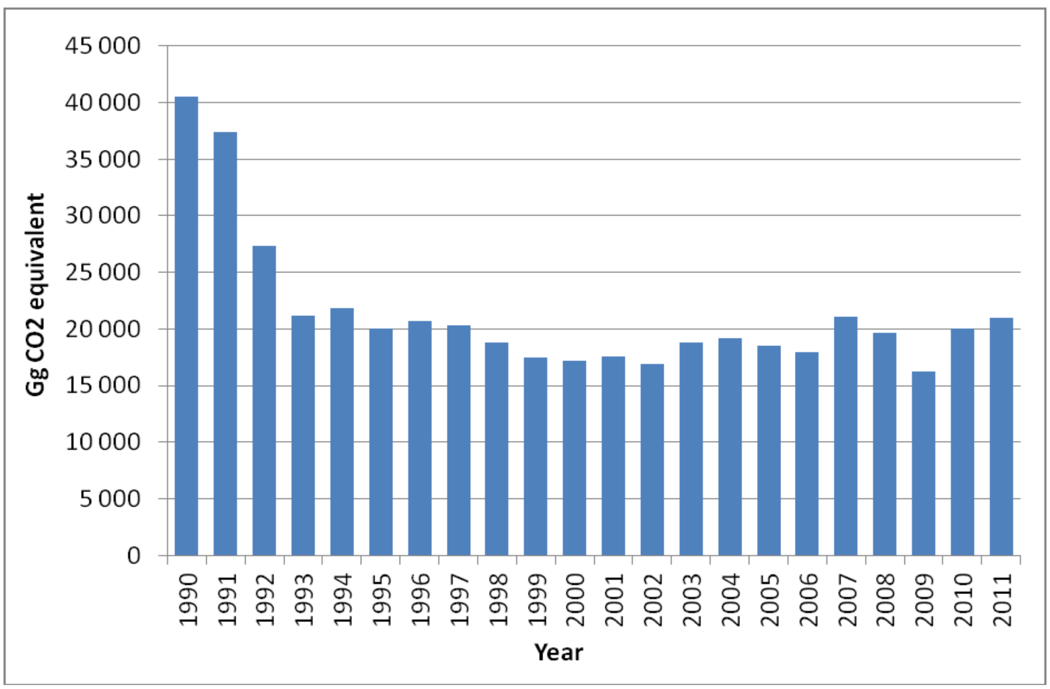


Figure 2.1. Overall development of greenhouse gases in Estonia, in CO_2 equivalents (without CO_2 from LULUCF)

2.2. Description and interpretation of emission trends by gas

In 2011, the most important GHG in Estonia was carbon dioxide (CO_2), contributing 89.87% of the total GHG emissions (excl. LULUCF) expressed in CO_2 equivalent, followed by nitrous oxide (N_2O), 4.79% and methane (CH_4), 4.57%. Fluorinated gases (the so-called „F-gases“) account for about 0.77% of the total emissions (Figure 2.2).

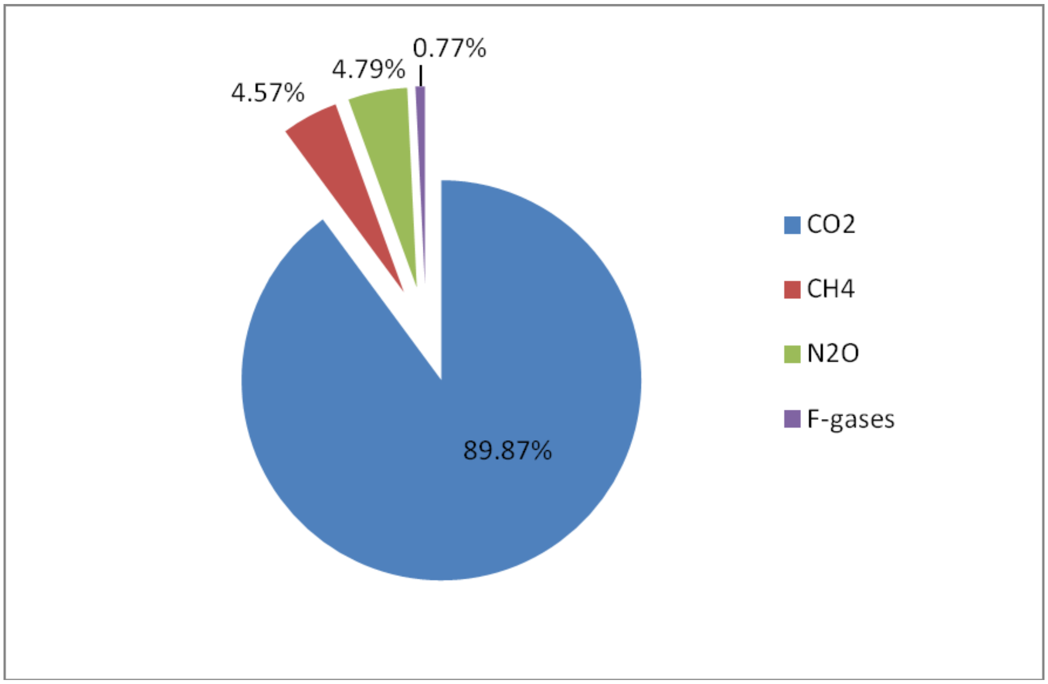


Figure 2.2. GHG emissions by gas in 2011, %

Figure 2.3 shows GHG emission trends in 1990 to 2011. Emissions of CO_2 decreased by 48.59% from 36 635.00 Gg in 1990 to 18 832.99 Gg in 2011, especially CO_2 emissions from Energy sub-sector Public Electricity and Heat Production, which is the major source of CO_2 in Estonia.

N_2O is the second most significant contributor to greenhouse gas emissions in Estonia after CO_2. Emissions of N_2O decreased by 55.06% from 2 233.95 Gg CO_2 equivalent in 1990 to 1 003.97 Gg CO_2 equivalent in 2011, especially N_2O emissions from Agriculture sub-sector Agricultural Soils, which is the major source of N_2O in Estonia.

Emissions of methane decreased by 42.78% from 1 673.18 Gg CO_2 equivalent in 1990 to 957.42 Gg CO_2 equivalent in 2011, especially from Agriculture sub-sector Enteric Fermentation, which is the major source of CH_4 in Estonia.

Emissions of the F-gases (HFCs, PFCs and SF_6) increased from 0 Gg CO_2 equivalent in 1990 to 161.19 Gg CO_2 equivalent in 2011, especially HFC emissions from refrigeration and air-conditioning equipment, which is the major source of halocarbons in Estonia. A key driver behind the growing emission trend in refrigeration and air conditioning sector has been the substitution of ozone depleting substances with HFCs. The second largest source is foam blowing which shows relatively steady increase of emissions throughout the years, except 2 major decreases (in 2001 one of two big Estonian producers of One Component Foam replaced HFC-134a with HFC-152a, followed by the other producer starting from 2007. Due to much lower GWP of HFC-152a the emissions decreased suddenly in the corresponding years).

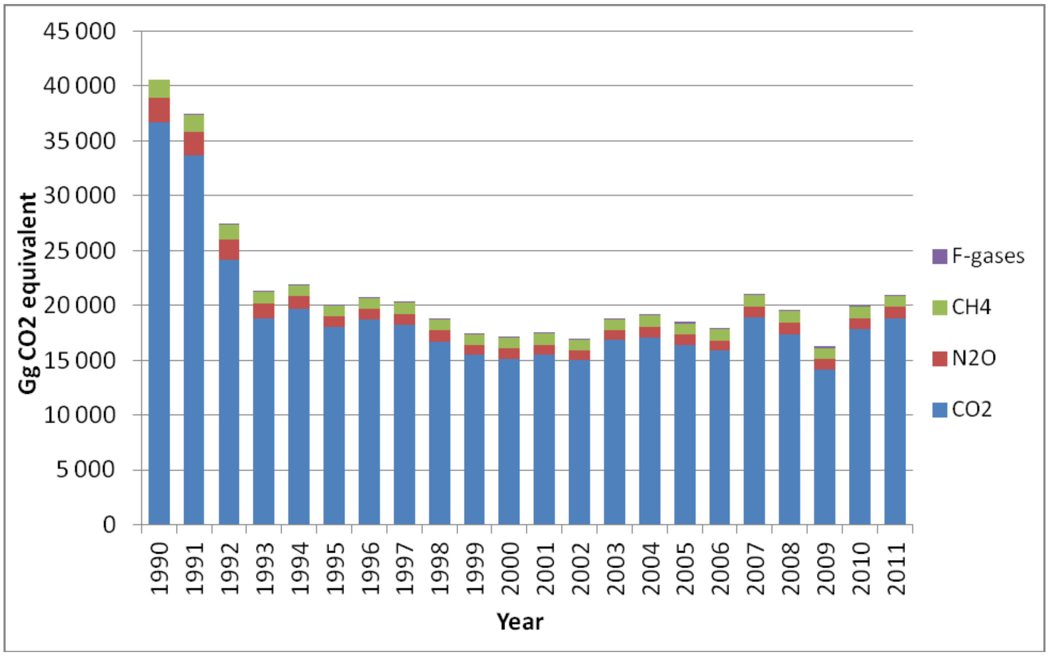


Figure 2.3. Greenhouse gas emission trends (CO_2 equivalent) in 1990 to 2011

2.3. Description and interpretation of emission trends by category

Greenhouse gas emissions broken down by IPCC sector are presented in Figure 2.4. It can be clearly seen that the largest contribution is from Energy sector, which in 2011 contributes 89.05% of total greenhouse gas emissions (excl. LULUCF). The second largest sector is Agriculture, which accounted for 6.06% of the total emissions in 2011. Emissions from Industrial Processes, Waste and Solvent and Other Product Use sectors accounted 2.93%, 1.86% and 0.09%, respectively of total emissions in 2011. Emissions of indirect gases are discussed in section 2.4.

Over the period 1990–2011, emissions from Energy sector decreased by 48.10%, emissions from the Industrial Processes, Agriculture and Solvent and Other Product Use sectors decreased by 41.44%, 59.88% and 28.69%, respectively. Emissions from Waste sector increased by 13.69%. Reported net CO_2 removals on Land Use, Land Use Change and Forestry sector decreased by 51.83% between 1990 and 2011. See Figure 2.4. Greenhouse gas emission trends, by source groups, in CO_2 equivalents.

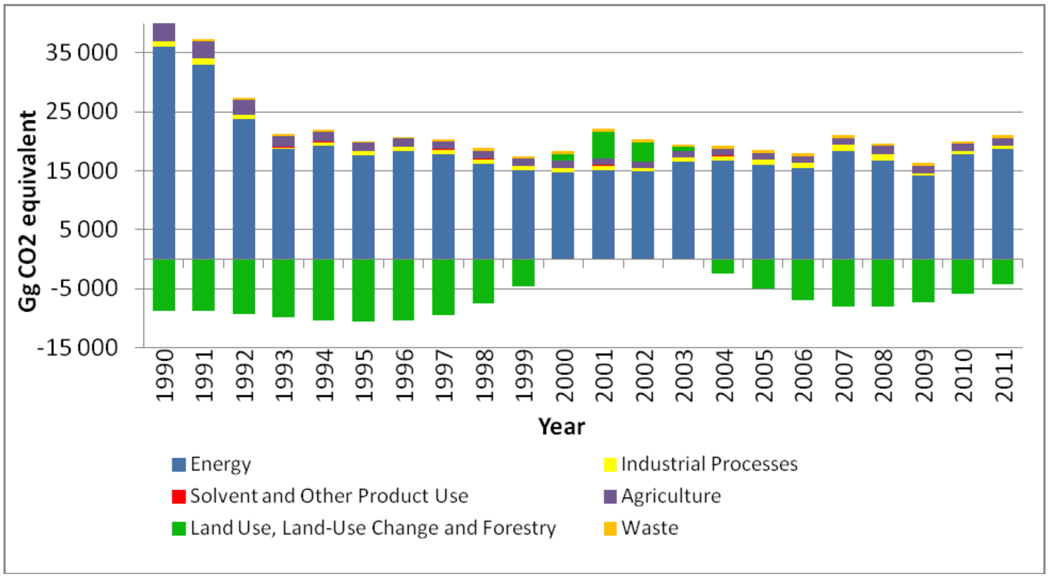


Figure 2.4. Greenhouse gas emission trends, by source groups, in CO_2 equivalents

The following sub-sectors discuss the main contributors to trends within each IPCC source sector incl. LULUCF.

2.3.1. Trends in Energy (CRF 1)

Estonia's emissions from Energy sector are divided into the following emission categories: Fuel Combustion, including Energy Industries, Manufacturing Industries and Construction, Transport, Other Sectors, Other and Fugitive emissions from fuels. The share of emissions by category is presented in Figure 2.5.

Energy sector is the main source of GHG emissions in Estonia. In 2011, the Energy sector contributed 89.05% of the total emissions. Most of the Energy sector emissions, 99.6%, originated from Fuel Combustion and only 0.4% is contributed by fugitive emissions.

Energy related CO_2 emissions varied mainly in relation to the economic trend, the energy supply structure and climate conditions.

Compared to the base year 1990, the emissions of energy sector decreased by 48.10% (incl. Energy Industries – 48.30%; Manufacturing Industries and Construction – 68.22%; Transport – 8.15%; Other Sector – 68.10%; Other – 54.51% and Fugitive Emissions from Fuels – 58.51%). This big decrease was caused by the structural changes in the economy after 1991 when Estonia became independent. There has been a drastic decrease in the consumption of fuels and energy in energy industries (closing of the factories), in agriculture (reorganisation and dissolution of collective farms), in transport (the proportion of new and environmentally friendly cars has increased; the number of agricultural machines has decreased), in households (energy saving), etc. The overall progressing of GHGs in the Energy sector in CO_2 equivalent is presented in Figure 2.5.

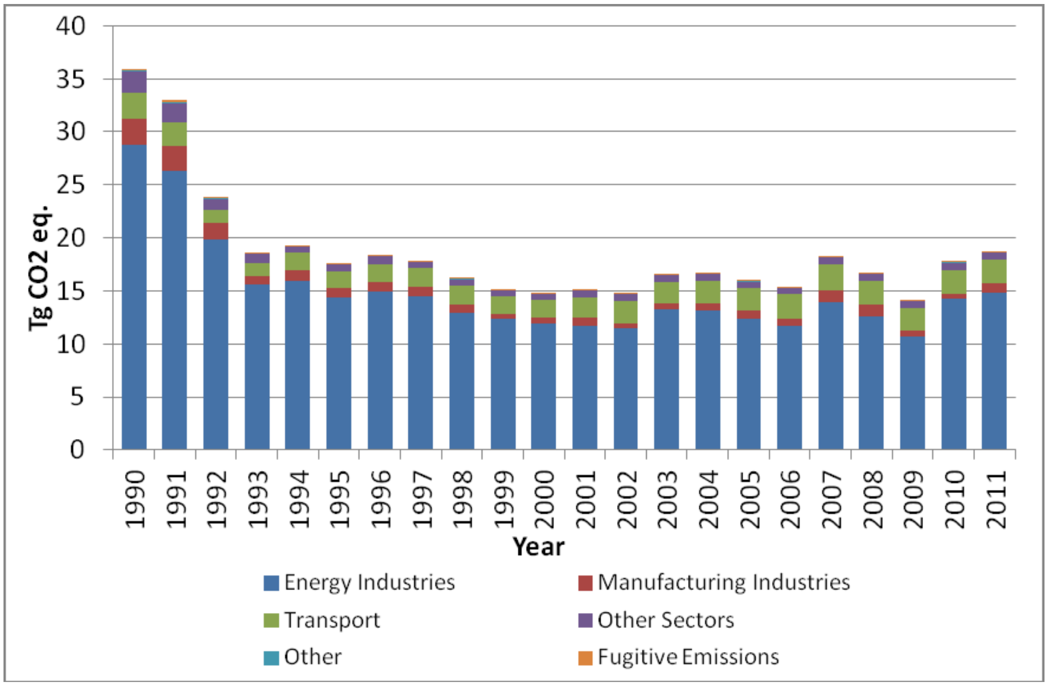


Figure 2.5. Trend in Emissions from Energy Sector 1990–2011

2.3.2. Trends in Industrial Processes (CRF 2)

Estonia's emissions from Industrial Processes sector are divided into the following emissions categories: Mineral Products, Chemical Industry, Consumption of Halocarbons and SF_6 and Other Production. Under Mineral products Estonia reports emissions from cement, lime, glass, bricks and tiles production as well as emissions from lightweight gravel production and soda ash use. Also NMVOC emissions from road paving with asphalt are reported in this category. Emissions from ammonia production are reported under Chemical Industry. The category Consumption of Halocarbons and SF_6 covers the emissions of F-gases from refrigeration and air-conditioning, foam blowing, aerosols and electrical equipment, as well as some smaller sources, such as fire extinguishers and other. Under Other production Estonia reports NMVOC emissions from pulp and paper and food industries. The share of emissions by category in CO_2 equivalent is presented in Figure 2.6.

In 2011 industrial GHG emissions contributed 2.93% of the total GHG emissions in Estonia, totalling 613.82 Gg CO_2 equivalent. The most important GHG emissions from Industrial Processes in Estonia's inventory in 2011 are the CO_2 emissions from Cement Production and Lime Production with 1.99% and 0.11%, respectively, and HFC emissions from Refrigeration and Air Conditioning Equipment with 0.71% of the total GHG emissions in Estonia. F-gas emissions comprised together 0.77% of the total GHG emissions.

Industrial CO_2 emissions have fluctuated strongly since 1990, reaching the lowest level in 1993. The decrease in the emissions during the early 1990's was caused by the transition from planned economy to market economy after 1991 when Estonia became independent. This led to lower emissions in industrial production, and to an overall decrease in the emissions from industrial processes between 1991 and 1993. In 1994 the economy began to recover and production increased. The decrease in emissions in 2002 and 2003 was caused by the decrease in ammonia production, because the only existing ammonia factory was being reconstructed. The sudden increase in emissions in 2007 is mainly caused by the increase of cement production, as the only cement factory Kunda Nordic Cement AS renovated its third kiln. In 2009, industrial processes sector was affected by the economic recession. Decline in production was mainly caused by the insufficient demand both in domestic and external markets. Increase in 2011 emissions was caused by increase of cement production. The overall progressing of GHGs in the Industrial Processes sector in CO_2 equivalent is presented in Figure 2.6.

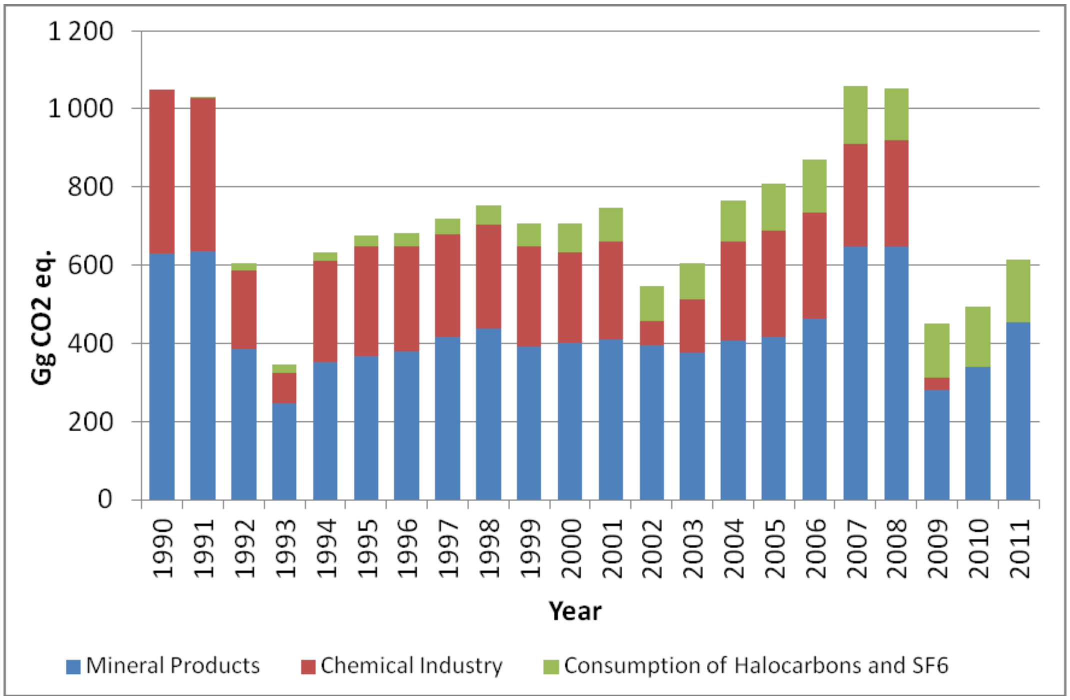


Figure 2.6. Trend in Emissions from Industrial Processes Sector 1990–2011

2.3.3. Trends in Solvent and Other Product Use (CRF 3)

Estonia's emissions from Solvent and Other Product Use sector are divided into the following emissions categories: Paint Application, Degreasing and Dry Cleaning, Chemical Products, Manufacture and Processing and Other. Under Other Estonia reports N_2O emissions from the use of N_2O in medical and other applications, N_2O emissions from aerosol cans and indirect CO_2 emissions from printing industry, domestic solvent use and other product use. The trend in emissions in CO_2 equivalents by category is presented in Figure 2.7.

In 2011, the Solvent and Other Product Use sector contributed 0.09% of the total GHG emissions in Estonia, totalling 18.86 Gg CO_2 equivalent. Indirect CO_2 emissions from paint application and indirect CO_2 emissions from other contributed the main share of the total emissions from the solvent and other product use sector – namely 29.86% and 28.19% accordingly.

Emissions from the solvent and other product use sector have decreased by 28.69% compared to the base year 1990. Two major categories where decrease of NMVOC emissions, and due to that decrease of indirect CO_2 emissions, have occurred in later years are paint application (CRF 3.A) and other product use (CRF 3.D.5). The fluctuation of NMVOC emissions in the period 1990–2011 has occurred mostly due to the welfare of the economic state of the country. The overall progression of GHG in the solvent and other product use sector in CO_2 equivalents is presented in Figure 2.7.

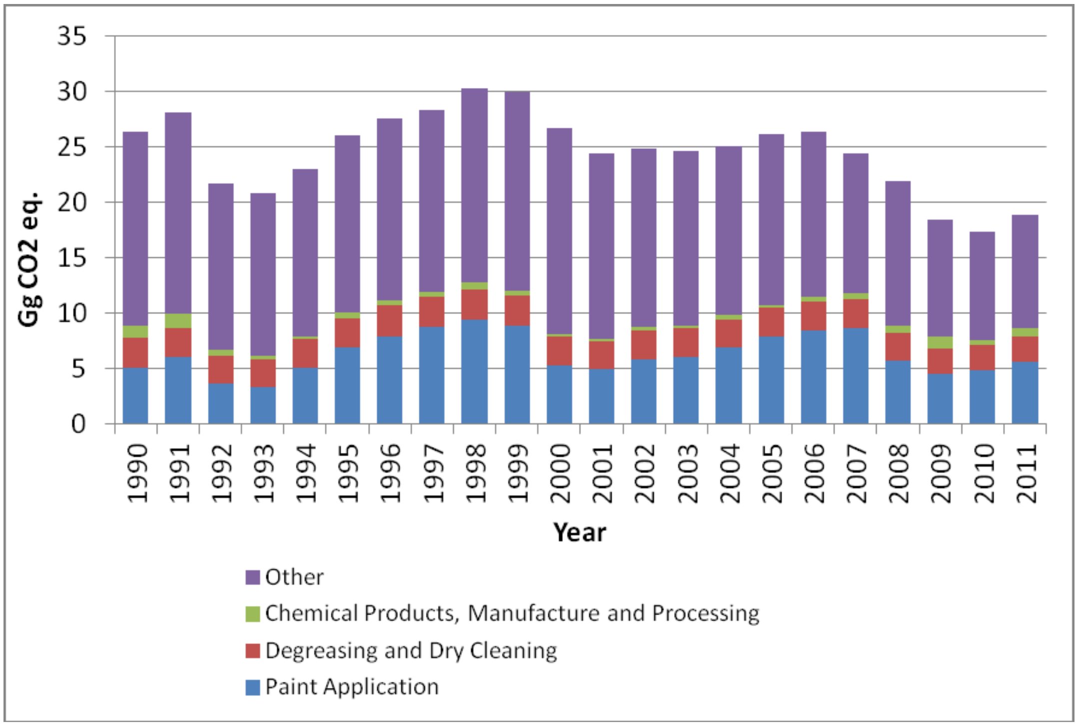


Figure 2.7. Trend in Emissions from Solvent and Other Product Use Sector 1990–2011

2.3.4. Trends in Agriculture sector (CRF 4)

Agricultural GHG emissions in Estonia consist of CH_4 emissions from enteric fermentation of domestic livestock, N_2O emissions from manure management systems, direct and indirect N_2O emissions from agricultural soils. Direct N_2O emissions include emissions from synthetic fertilizers, animal manure and sewage sludge applied onto agricultural soils, and emission occurred from crops growing (i.e., N-fixing crops and crop residues), and due to cultivation of histosols. Indirect N_2O emissions include emissions due atmospheric deposition and due to nitrogen leaching and run-off. The trend in emissions in CO_2 eq. by category is presented in Figure 2.8.

In 2011, Agriculture sector contributed 6.06% of the total GHG emissions occurred in Estonia, totalling 1 270.52 Gg CO_2 eq. Emissions from enteric fermentation of livestock and direct emissions from agricultural soils contributed major share to the total emissions occurred in the sector – namely 32.3% and 31.5%, accordingly.

Emissions from the agricultural sector have declined 59.88% compared to the base year, due to decrease in livestock population and in amounts of synthetic fertilizers and manure applied to agricultural fields. The total GHG emissions from the sector are presented in Figure 2.8 for the entire time-series.

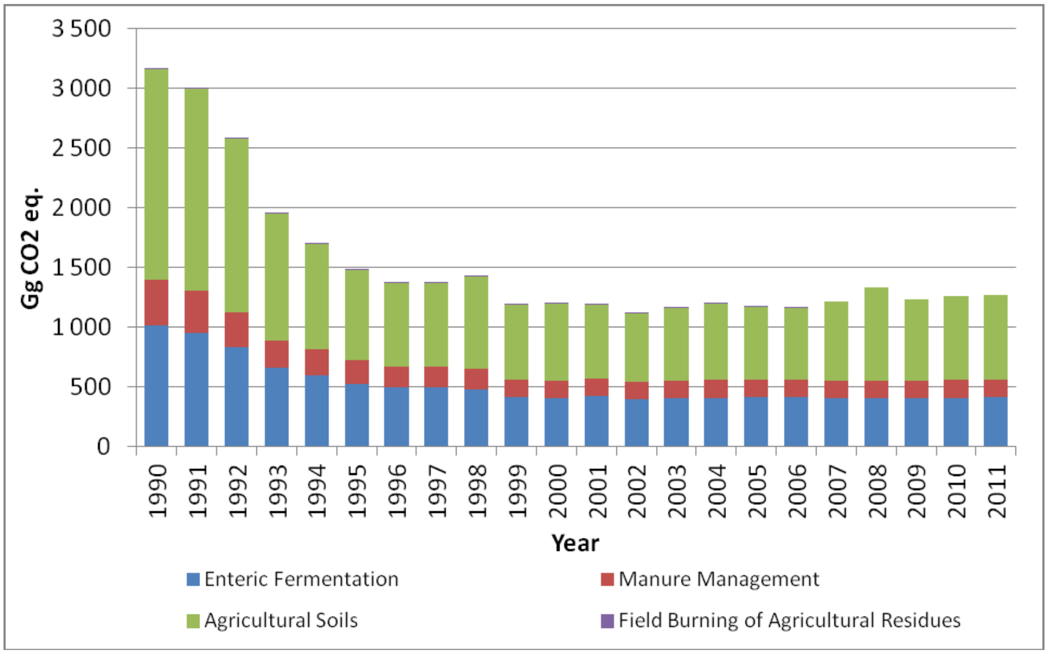


Figure 2.8. Trend in Emissions from Agriculture Sector 1990–2011, Gg CO_2 eq

2.3.5. Trends on Land Use, Land Use Change and Forestry sector (CRF 5)

LULUCF sector, acting as the only possible sink of greenhouse gas emissions in Estonia, plays an important role in the national carbon cycle. Emissions and removals from the LULUCF sector are divided into the following categories: Forest Land, Cropland, Grassland, Wetlands (Peatland), Settlements and Other Land, each category is further divided into 'land remaining' and 'land converted to' subcategories.

The share of LULUCF sector emissions and removals by each land use category during the time period 1990–2011 is presented in Figure 2.9. In 2011, LULUCF sector acted as a CO_2 sink, totalling uptake of 4 262.81 Gg CO_2 equivalent. Compared to the base year 1990, uptake of CO_2 has decreased by 51.83% and compared to the previous year 2010, 28.26%. In the last decade, CO_2 emissions have varied widely due to the highly unstable rates of felling and deforestation. As seen in Figure 2.9, LULUCF sector has also acted as a net source during 2000–2003, when harvesting exceeded biomass increment in forests. A key driver behind these trends has been the socio-economic situation in Estonia.

Majority of CO_2 removals in LULUCF sector come from biomass increment in Forest Land remaining Forest Land and land converted to Forest Land subcategories. In 2011, Forest Land was the only net sink category.

During 2003–2007, Grasslands constituted a significant CO_2 sink in addition to Forest Land. Grasslands are reallocated to forest land category when the tree grown cover exceeds 30% due to natural succession and reduction of management activities.

Most of the emissions in LULUCF sector are the result of biomass loss due to land conversion to Settlements and drainage of organic soils, minor sources of CO_2 are biomass burning (wildfires), cropland liming and peat extraction.

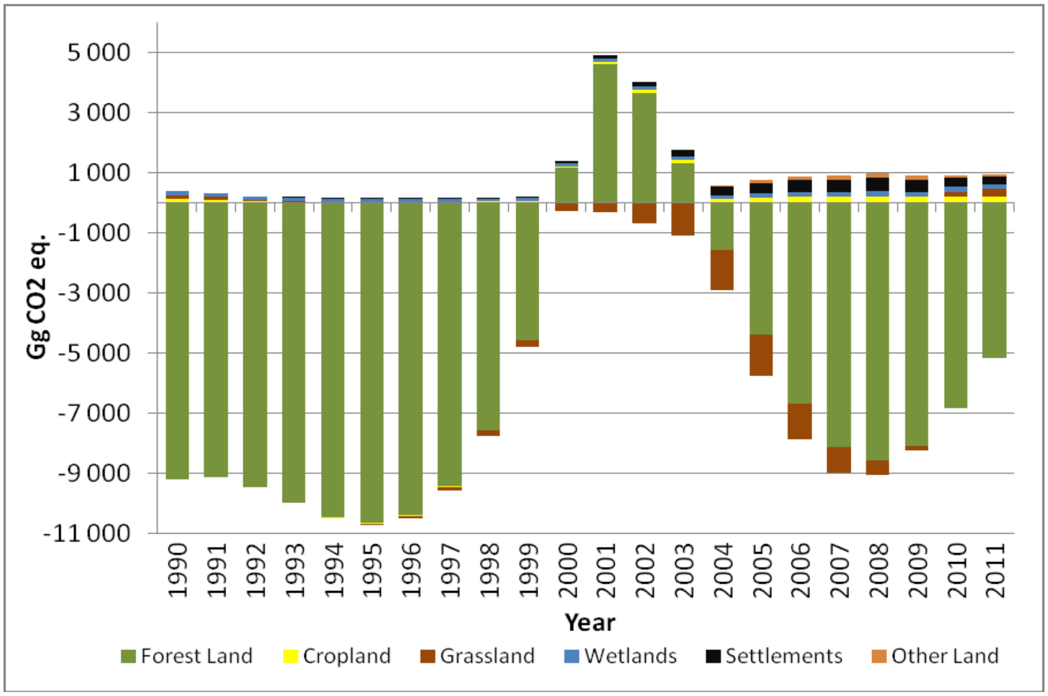


Figure 2.9. Trend in Emissions from Land Use, Land-Use Change and Forestry Sector 1990–2011

2.3.6. Trends in Waste (CRF 6)

The Estonian inventory of GHG in waste sector covers CH_4 emissions from solid waste disposal sites including solid municipal and industrial waste, domestic and industrial sludge. The waste sector also covers GHG emissions from waste incineration (incl biogas burnt in a flare), biological treatment and wastewater handling including domestic, commercial and industrial wastewater. The share of emissions by category is presented in Figure 2.10.

In 2011 the Waste sector contributed 1.86% of the total GHG emissions, totalling 390.76 Gg CO_2 equivalent. Solid Waste Disposal on Land contributed the most to the total emissions for the Waste sector in Estonia on 2011.

The total CO_2 equivalent emission from waste sector in 2011 increased 13.69% compared to the base year: the emission from solid waste landfilled increased 41.5% and emission from waste composting processes increased about hundred fold – from 1.26 Gg to 96.1 Gg in 2011. As seen from the Figure 2.10 in 1995 GHG emissions from waste sector decreased, which is due to CH_4 emissions from paper and sludge waste from solid waste disposal on land in 1995 has decreased. There have been a sharp fluctuations in the quantities of CO_2 and N_2O emissions from waste incineration in 1998–2001, as large amounts of inert, naphta, oil and wood were burnt 2008 and 2009. Since 2007 CO_2 emission have not occurred, as no non-biogenic waste have been incinerated, in 2008 and 2011 no wastes were incinerated without energy recovery, which resulted in no emerged emissions. The total CO_2 equivalent in 2007 is the highest during the whole period due to steady increase in emissions from biological treatment, which is related to the obligations stated in the Waste Act. The total CO_2 equivalent in 2011 has decreased significantly compared to the previous years mainly because the change in national currency, which uplifted the prices in the country and therefore lessened the consumption habits and waste generation. The overall progression of GHGs in the Waste sector in CO_2 equivalent is presented in Figure 2.10.

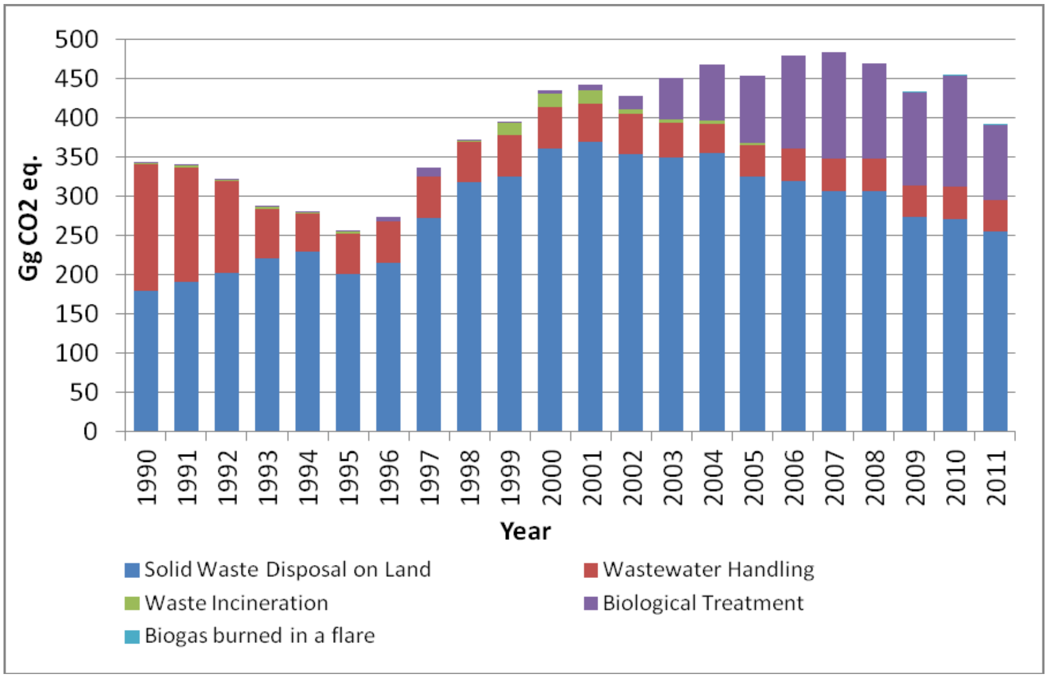


Figure 2.10. Trend in Emissions from Waste Sector 1990–2011

2.4. Description and interpretation of emission trends for indirect greenhouse gases and SO_2

The emissions of NOx, CO, NMVOC and SO_2 for the years 1990 to 2011 are presented in Figure 2.11. Total NOx emissions decreased by 56.17% from 77.20 Gg in 1990 to 33.84 Gg in 2011. Total CO emissions decreased by 27.95% from 190.00 Gg in 1990 to 136.90 Gg in 2011. Total NMVOC emissions decreased by 42.29% from 53.82 Gg in 1990 to 31.06 Gg in 2011. Total SO_2 emissions decreased by 60.55% from 184.26 Gg in 1990 to 72.68 Gg in 2011.

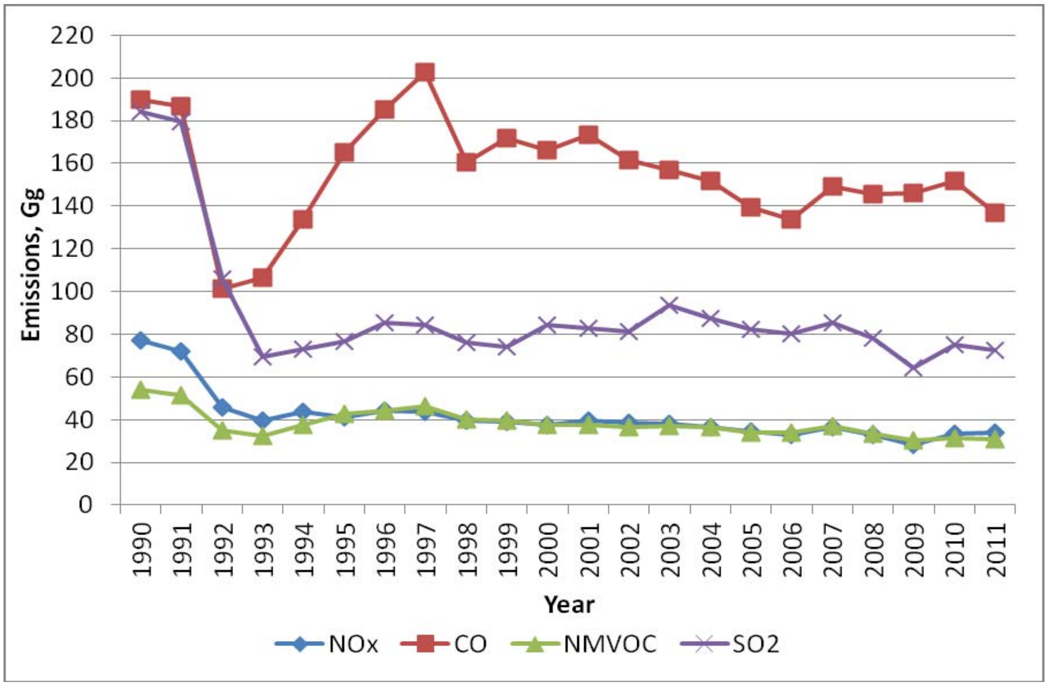


Figure 2.11. Emissions of NOx, CO, NMVOC and SO_2 1990–2011, Gg

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

In 2011, Article 3.3 activities were a net source in Estonia. The total net emissions were estimated at 232 Gg CO_2 eq. Afforestation and reforestation resulted in a net removal of -145 Gg CO_2 eq. and deforestation a net emission of 377 Gg CO_2 eq. (Table ES.3). Areas subject to AR and D were 27 295 and 19 135 ha, respectively by the end of 2011.

On AR areas, non-CO_2 emissions related to wildfires are estimated (Table 2.1). CO_2 emissions from fires are included in the biomass estimates due to stock-change method used. On D areas, emissions from wildfires are not provided, since all biomass present on forest land before deforestation is assumed to be lost after the land use change.

Table 2.1. CH_4 and N_2O emissions from wildfires on AR

AR Biomass burning				
	2008	**2009**	**2010**	**2011**
Area, ha	4.47	4.54	4.61	4.67
CH_4, kg	0.59	0.66	0.73	0.80
N_2O, kg	0.01	0.01	0.01	0.01
Total CO_2 eq., kg	14.68	16.29	18.03	19.95

3. ENERGY (CRF 1)

3.1. Overview of sector

Energy sector is the main source of greenhouse gas emissions in Estonia. In 2011, the energy sector contributed about 89% of total emissions, totalling 18 661.6 Gg of CO_2 equivalent (see Figure 3.1). Compared to the base year 1990, the emissions were about 48.1% below that level (35 956.9 Gg CO_2). Most of the energy sector emissions – 99.6% originate from fuel combustion and only 0.4% are contributed by fugitive emissions.

The substantial amount of energy related emissions are caused by extensive consumption of fossil fuels for power and heat production.

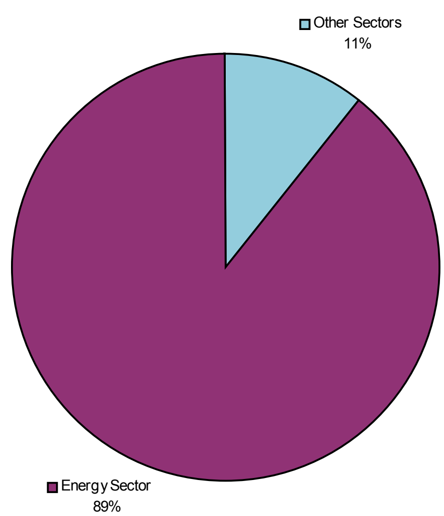


Figure 3.1. Emissions from the energy sector compared to the total emissions in 2011

The share of domestic fuels is large in Estonia's total energy resources and in the balance of primary energy which is based mainly on oil shale. This gives strategic independence to the supply of electricity – the share of imported fuels accounts for approximately 1/3 by us, in the European Union (EU) Member States on average it is about 2/3. The volume of exported electricity essentially influences the share of oil shale in the balance of primary energy – the bigger the exports of electricity is, the bigger is the share of oil shale in the balance of primary energy.

The development of primary energy supply in Estonia is presented in Figure 3.2.

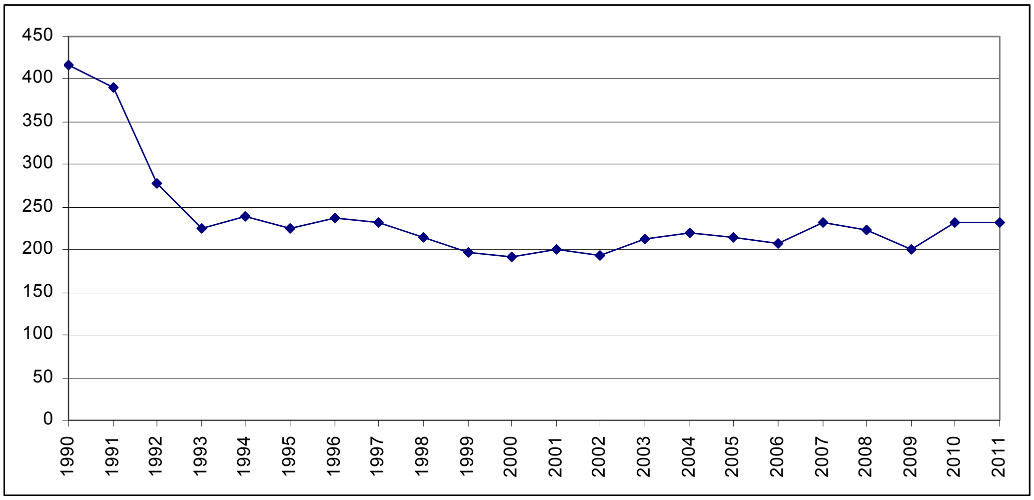
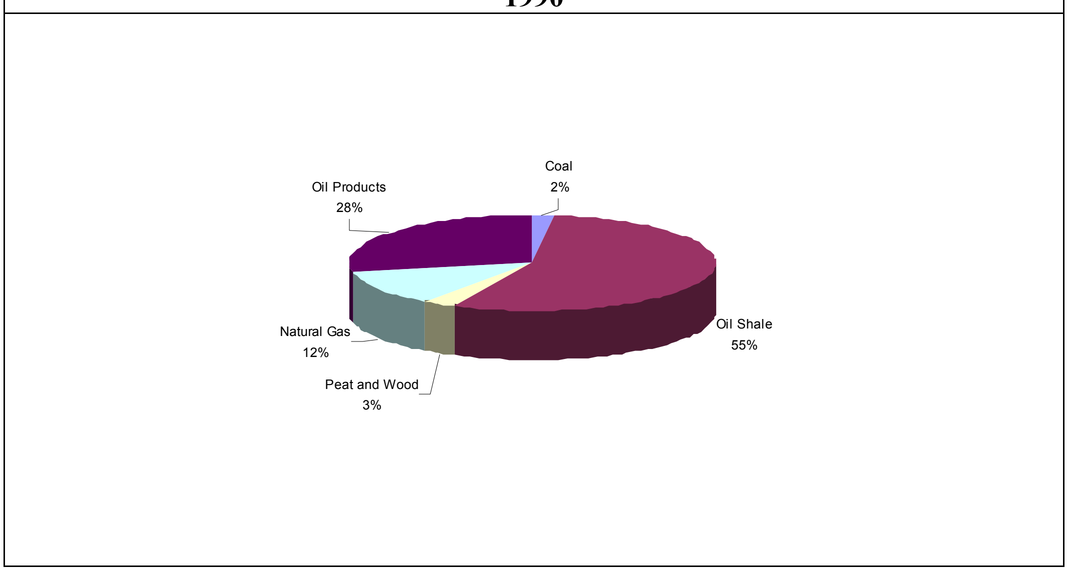


Figure 3.2. Development of Total Primary Energy Supply in Estonia in 1990–2011, PJ (Source: Statistics Estonia)

In 2011 the supply of primary energy was 232.3 PJ, of which oil shale formed 66%, and peat and wood together – 14%. The share of renewable energy sources amounted to approximately 13%, of which wood fuels comprised the main portion and other sources 0.1%. About 50% of the primary fuel energy was used for electricity and 16% for heat generation. The total primary energy supply stayed in the same level in 2011 compared with the previous year (see Figure 3.2).

The structure of primary energy supply in 1990 and 2011 accordingly is presented in Figure 3.3.

1990



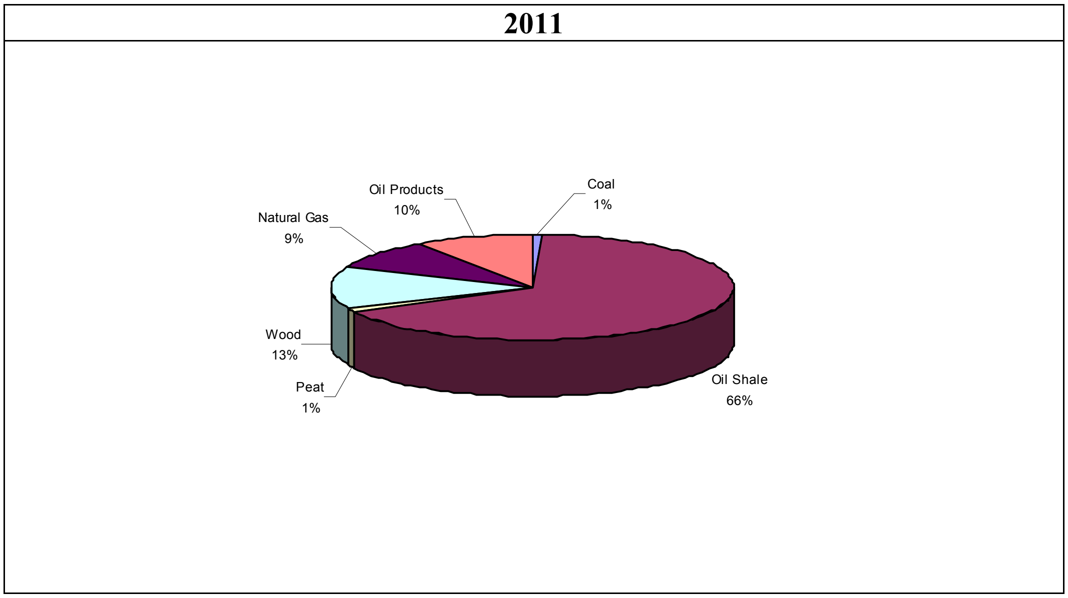


Figure 3.3. Structure of primary energy supply in Estonia in 1990 and 2011

The economic situation in 2011 was quite similar to 2010. Final consumption of energy decreased about 2.8% compared to 2010.

Domestic fuels hava a large share in Estonia's total energy resources and in the balance of primary energy – mainly based on oil shale. In 2011, 18.7 million tons of oil shale was produced, which is 4% more than in 2010. The majority of oil shale is consumed in power plants and as raw material for shale oil. The demand for shale oil in Estonia and in external markets increased the production of shale oil by about 7%. Nearly three quarters of the production was exported – 13% more than in 2010. More than half (54%) of this amount was exported to the Netherlands, followed by Russia (15%) and the United Kingdom (8%). At the same time, the production of other fuels declined. Due to decreased external demand, the production of peat, peat briquettes and wood pellets fell about 10% compared to 2010. Exports of pellets decreased nearly 7%. (Figure 3.3).

Emissions from the energy sector by subcategory in 1990–2011 are presented on the Figure 3.4.

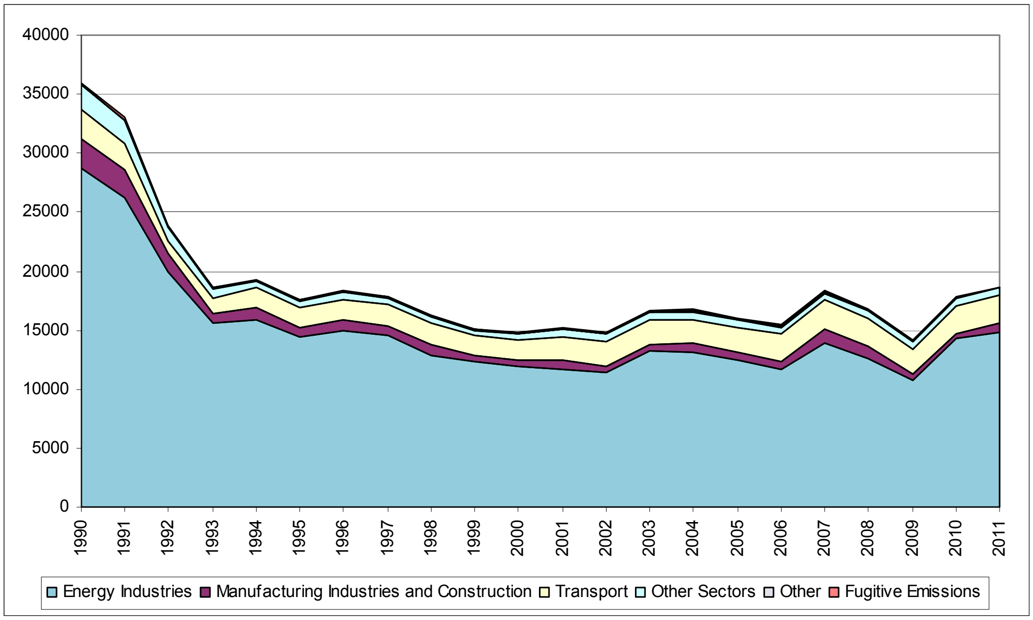


Figure 3.4. Emissions from the energy sector by subcategory in 1990–2011 (Gg CO_2 equivalent)

Trend of fuel consumption in Energy sector in 1990–2011 is presented on the Figure 3.5.

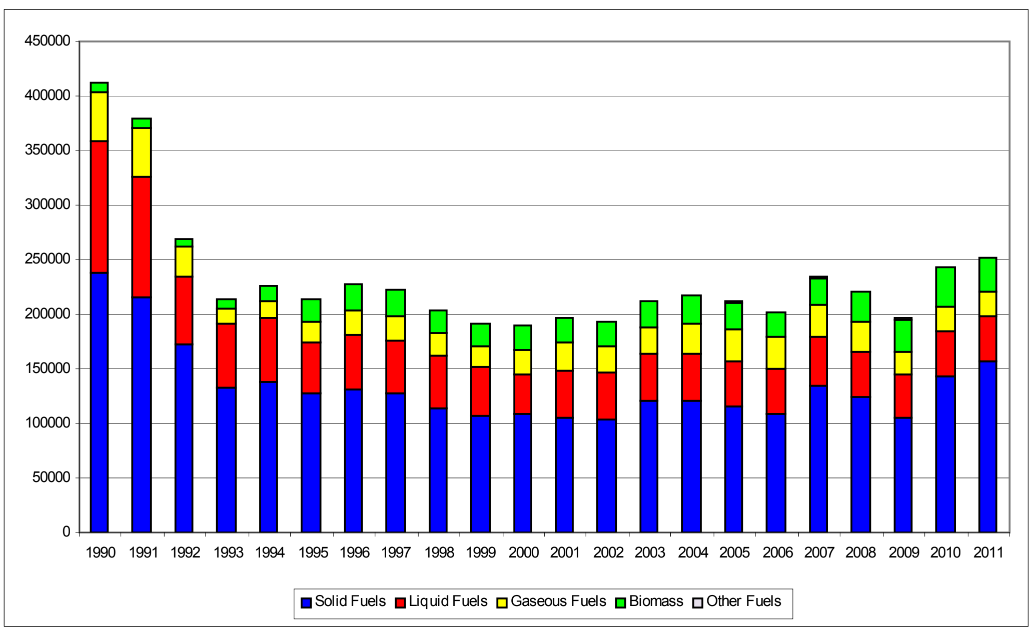


Figure 3.5. Fuel consumption in 1990–2011, TJ

Table 3.1. Emissions from the energy sector in 1990–2011 by sub-category and greenhouse gas (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy Total, CO_2 eq	35 956.90	32 967.77	23 816.15	18 603.92	19 225.41	17 596.48	18 341.04	17 857.11	16 205.29	15 103.37	14 770.96
1.A Fuel Combustion Total, CO_2 eq	35 775.81	32 786.83	23 710.46	18 550.53	19 149.25	17 510.15	18 246.20	17 764.41	16 117.27	15 017.61	14 673.78
1.A Fuel Combustion, CO_2	35 565.96	32 585.73	23 576.37	18 428.92	19 011.55	17 314.04	18 017.54	17 534.17	15 928.44	14 836.41	14 490.57
1.A Fuel Combustion, CH_4	4.70	4.52	3.00	2.70	3.50	5.74	6.70	6.95	5.48	5.45	5.37
1.A Fuel Combustion, N_2O	0.36	0.34	0.23	0.21	0.21	0.24	0.28	0.27	0.24	0.22	0.23
1.B Fugitive Emissions, CO_2 eq	181.10	180.95	105.68	53.40	76.16	86.33	94.84	92.70	88.02	85.76	97.17

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. Energy Total, CO_2 eq	15 129.28	14 824.75	16 594.37	16 722.18	16 020.66	15 385.39	18 270.54	16 745.77	14 129.73	17 767.99	18 661.63
1.A Fuel Combustion Total, CO_2 eq	15 024.25	14 737.10	16 497.18	16 608.49	15 903.46	15 266.51	18 151.97	16 632.30	14 052.07	17 684.80	18 586.49
1.A Fuel Combustion, CO_2	14 820.85	14 528.06	16 301.62	16 404.21	15 711.61	15 086.67	17 944.61	16 422.21	13 832.39	17 449.42	18 366.41
1.A Fuel Combustion, CH_4	5.42	5.38	5.50	5.64	5.02	4.82	5.83	5.93	6.22	6.52	5.73
1.A Fuel Combustion, N_2O	0.29	0.31	0.26	0.28	0.28	0.25	0.27	0.28	0.29	0.32	0.32
1.B Fugitive Emissions, CO_2 eq	105.02	87.65	97.20	113.69	117.20	118.88	118.57	113.47	77.66	83.19	75.14

Three greenhouse gases are emitted from energy sector, carbon dioxide (CO_2) and small amounts of methane (CH_4) and nitrous oxide (N_2O) (Figure 3.4). Energy related CO_2 emissions vary mainly according to the energy supply structure and climate conditions. Essential role has also on the export of electricity, because the main share of electricity in Estonia is produced from oil shale. As suggested in the IPCC 1996 guidelines, the 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 in 1990–2011 by sub-category and greenhouse gas are presented in the Table 3.1.

3.2. Emissions from fuel combustion (CRF 1.A)

The emissions from fuel combustion comprise all fuel combustion, including point sources, transport and other fuel combustion. Direct and indirect GHGs (CO_2, CH_4, N_2O, CO, NMVOC, NOx) as well as SO_2 are reported. Emissions from fuel combustion in the energy sector are divided into four 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 (including Commercial, Residential and Agriculture/Forest/Fishery sectors)
CRF 1.A 5 – Other/Military Fuels

Reported GHG emissions are listed in Table 3.2.

Table 3.2. Reported emissions under the subcategory fuel combustion in the Estonian inventory

CRF	**Source**	**Emissions reported**
1.A.1	Energy Industries	
	a. Public Electricity and Heat Production	CO_2, CH_4, N_2O
	c. Manufacture of Solid Fuels and Other Energy Industries	CO_2, CH_4, N_2O
1.A.2	Manufacturing industries and construction	
	a. Iron and Steel	CO_2, CH_4, N_2O
	b. Non-Ferrous Metals	CO_2, CH_4, N_2O
	c. Chemicals	CO_2, CH_4, N_2O
	d. Pulp, Paper and Print	CO_2, CH_4, N_2O
	e. Food Processing, Beverages and Tobacco	CO_2, CH_4, N_2O
	f. Other	CO_2, CH_4, N_2O
1.A.3	Transport	CO_2, CH_4, N_2O
	a. Civil Aviation	CO_2, CH_4, N_2O
	b. Road Transportation	CO_2, CH_4, N_2O
	c. Railways	CO_2, CH_4, N_2O
	d. Navigation	CO_2, CH_4, N_2O
1.A.4	Other sectors	
	a. Commercial/Institutional	CO_2, CH_4, N_2O

	b. Residential	CO_2, CH_4, N_2O
	c. Agriculture/Forestry/ Fisheries	CO_2, CH_4, N_2O
1.A.5	Other/b. Mobil	CO_2, CH_4, N_2O

Quantitative overview

CO_2 emissions from fossil fuel combustion (18 366.41 Gg) accounted for 98.42% of the energy sector's total emissions and 87.64% of total greenhouse gas emissions in 2011.

The share of CH_4 emissions from fuel combustion (120.3 Gg CO_2 eq.) was 0.64% in 2011, mainly due to the incomplete combustion of wood fuels (small combustion). N_2O emissions from fuel combustion are relativly small (99.78 Gg CO_2 eq.) accounting for about 0.53%. N_2O emissions are emitted mainly from energy industries and transport sectors (Table 3.8 and Table 3.22).

Table 3.3. Emissions from fuel combustion in Estonia in 1990–2011 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A Fuel Combustion total, CO_2 eq	35 775.81	32 786.83	23 710.46	18 550.53	19 149.25	17 510.15	18 246.20	17 764.41	16 117.27	15 017.61	14 673.78
1.A.1 Energy Industries, CO_2 eq	28 775.65	26 264.95	19 874.96	15 642.77	15 907.81	14 391.25	14 911.17	14 489.02	12 915.52	12 345.33	11 912.10
1.A.2 Manufacturing Industries and Construction, CO_2 eq	2 486.89	2 345.86	1 577.00	745.62	1 049.08	883.63	962.12	881.23	826.65	477.02	575.38
1.A.3 Transport, CO_2 eq	2 460.48	2 240.09	1 155.68	1 279.27	1 605.90	1 574.96	1 639.91	1 746.98	1 798.44	1 679.01	1 667.13
1.A.4 Other Sectors, CO_2 eq	2 008.42	1 881.57	1 067.97	871.86	575.28	630.99	716.45	633.25	559.15	498.74	502.00
1.A.5 Other, CO_2 eq	44.36	54.36	34.85	11.01	11.19	29.31	16.55	13.94	17.51	17.50	17.17

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A Fuel Combustion total, CO_2 eq	15 024.25	14 737.10	16 497.18	16 608.49	15 903.46	15 266.51	18 151.97	16 632.30	14 052.07	17 684.80	18 586.49
1.A.1 Energy Industries, CO_2 eq	11 728.17	11 449.83	13 248.30	13 172.41	12 394.57	11 659.61	13 904.53	12 607.92	10 691.11	14 238.63	14 875.63
1.A.2 Manufacturing Industries and Construction, CO_2 eq	700.87	485.26	555.15	663.96	719.01	714.70	1 183.72	1 078.00	591.05	510.24	790.22
1.A.3 Transport, CO_2 eq	1 996.39	2 125.21	2 019.37	2 066.19	2 137.38	2 296.24	2 420.77	2 303.92	2 126.40	2 248.24	2 259.87
1.A.4 Other Sectors, CO_2 eq	579.96	661.83	655.00	677.66	617.04	563.75	611.79	631.49	613.86	646.10	640.59
1.A.5 Other, CO_2 eq	18.86	14.97	19.35	28.27	35.46	32.21	31.16	10.97	29.66	41.58	20.18

Methods

Emissions from fuel combustion (CRF 1.A.1–1.A.2) 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 of the fraction of carbon oxidised is included.

Calculations of all emissions from fuel combustion are done with the Excel Work Tables created by energy sector expert.

Key Categories

Several emission sources in the energy combustion sector are key categories. The key categories in 2011 by level and trend and with and without LULUCF are listed in the Table 3.4, Table 3.5, Table 3.6 and Table 3.7.

Table 3.4. Key categories in the Energy sector in 2011, Level Assessment (without LULUCF) (quantitative method used: Tier 2)

IPCC code	IPCC source category	GHG	2011 Gg CO_2 equivalent
1.A.1.a	Energy Industries/Electricity and Heat Production – Solid Fuels	CO_2	13 162.32
1.A.1.c	Energy Industries/Other Energy Industries – Solid Fuels	CO_2	413.74
1.A.2.f	Manufacturing Industries and Constructions/Other – Solid Fuels	CO_2	448.98
1.A.4.b	Other Sectors/Residential – Biomass	CH_4	96.16

Table 3.5. Key sources in the Energy sector in 2011, Trend Assessment (without LULUCF) (quantitative method used: Tier 2)

IPCC code	IPCC source category	GHG	1990 Gg CO_2 equivalent.	2011 Gg CO_2 equivalent
1.A.1.a	Energy Industries/Electricity and Heat Production – Solid Fuels	CO_2	21 889.13	13 162.32
1.A.1.a	Energy Industries/Electricity and Heat Production – Liquid Fuels	CO_2	4 825.04	339.06
1.A.1.c	Energy Industries/Other Energy Industries – Solid Fuels	CO_2	65.20	413.74
1.A.4.b	Other Sectors/Residential – Biomass	CH_4	33.67	96.16
1.A.2.f	Manufacturing Industries and Constructions/Other – Other Fuels	CO_2	0.00	88.51
1.A.4.b	Other Sectors/Residential – Solid Fuels	CO_2	669.20	44.11
1.A.4.b	Other Sectors/Residential – Biomass	N_2O	6.63	18.93
1.A.2.c	Manufacturing Industries and Constructions/Chemicals – Solid Fuels	CO_2	620.79	0.00
1.A.3.b	Road Transport- Liquid Fuels	CO_2	2 236.11	2 113.72

Table 3.6. Key categories in Energy sector in 2011, Level Assessment (with LULUCF) (quantitative method used: Tier 2)

IPCC code	IPCC source category	GHG	2011 Gg CO_2 equivalent.
1.A.1.a	Energy Industries/Electricity and Heat Production – Solid Fuels	CO_2	13 162.32
1.A.1.c	Energy Industries/Other Energy Industries – Solid Fuels	CO_2	413.74
1.A.2.f	Manufacturing Industries and Constructions/ Other – Solid Fuels	CO_2	448.98
1.A.4.b	Other Sectors/Residential – Biomass	CH_4	96.16

Table 3.7. Key sources in Energy sector in 2011, Trend Assessment (with LULUCF) (quantitative method used: Tier 2)

IPCC code	IPCC source category	GHG	1990 Gg CO_2 equivalent.	2011 Gg CO_2 equivalent.
1.A.1.a	Energy Industries/Electricity and Heat Production – Solid Fuels	CO_2	21 889.13	13 162.32
1.A.1.a	Energy Industries/Electricity and Heat Production – Liquid Fuels	CO_2	4 825.04	339.06
1.A.1.c	Energy Industries/Other Energy Industries – Solid Fuels	CO_2	65.20	413.74
1.A.2.f	Manufacturing Industries and Constructions/Other – Other Fuels	CO_2	0.00	88.51
1.A.4.b	Other Sectors/Residential – Biomass	CH_4	33.67	96.16
1.A.4.b	Other Sectors/Residential – Solid Fuels	CO_2	669.20	44.11
1.A.2.c	Manufacturing Industries and Constructions/ Chemicals – Solid Fuels	CO_2	620.79	0.00
1.A.3.b	Road Transport- Liquid Fuels	CO_2	2 236.11	2 113.72
1.A.4.b	Other Sectors/Residential – Biomass	N_2O	6.63	18.93

3.2.1. Comparison of the sectoral approach with the reference approach (CRF 1.AB)

Reference approach (RA) is carried out using import – export, production and stock change data from the National Energy Balance published by Statistics Estonia (www.stat.ee).

In the 2013 inventory submission, the difference of CO_2 emissions between RA and Sectoral Approach (SA) was 2.23%.

The gaseous fuel consumption was equal in SA and RA because there was no non-energy use of natural gas in 2011.

However, differences in solid and liquid fuel consumption between RA and SA are caused by the fact that there is lot of secondary fuels used in final consumption (SA): shale oil, semi coke and oil shale gas – all made from oil shale, etc. Also a major reason for differences in fuels consumption in SA and RA is the statistical difference in National Energy Balance.

3.2.2. International Bunker Fuels

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

In 2011, GHG emissions from international bunkering were 704.36 Gg CO_2 equivalent including marine bunkers 599.26 Gg equivalent and aviation bunkers 105.11 Gg of CO_2 equivalent.

GHG emissions from international navigation increased throughout the period of 2005–2008. After 2008 the emissions have been declining.

GHG emissions from marine bunkering increased throughout the period of 2005–2008. From 2009 the emissions have been declining. In the last years volume of goods transport and also the volume of goods transit has been increased in Estonian ports. The trend of emissions in international aviation has been pretty stable, small increases of GHG emissions in 2005 and 2007 were caused by lower bunker fuel price in Estonia (Figure 3.6). In 2011, the emissions from marine bunkering declined about 14% compared to previous year. Emissions from aviation bunkering stayed about the same level in 2011 as they were in 2010.

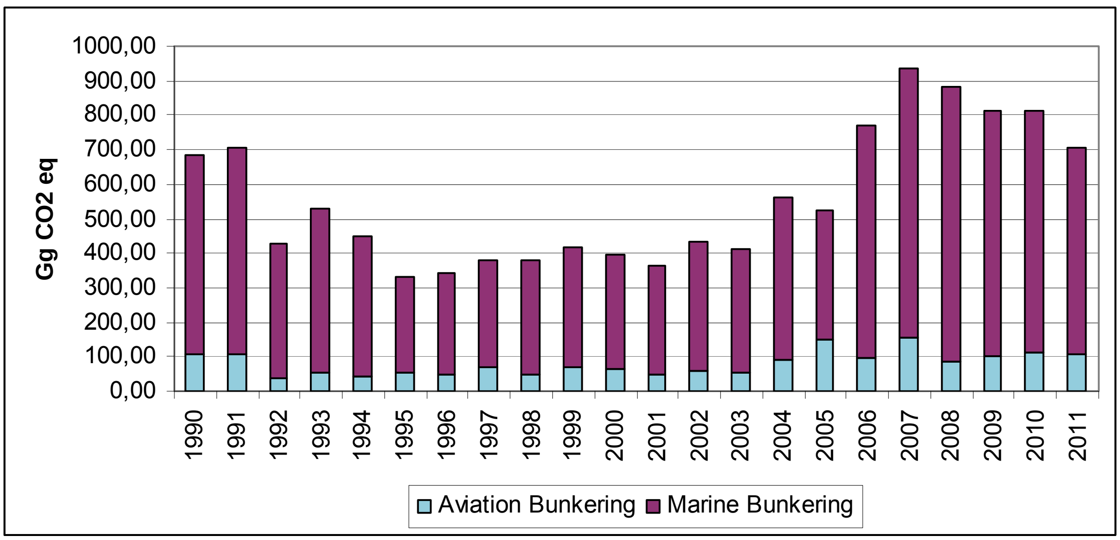


Figure 3.6. Emissions from international bunkers in 1990–2011, Gg CO_2 equivalent

The emissions are calculated using the IPCC methodology and default emission factors. Fuel consumption data on marine bunkering is obtained from the energy statistics and it includes fuel sales to ships abroad. The IPCC 1996 CO_2 emission factors are the same as for domestic aviation and navigation. The average non–CO_2 emission factors have been selected from the IPCC 1996 Guidelines, taking into account estimated fuel consumption and emissions from international landings and take-offs from the Estonia region. Activity data used in the calculations for domestic and international aviation (landing and take off cycles, fuel consumption) is obtained from the Estonian Environment Information Centre (COPERT model).

Source-specific recalculations

In the CRF source category 1.C.1.A – Aviation Bunkering, the activity data of Jet Kerosene has been revised due to changes made by Statistics Estonia:

	Year	2012 submission	2013 submission
Jet Kerosene, TJ	1993	747.7	735.3
	1996	647.9	653.6

3.2.3. Feedstocks and Non-Energy Use of Fuels

The following fuels are reported under CRF source category 1.AD Feedstocks and non–energy use of fuels:

1.AD.2 Lubricants
1.AD.3 Bitumen
1.AD.5 Natural Gas
1.AD.10 Other/Oil Shale

Activity data on lubricants and bitumen consumption is received from Statistics Estonia (Joint Questionnaire that Statistics Estonia send to IEA annually). Data on natural gas use for non-energy use is taken from national energy balance sheet. Activity data on oil shale reported in the CRF 1.AD is calculated (see Annex 3). This is oil shale semi coke – the by product of shale oil production and contains a small amount of organic matter (carbon). Oil shale semi-coke is stored in the oil shale waste dumps (carbon stored).

Natural gas for non-energy purposes are used for ammonia production and are reported in the CRF source category 2.B.1. In 2011 (as was in 2010), the ammonia production factory in Estonia was temporarily closed down due to low ammonia price in the Word market. Therefore no natural gas was consumed for non-energy purposes.

Lubricants are used in energy sector for lubricating (mainly in transport and manufacturing sub-sectors). Some used lubricants (waste oils) are incinerated and corresponding emissions are taken into account in the CRF 1.A.2.f/Other fuels.

Source-specific recalculations

1. In the CRF source category 1.AD.2 – Lubricants, the activity data has been revised due to changes made by Statistics Estonia:

	Year	2012 submission	2013 submission
Lubricants consumption, TJ	1990	1 139	1 085
	1991	1 097	1 045
	1992	717	683
	1993	549	522
	1994	717	683

	Year	2012 submission	2013 submission
	1995	464	442
	1996	506	482
	1997	380	362
	1998	422	402
	1999	295	281
	2000	338	362
	2001	295	322
	2002	253	241
	2003	295	281
	2004	253	241
	2005	169	161
	2006	169	161
	2007	295	281
	2008	211	201
	2009	160	161
	2010	125	161

2. In the CRF source category 1.AD.3 – Bitumen, the activity data has been revised due to changes made by Statistics Estonia:

	Year	2012 submission	2013 submission
Bitumen consumption, TJ	1990	2 105	2 170
	1991	1 794	1 849
	1992	936	965
	1993	1 209	1 246
	1994	1 326	1 366
	1995	819	844
	1996	1 092	1 125
	1997	1 014	1 045
	1998	1 248	1 286
	1999	1 248	1 286
	2000	1 326	1 366
	2001	1 092	1 125
	2002	2 651	2 733
	2003	1 170	1 206
	2004	1 716	1 768
	2005	1 599	1 648
	2006	2 105	2 170
	2007	1 365	1 407
	2008	1 507	1 407
	2009	1 323	1 348
	2010	1 366	1 560

3. In the CRF source category 1.AD.5 – Natural Gas, the activity data has been revised due to changes made by Statistics Estonia:

	Year	2012 submission	2013 submission
Natural gas consumption, TJ	1999	4 687	4 674
	2002	1 148	1 152
	2003	2 400	2 413
	2005	4 932	4 915
	2007	4 722	4 715

4. In the CRF source category 1.AD.10 – Other/Oil Shale, the carbon stored by oil shale has been recalculated due to new carbon balance:

	Year	2012 submission	2013 submission
Carbon Stored with semi-coke and black ash, Gg	1990	177.89	166.40
	1991	156.23	148.08
	1992	142.31	133.26
	1993	172.08	162.84
	1994	111.96	104.11
	1995	165.51	154.86
	1996	155.38	145.02
	1997	166.27	156.25
	1998	131.53	126.67
	1999	64.43	61.82
	2000	119.97	112.44
	2001	157.76	150.11
	2002	132.21	123.94
	2003	134.17	126.15
	2004	127.58	122.35
	2005	131.50	126.05
	2006	117.51	110.53
	2007	110.66	102.54
	2008	104.85	95.60
	2009	104.09	95.92
	2010	125.37	115.86

3.2.4. CO_2 capture from flue gases and subsequent CO_2 storage, if applicable

Up to now, no CO_2 capture and storage is used in Estonia.

3.2.5. Energy Industries and Manufacturing Industries and Construction (CRF1.A.1, CRF1.A.2)

3.2.5.1. Source category description

Energy Industries (CRF1.A.1) and Manufacturing Industries and Construction (CRF1.A.2) 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).

In 2011, the category Energy Industries (1.A.1) contributed 79.71% of energy sector emissions, totalling 14 875.63 Gg of CO_2 equivalent (see Table 3.3) and about 71% of total GHG emissions. Compared to the base year 1990, the emissions were about 48.3% lower (28 775.65 Gg CO_2 eq.).

The emissions from energy industries by relevant subcategories and gases in 1990–2011 are presented in the Table 3.8. The Figure 3.7 presents the trend of GHG emissions from Energy Industries by relevant subcategories in 1990 to 2011.

In general, the trend of GHG emissions in Energy Industries follows the trend of fuel consumption (Figure 3.5). In 2011, the emissions of Energy Industries decreased by 48.3% compared to 1990. The decrease of GHG emissions in electricity and heat production sub-sector was 49.7%. This big decrease was caused by the structural changes in the economy after 1991, when Estonia regained its independence. There has been a drastic decrease in the consumption of fuels and energy in energy industries (closing of the factories, decrease of electricity import, etc.). At the same time GHG emission trend of other energy industries (1.A.1.c) has increased about 10 times compared to 1990 due to enlarged export volumes of shale oil.

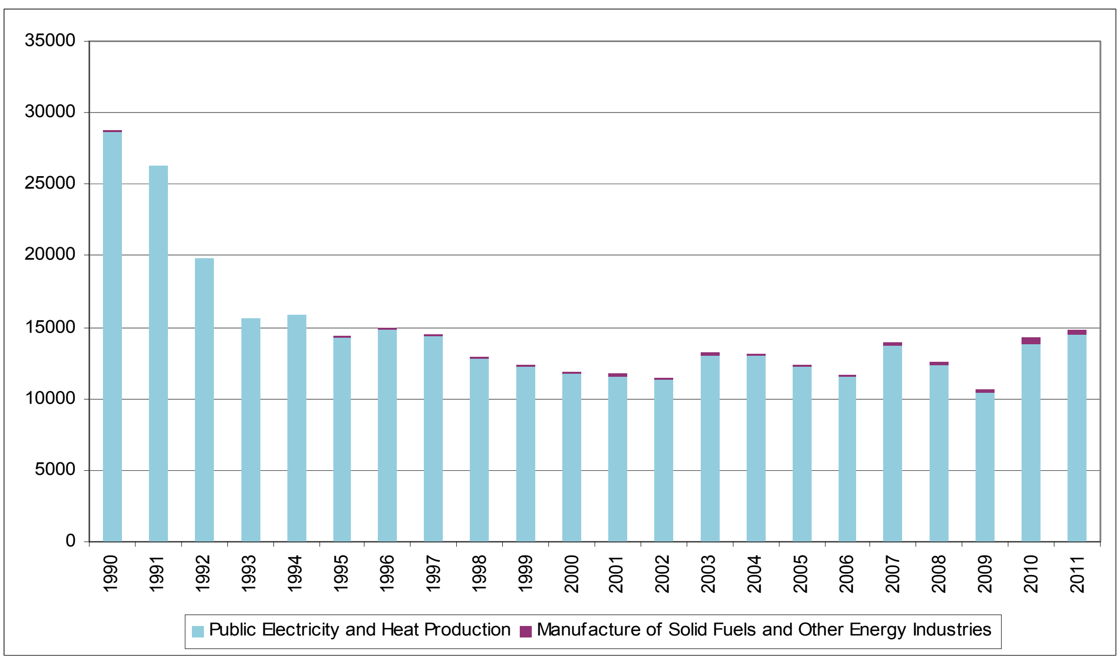


Figure 3.7. Trend of GHG emissions from Energy Industries by relevant subcategories in 1990–2011 (Gg CO_2 equivalent)

In 2011, the gross production of electricity was 12,893 GWh – basically equal to 2010 (12,964 GWh). Both import and export of electricity increased in 2011 compared to 2010. Import increased 53.6% and export increased 20.6%. The largest part (40%) of exported electricity was sold to Latvia. The rest of electricity was exported to Finland (32%) and Lithuania (28%). Almost 50% of electricity imported, came also from Latvia.

In Estonia, renewable energy is generated from hydro- and wind energy and biomass. Since electricity generation in hydroelectric power plants and wind parks has increased rapidly, the proportion of renewable energy has increased. In 2011 compared to 2010, the production of electricity from wind increased by 33%. The installed capacity of wind parks increased about 37% in 2011 compared to 2010. Electricity generation from hydroenergy has been stable since 2008. In 2008 the share of electricity generated from renewable sources was only 2.1% in the total electricity consumption, in 2009 it was 6.1%, in 2010 it was 8.1%, and in 2011 – 13%. The growth was due to the enlargement of the existing wind parks and commissioning of new wood fuel-based combined heat and power plants.

The warmer-than-average winter influenced the production of heat. In 2011 compared to 2010, the production of heat decreased by nearly 7%. About 60% of heat was produced by heating plants – by 3% more than in 2010. The shares of natural gas and wood used for heat production were 40% and 31% accordingly in 2011. A 22% increase occured in the production of heat from shale oil.

38% of heat was produced at power plants, and compared to 2010 the production decreased by nearly 13%. About 85% of the heat produced by power plants was generated in combined power and heat production plants.

In 2011, imports of energy products included natural gas, liquid fuels, coal and coke. The total import of fuels decreased about 3% compared to 2010. Decrease in natural gas imports was about 10%. This decrease was derived by smaller demand by power plants. The imports of motor gasoline decreased about 4%, while imports of diesel oil increased 13% compared to 2010.

In 2011, the category Manufacturing Industries and Construction (1.A.2) contributed 4.23% of energy sector emissions, totalling 790.22 Gg of CO_2 equivalents and about 3.8% of total GHG emissions.

The emissions from manufacturing industries and construction by relevant subcategories and greenhouse gases in 1990–2011 are presented in Table 3.9 and Figure 3.9. Compared to 1990, the emissions of Manufacturing Industries and Construction decreased by 68.22% in 2011. This big decrease was caused by the structural changes in the economy after 1991 when Estonia regained its independence.

To follow the structure of CRF Reporter all Manufacturing Industries and Construction sub-sectors are presented in the six CRF Reporter sub-categories: 2.a Iron and Steel, 2.b Non-Ferrous Metals, 2.c Chemicals, 2.d Pulp, Paper and Print, 2.e Food Processing, Beverage and Tobacco and 2.e Other. The shares of GHG emissions of relevant Manufacturing Industries and Constructions subcategories in 2011 are presented in the Figure 3.8.

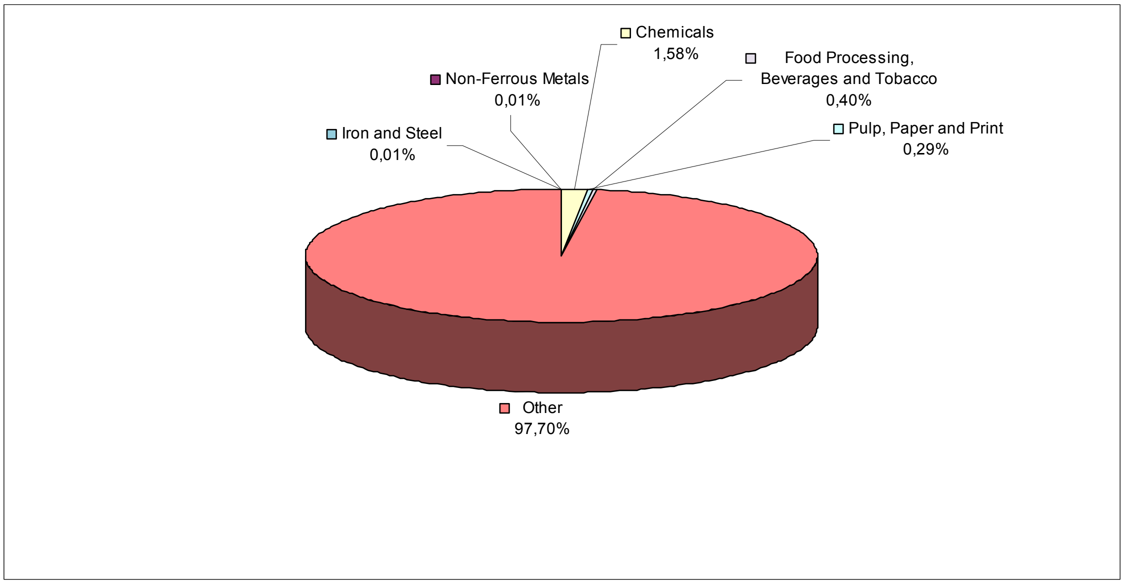


Figure 3.8. The share of GHG emissions from manufacturing industries and construction by relevant subcategories in 2011, %

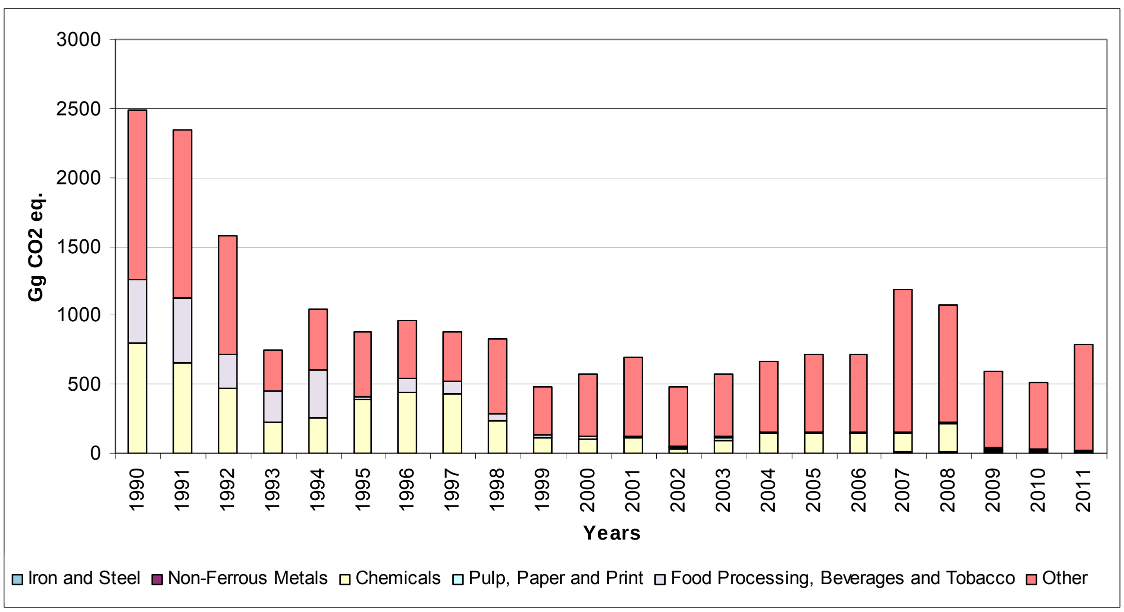


Figure 3.9. Trend of emissions GHG from manufacturing industries and construction by relevant subcategories in 1990–2011, Gg CO_2 equivalent

In Estonia, the share of the CRF sub-category 1.A.2.a Iron and Steel is very small forming only 0.01% of the manufacturing industries GHG emissions in 2011 (see Figure 3.8).

The source category '1.A.2.a Iron and Steel' consists mainly from factories using fuel for manufacturing goods from imported iron and steel. Since raw material (iron and steel) for this industry was imported from Russia, then after regaining its independence in 1991 all iron and steel using factories were closed. In 1994 those factories started working again. As the production of goods depends from the raw material supply and final production export possibilities, the production decrease in 1997–1999 was directly caused by economic crisis in Russia at the same period. The production stabilised in 2000 up to 2007 and small decrease of emissions in 2008 and 2009 is connected with the last economic depression which started in the end of 2008. In 2010 the emissions of GHG increased to the 2008 level due to upturn of export possibilities of the sector. In 2011 the emissions dropped drastically due to decreased fuel consumption in Iron and Steel Industry.

The trend of GHG emissions of the CRF source category 1.A.2.a Iron and Steel in 1990–2011 is presented in Figure 3.10.

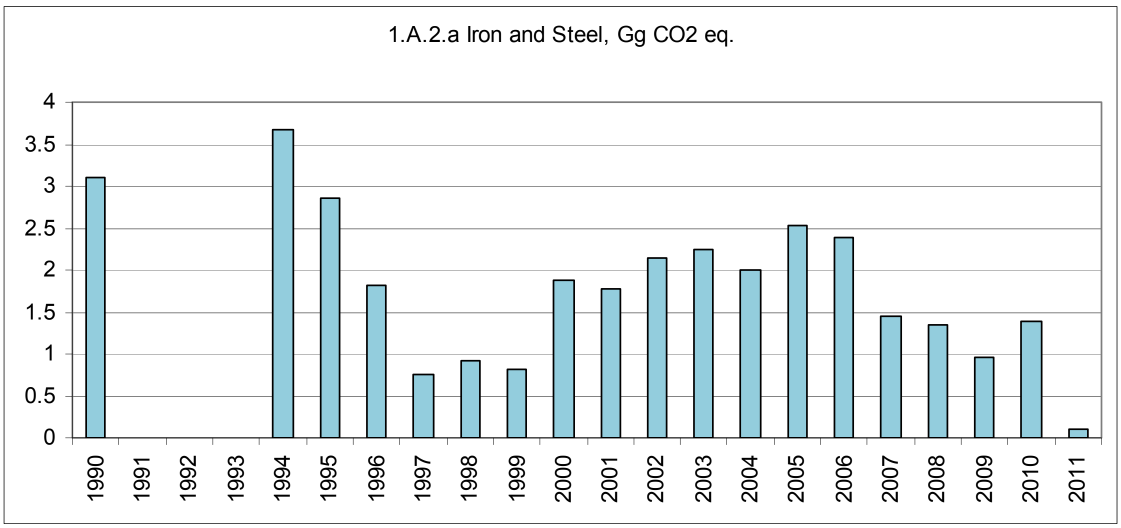


Figure 3.10. Trend of GHG emissions of the sub-sector Iron and Steel in 1990–2011, Gg CO_2 eq

The trend of GHG emissions of the CRF source category 1.A.2.b Non-Ferrous Metals in 1990–2011 is presented in Figure 3.11.

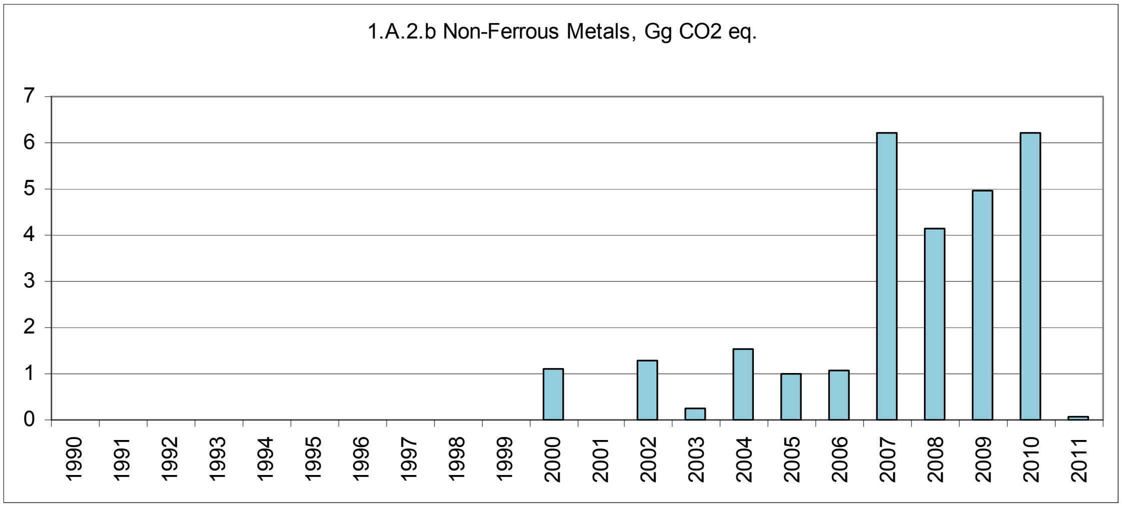


Figure 3.11. Trend of GHG emissions of the sub-sector Non-Ferrous Metals in 1990–2011, Gg CO_2 eq

The non-ferrous metal sub-sector is very small in Estonia consisting of 2–3 enterprises only. The big increase of GHG emissions in 2007 comparing with previous years is connected with fuel consumption increase and is probably caused by same large order(s) for some of these enterprises. The share of the CRF sub-category 1.A.2.b Non-Ferrous Metals is very small forming 0.01% of the manufacturing industries GHG emissions in 2011 (see Figure 3.8). In 2011 the emissions from Non-Ferrous Metals were only 0.07 Gg CO_2 equivalent. The shape of the GHG emission trend follows the trend of fuel consumption in the sub-category.

The trend of GHG emissions of the sub-category Chemicals in 1990–2011 is presented in the Figure 3.12.

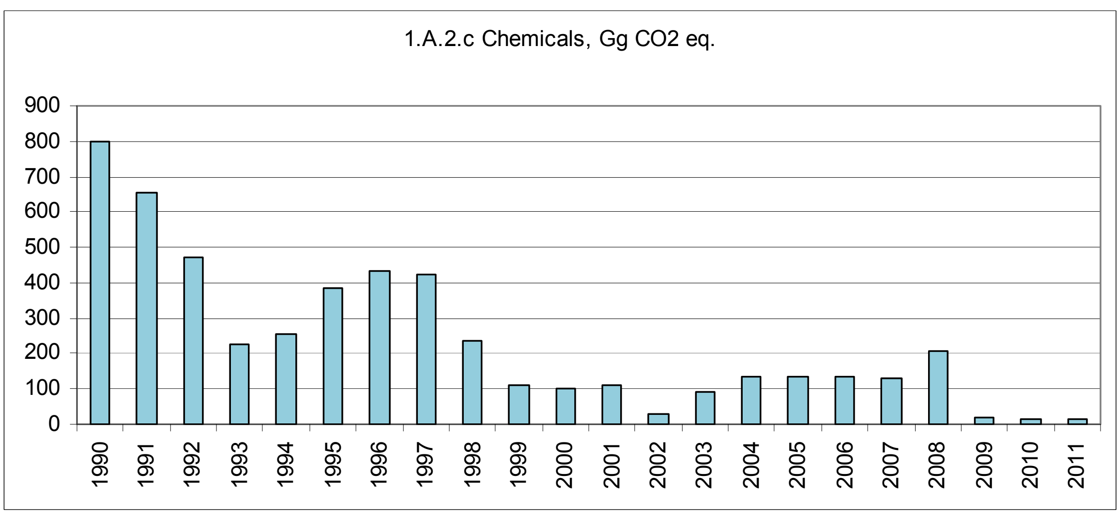


Figure 3.12. Trend of GHG emissions of the sub-sector Chemicals in 1990–2011, Gg CO_2 eq

Under this sub-category emissions from several chemical factories are reported. The biggest fuel consumer (mainly of natural gas) is the ammonia and urea producer Nitrofert AS.

The share of the CRF sub-category 1.A.2.c Chemicals sub-sector is small forming about 1.58% of the manufacturing industries GHG emissions in 2011 (see Figure 3.8).

The first decrease in the trend of GHG emissions in 1992/1993 was caused by privatisation of chemical enterprises after regaining independence in 1991 and by transition from eastern markets to the western markets. The second big decrease in 1999 is caused by extensive restructuring in the Estonian biggest chemical enterprise – Kiviter AS. The main product of the Kiviter was shale oil (a liquid fuel made from oil shale), but since 1999 shale oil production is reported under energy sector not under chemical industry as earlier. Only the productions of oil shale industry by-products like formalin, toluene, etc are still under chemical industry. In 2002 and 2009 the production of the Nitrofert was very small and in 2010 and 2011 the factory was temporarily closed down due to low ammonia prices in world market. Since the shape of the GHG emission trend follows the trend of fuel consumption, then the fluctuations of the trend are determined by the ammonia export possibilities of the chemical factory Nitrofert.

In the Figure 3.13 trend of GHG emissions from the sub-sector Pulp, Paper and Print in 1990–2011 is presented.

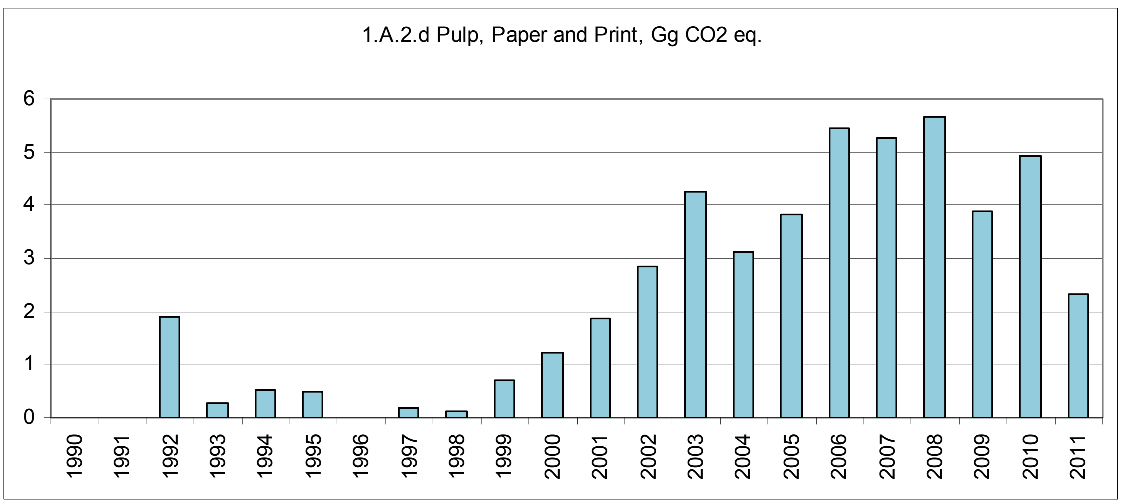


Figure 3.13. Trend of GHG emissions from the sub-sector Pulp, Paper and Print in 1990–2011, Gg CO_2 eq

The share of the CRF sub-category 1.A.2.d Pulp, Paper and Print is small, forming about 0.29% of the manufacturing industries GHG emissions in 2011 (see Figure 3.8).

There are only a few major pulp and paper factories in Estonia: Horizon Tselluloosi ja Paberi AS (Horizon Pulp and Paper Ltd, former Kehra paper factory), Kohila Paber AS (Kohila paper factory) and Räpina Paberivabrik AS (Räpina paper factory) using waste paper for paper and carton production. In 2006 a new aspen pulp factory Estonian Cell AS was commissioned. There was no pulp and paper production in 1990–1991 since the big Tallinn

Pulp and Paper factory was closed in the end of 80s and all small factories were not yet privatized.

In 1992–1998 the production of paper fluctuated because of standstill of some factories caused by ownership changes. Since 1999–2003 the production of paper grew every year compared to the previous year. In 2004 manufacturing of wood pulp fell. In 2005 manufacturing of paper and paper products increased due to lively investment and growth of export. In 2009 the production of paper decreased again due to the economic depression. In 2010 manufacturing of paper and paper products increased again due growth of export. The decrease of emissions in 2011 compared to 2010 is related to declining consumption of natural gas.

All above described factors are behind the GHG emission trend changes.

The trend of GHG emissions of the sub-sector Food Processing, Beverages and Tobacco in 1990–2011 is presented in the Figure 3.14.

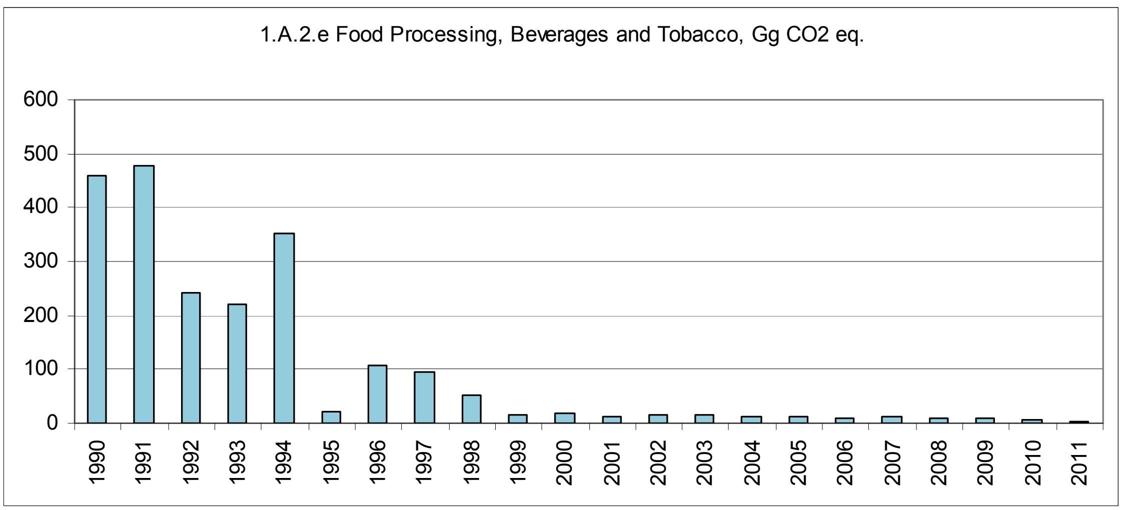


Figure 3.14. Trend of GHG emissions of the sub-sector Food Processing, Beverages and Tobacco in 1990–2011, Gg CO_2 eq

The share of the CRF sub-category 1.A.2.e Food Processing, Beverage and Tobacco is small forming about 0.40% of the manufacturing industries GHG emissions in 2011 (see Figure 3.8).

Manufacture of food products is the largest branch of manufacturing in Estonia giving about 15% of the total manufacturing output. Compared with other branches of industry, the manufacture of food products has been one of the most stable one. While before the economic crisis the growth in production was 3–4% a year, in 2007 production slowed down and during the following three years the volume of output at constant prices decreased a bit. Economic crisis influenced the manufacture of food products somewhat less than other branches, because food products are basic commodities directed mainly to the domestic market. Situation in the foreign market did not affect this sector so much.

The trend of GHG emissions of the sub-sector Other in 1990–2011 is presented in the Figure 3.15.

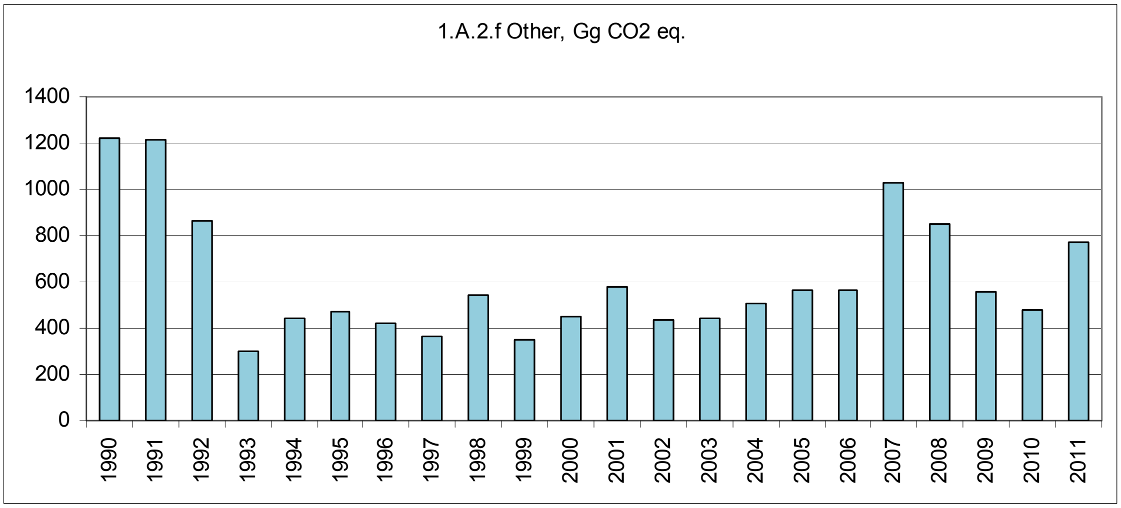


Figure 3.15. Trend of GHG emissions of the sub-sector Other in 1990–2011, Gg CO_2 eq

The share of the CRF sub-category 1.A.2.f Other is the biggest forming about 97.7% of the manufacturing industries GHG emissions in 2011 (see Figure 3.8).

In Estonia, the Manufacturing Industries and Construction sector's 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'. In general, the shape of the GHG emission trend follows the trend of fuel consumption of the sector. The fluctuations of the trend are determined by the export possibilities of the sectors factories. The decrease of emissions in 2010 is connected with economic depression which started in 2008. Despite the upturn of economy in some branches of manufacturing industries the total volume of output in the manufacturing industry decreased in 2010. Recession in the construction market low, which caused a low demand for building materials in the domestic and international markets, was the main reason for that. In 2011, GHG emissions increased about 61.5% compared to 2010. The biggest share in this increase was due to use of oil shale and coal in cement production (the use of oil shale increased over 2 times in 2011 compared to 2010).

The values of CO_2 IEFs of liquid fuels in the Manufacturing Industries and Construction are between 72.75 t/TJ (in 2007) and 75.23 t/TJ (in 1995) and the values of CO_2 IEF of solid fuels are between 97.91 t/TJ (in 2009) and 127.3 t/TJ (in 1997). The trends are fluctuating due to changes in the contribution of different solid and liquid fuels over time.

Table 3.8. The emissions from Energy Industries by relevant subcategories and gases in 1990–2011 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.1 Energy Industries Total, CO_2 eq	28 775.65	26 264.95	19 874.96	15 642.77	15 907.81	14 391.25	14 911.17	14 489.02	12 915.52	12 345.33	11 912.10
1.A.1 Energy Industries, CO_2	28 748.11	26 240.22	19 857.25	15 626.10	15 888.78	14 371.02	14 887.82	14 467.07	12 893.82	12 323.74	11 892.21
1.A.1 Energy Industries, CH_4	0.36	0.33	0.23	0.22	0.27	0.30	0.35	0.33	0.33	0.33	0.31
1.A.1 Energy Industries, N_2O	0.06	0.06	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.04
1.A.1.a Public Electricity and Heat Production, CO_2	28 682.91	26 204.02	19 820.88	15 579.83	15 802.76	14 291.04	14 817.57	14 383.77	12 821.84	12 240.80	11 746.82
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries CO_2	65.20	36.20	36.37	46.27	86.02	79.98	70.25	83.30	71.98	82.94	145.39

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.1 Energy Industries Total, CO_2 eq	11 728.17	11 449.83	13 248.30	13 172.41	12 394.57	11 659.61	13 904.53	12 607.92	10 691.11	14 238.63	14 875.63
1.A.1 Energy Industries, CO_2	11 705.03	11 425.98	13 224.50	13 144.25	12 360.55	11 629.43	13 875.70	12 575.99	10 656.87	14 194.43	14 829.11
1.A.1 Energy Industries, CH_4	0.36	0.38	0.38	0.40	0.44	0.37	0.35	0.40	0.46	0.61	0.64
1.A.1 Energy Industries, N_2O	0.05	0.05	0.05	0.06	0.08	0.07	0.07	0.08	0.08	0.10	0.11
1.A.1.a Public Electricity and Heat Production, CO_2	11 568.35	11 272.03	13 041.03	12 968.98	12 170.11	11 474.62	13 729.51	12 354.02	10 347.77	13 776.18	14 415.37
1.A.1.c Manufacture of Solid Fuels and Other Energy Industries CO_2	136.68	153.95	183.47	175.27	190.43	154.81	146.20	221.98	309.10	418.25	413.74

Table 3.9. The emissions from Manufacturing Industries and Construction by relevant subcategories in 1990–2011 (Gg, CO_2 equivalent)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.2 Manufacturing Industries and Construction Total	2 486.89	2 345.86	1 577.00	745.62	1 049.08	883.63	962.12	881.23	826.65	477.02	575.38
1.A.2.a Iron and Steel	3.09	NO	NO	NO	3.68	2.85	1.81	0.75	0.92	0.81	1.88
1.A.2.b Non-Ferrous Metals	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1.10
1.A.2.c Chemicals	800.09	653.33	472.32	224.79	254.02	387.08	434.78	424.37	235.19	111.37	101.98
1.A.2.d Pulp, Paper and Print	NO	NO	1.89	0.28	0.53	0.48	NO	0.19	0.11	0.70	1.23
1.A.2.e Food Processing, Beverages and Tobacco	459.78	477.10	241.23	220.77	350.97	21.52	105.86	94.55	51.03	16.74	17.32
1.A.2.f Other	1 223.92	1 215.42	861.56	299.79	439.88	471.70	419.67	361.38	539.41	347.41	451.86

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.2 Manufacturing Industries and Construction Total	700.87	485.26	555.15	663.96	719.01	714.70	1 183.72	1 078.00	591.05	510.24	790.22
1.A.2.a Iron and Steel	1.78	2.13	2.24	2.01	2.52	2.40	1.44	1.35	0.97	1.40	0.11
1.A.2.b Non-Ferrous Metals	NO	1.29	0.26	1.54	0.99	1.05	6.20	4.13	4.96	6.23	0.07
1.A.2.c Chemicals	109.08	29.78	90.79	137.03	136.23	135.08	131.07	206.20	17.51	12.67	12.52
1.A.2.d Pulp, Paper and Print	1.87	2.83	4.26	3.13	3.82	5.46	5.25	5.66	3.89	4.93	2.32
1.A.2.e Food Processing, Beverages and Tobacco	13.07	16.29	15.38	13.34	12.65	9.41	11.48	9.31	9.48	6.96	3.18
1.A.2.f Other	575.07	432.94	442.22	506.91	562.81	561.30	1 028.27	851.34	554.23	478.06	772.01

3.2.5.2. Methodological issues

Methods

Emissions from fuel combustion are in general calculated by using the methodology of the IPCC 1996 Guidelines. Different tiers have been applied for different fuels and greenhouse gases.

For imported fuels mainly Tier 1 approach has been applied. For domestic fuels – oil shale, shale oil, oil shale semi-coke, oil shale semi-coke gas and generator gas and peat Tier 2 and Tier 3 approaches were used.

Tier 1 for CO_2 emissions:

CO_2 EMISSIONS FROM STATIONARY COMBUSTION

$$Emission_{fuel} = Fuel\ Consumption_{fuel} \bullet Emission\ Factor_{fuel} \bullet Oxidation\ Factor_{fuel}$$

Where:

Emission $_{fuel}$ = emissions of CO_2 by type of fuel (Gg)
Fuel Consumption $_{fuel}$ = amount of fuel combusted (TJ)
Emission Factor $_{fuel}$ = default emission factor of CO_2 by type of fuel (t/TJ)
Oxidation Factor $_{fuel}$ = fuel specific oxidation factor

For other GHG:

GREENHOUSE GAS EMISSIONS FROM STATIONARY COMBUSTION

$$Emission_{GHG,fuel} = Fuel\ Consumption_{fuel} \bullet Emission\ Factor_{GHG,fuel}$$

Where:

Emissions $_{GHG,\ fuel}$ = emissions of a given GHG by type of fuel (Gg)
Fuel consumption $_{fuel}$ = amount of fuel combusted (TJ)
Emission Factor $_{GHG,\ fuel}$ = default emission factor of a given GHG by type of fuel (t/TJ).

Tier 2 for CO_2 emissions:

CO_2 EMISSIONS FROM STATIONARY COMBUSTION

$$Emission_{fuel} = Fuel\ Consumption_{fuel} \bullet Emission\ Factor_{fuel} \bullet Oxidation\ Factor_{fuel}$$

Where:

Emission $_{fuel}$ = emissions of CO_2 by type of fuel (Gg)
Fuel Consumption $_{fuel}$ = amount of fuel combusted (TJ)
Emission Factor $_{fuel}$ = country specific emission factor of CO_2 by type of fuel (t/TJ)
Oxidation Factor $_{fuel}$ = fuel specific oxidation factor

GREENHOUSE GAS EMISSIONS FROM STATIONARY COMBUSTION

$$Emission_{GHG,fuel} = Fuel\ Consumption_{fuel} \bullet Emission\ Factor_{GHG,fuel}$$

Where:

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

Fuel consumption $_{fuel}$ = amount of fuel combusted (TJ)
Emission Factor $_{GHG,\ fuel}$ = country specific emission factor of a given GHG by type of fuel (t/TJ).

Tier 3 for CO_2 emissions:

CO_2 EMISSIONS FROM STATIONARY COMBUSTION

$$Emission_{fuel,technology} = Fuel\ Consumption_{fuel,technology} \bullet EF_{fuel,technology} \bullet Oxidation\ Factor_{fuel}$$

Where:

Emissions $_{GHG,\ fuel,\ technology}$ = emissions of a given GHG by type of fuel and technology (Gg)

Fuel consumption $_{fuel,\ technology}$ = amount of fuel combusted by each technology (TJ)
Emission Factor $_{GHG,\ fuel,\ technology}$ = technology specific emission factor of a given GHG by type of fuel (t/TJ).

Oxidation Factor $_{fuel}$ = fuel specific oxidation factor

GREENHOUSE GAS EMISSIONS BY TECHNOLOGY

$$Emission_{GHG,\ fuel,technology} = Fuel\ Consumption_{fuel,technology} \bullet Emission\ Factor_{GHG,\ fuel,technology}$$

Where:
Emissions $_{GHG,\ fuel,\ technology}$ = emissions of a given GHG by type of fuel and technology (Gg)
Fuel consumption $_{fuel,\ technology}$ = amount of fuel combusted by each technology (TJ)
Emission Factor $_{GHG,\ fuel,\ technology}$ = technology specific emission factor of a given GHG by type of fuel (t/TJ).

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 (45–47%), a moderate content of moisture (11–13%) and sulphur (1.5–1.7%), a low net calorific value (8.3–8.7 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 (Arvo Ots, 2004).

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 (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. The 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 pulverised 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 circulated fluidised bed combustion (CFBC) technology are at present used in the Estonian Power Plants.

The first CFBC power unit (215 MW_{el}) 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 (k_S=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 MW_{el}) started at the Narva Power Plants in 2004. The successful operation of the new CFBC units allows continuing the construction of additional units. A new CFBC power unit (300 MW_{el}) is expected to be completed at the end of 2015.

A formula for the calculation of Estonian (pulverised combustion) oil shale carbon emission factor, taking into consideration the decomposition of its ash carbonate part and CO_2 binding at ash fields, is as follows:

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

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* = 0.64 for pulverised combustion of oil shale).

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).

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%;

k, decomposition rate of ash carbon part = 0.64 for pulverised combustion of oil shale.

With the introduction of new power units with circulating fluidised bed (CFB) boilers at the Eesti and Balti Power Plants in 2004, the situation concerning the 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.

The researchers of the Department of Thermal Engineering (DTE) of TUT recommend to use a 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 are calculated separately.

Shale oil

In Estonia, the oil shale thermal processing for shale oil production takes place in three plants: in ***Kiviõli Keemiatööstuse OÜ*** (*Kiviõli Oil Shale Processing and Chemicals Plant Ltd.*), in ***Viru Keemia Grupp AS*** (*Viru Chemistry Group(VKG) Ltd.* in Kohtla-Järve) and in ***Narva Oil Plant AS*** at the Eesti Power Plant.

There are two different technologies in use – since 1924 up to the present: the technology of processing large-particle oil shale in vertical retorts with gaseous heat carrier, and since 1980 that of processing fine-grained oil shale with solid heat carrier (SHC) are in operation. Since 2010, in Kohtla-Järve and Kiviõli both technologies and in the Narva Oil Plant the solid heat carrier technology is used.

The technology of processing oil shale in **vertical retorts** with gaseous heat carrier is universal technology and suitable for retorting high-calorific oil shale. The vertical retort is a metal vessel lined from inside with refractory bricks. The oil shale charging device and spent shale discharge chute and extractor are arranged on the top and in the lower part of the retort vessel, respectively. Thermal processing of oil shale takes place in retorting chambers in the cross flow of gaseous heat carrier. By influence of gases, oil shale is warmed and dried up and after achieving needful temperature for retorting, the organic part of oil shale starts quickly to decompose. The mixture of the heat carrier with oil and water vapour moves into collector chambers, semi-coke (retorted oil shale) moves downward to cooling chambers. Oil vapour and gas are let out of the retort via outlet connections to condensation system. (J. Soone, S. Doilov, 2003). Cleaned generator gas is delivered to heating boilers for burning. Thermal processing of oil shale in vertical retorts takes place without any contact with the ambient atmosphere; therefore no pollutants are emitted.

In **Solid Heat Carrier installation (SHC),** hot oil shale dust as a heat carrier is used. Pre-dried fine-grained oil shale with hot oil shale dust (800^{o}C) is delivered to a horizontal rotating reactor where during just a few minutes the retorting process is occurring. The mixture of heat carrier with oil and water vapours moves into dust separation chamber. Oil vapours and gas are sent to the condensing chamber where the condensed oil is separated and semi-coke gas is sent for burning to power plant. Mixture of semi-coke and dust will delivered to an aero fountain combustor chamber, where semi-coke is burned and flue gases separated. The flue gases are partly used for pre-heating of oil shale in dryer but partly emitted into atmosphere. Dust is delivered to ash fields but partly back to the reactor.

Therefore, in 2011, 44.62 PJ of oil shale was consumed for shale oil production in total but only processing of 19.41 PJ of oil shale caused CO_2 emissions at the plants (see Table 3.10).

Table 3.10. Oil shale consumption for shale oil production by different technologies, PJ

Year	Solid Heat Carrier			Total	Gas generators		Total	Total
	Narva	VKG	Kiviõli	in SHC	VKG	Kiviõli	in gas generators	Oil shale
1990	3.24			3.24	21.56	5.55	27.11	**30.36**
1991	1.77			1.77	19.05	5.24	24.29	**26.06**
1992	2.57			2.57	18.22	5.26	23.47	**26.05**
1993	4.20			4.20	20.09	5.44	25.53	**29.73**
1994	4.75			4.75	18.14	5.00	23.14	**27.89**
1995	4.31			4.31	20.14	5.35	25.49	**29.81**
1996	4.58			4.58	21.42	5.37	26.79	**31.38**
1997	5.15			5.15	21.22	5.47	26.69	**31.84**
1998	4.35			4.35	13.14	4.34	17.49	**21.83**
1999	4.14			4.14	9.75	0.47	10.23	**14.37**
2000	5.86			5.86	13.57	5.30	18.87	**24.73**
2001	6.24			6.24	15.38	5.29	20.67	**26.91**
2002	6.74			6.74	16.13	5.52	21.65	**28.38**
2003	7.66			7.66	16.93	5.49	22.42	**30.08**
2004	8.13			8.13	17.63	4.69	22.32	**30.44**
2005	8.87			8.87	17.78	4.21	22.00	**30.86**
2006	8.40			8.40	19.73	4.17	23.90	**32.30**
2007	7.96			7.96	20.72	4.26	24.98	**32.94**
2008	10.85			10.85	19.99	3.87	23.86	**34.70**
2009	13.07			13.07	20.45	4.04	24.49	**37.56**
2010	14.74	2.22	0.20	17.16	21.15	4.10	25.25	**42.41**
2011	13.39	5.48	0.54	19.41	21.28	3.99	25.27	**44.62**

Oil shale gas

Oil shale gas is a by-product of the thermal processing of oil shale. There are different types of oil shale gases depending on the technology used for oil shale processing. Oil shale gas as the by-product of oil shale thermal processing in solid heat carrier installation (SHC) is called as semi-coke gas and gas formed in the oil shale processing in vertical reactors (gas generators) is called as generator gas. In the Table 3.11 semi-coke and generator gas production data of different oil plants are presented.

Table 3.11. Semi-coke and generator gas production by oil plants, PJ

Year	Solid Heat Carrier			Total	Gas generators		Total	Total
	Narva	VKG	Kiviõli	in SHC	VKG	Kiviõli	in gas generators	Oil shale gas
1990	0.70			0.70	2.82	0.39	3.20	**3.90**
1991	0.37			0.37	2.47	0.37	2.84	**3.21**
1992	0.54			0.54	2.52	0.41	2.94	**3.48**
1993	0.70			0.70	2.65	0.42	3.07	**3.77**
1994	0.91			0.91	2.74	0.41	3.14	**4.05**

Year	Solid Heat Carrier			Total in SHC	Gas generators		Total in gas generators	Total Oil shale gas
	Narva	VKG	Kiviõli		VKG	Kiviõli		
1995	0.90			0.90	2.69	0.46	3.15	**4.05**
1996	1.00			1.00	2.91	0.43	3.34	**4.34**
1997	1.05			1.05	2.85	0.42	3.27	**4.32**
1998	0.92			0.92	1.30	0.35	1.66	**2.58**
1999	0.79			0.79	1.20	0.04	1.24	**2.03**
2000	1.04			1.04	1.75	0.43	2.17	**3.21**
2001	1.26			1.26	1.97	0.47	2.44	**3.70**
2002	1.26			1.26	2.15	0.49	2.64	**3.90**
2003	1.32			1.32	2.27	0.48	2.74	**4.06**
2004	1.48			1.48	2.28	0.48	2.76	**4.24**
2005	1.59			1.59	2.26	0.53	2.78	**4.38**
2006	1.62			1.62	2.66	0.55	3.21	**4.83**
2007	1.53			1.53	2.92	0.54	3.46	**4.99**
2008	2.00			2.00	2.79	0.50	3.29	**5.28**
2009	2.40			2.40	2.88	0.50	3.38	**5.78**
2010	2.83	0.34	0.03	3.12	3.02	0.52	3.77	**6.89**
2011	2.75	0.94	0.08	3.77	2.63	0.52	3.15	**6.92**

In the Table 3.12 the calorific values and CO_2 emission factors of different oil shale gases are presented for the year 2011 (plant data).

Table 3.12. Calorific values and carbon emission factors of different oil shale gases

Plant/Technology	Calorific value, MJ/Nm3	Carbon Emission Factor, tC/TJ
Narva Oil Plant Semi-coke gas	46.173	16.63
VKG Oil Plant Semi-coke gas	42.293	19.112
Kiviõli Oil Plant Semi coke gas	28.107	18.594
VKG Oil Plant Generator gas	3.194	50.322
Kiviõli Oil Plant Generator gas	2.638	52.45

CO_2 emissions from the combustion of different oil shale gases are calculated separately and included into CRF source-category CRF 1.A.1.a Public Electricity and Heat Production/Solid Fuels (see also Annex 2, Table A.2.1–A.2.5).

CO_2 emission factors and other parameters

Plant-specific, country specific and IPCC default CO_2 emission factors are used in GHG emission calculations. CO_2 emission factors, oxidation factors and net caloric values of different fuels are presented in Table 3.13 below. In order to improve the accuracy of the inventory, some of the CO_2 emission factors were checked and updated for the current inventory.

Table 3.13. CO_2 emission factors, oxidation factors and net caloric values by fuel

Fuels	NCV average	Unit	CEF tC/TJ	CO_2 EF CO_2/TJ	Oxidation factor	Source of emission factor
Liquid fuels						
LPG (Liquefied petrol Gas)	45.5	GJ/t	17.2	63.1	0.99	D, IPCC 1996, Vol. 2, Table 1-2

Fuels	NCV average	Unit	CEF tC/TJ	CO_2 EF CO_2/TJ	Oxidation factor	Source of emission factor
Gasoline (for non-road transport)	44.00	GJ/t	19.03-19.79	69.77-72.57	1	CS (Estonia)
Jet Kerosene	43.00	GJ/t	19.5	71.5	0.99	D, IPCC 1996
Aviation Gasoline	43.00	GJ/t	19.5	71.5	0.99	D, IPCC 1996
Gasoil (light fuel oil)	42.297	GJ/t	20.2	74.1	0.99	CS, LT (Lithuania) = D, IPCC 1996, Vol. 2, Table 1-2
Gasoil (for non-road use)	42.297	GJ/t	20.2	74.1	0.99	CS, LT (Lithuania) = D, IPCC 1996, Vol. 2, Table 1-2
Shale Oil (heavy fraction)	39.216	GJ/t	21.1	77.4	0.99	CS, MoE 2006
Shale Oil (light fraction)	41.8	GJ/t	20.2	74.1	0.99	CS, LT (Lithuania) = D, IPCC 1996, Vol. 2, Table 1-2
Diesel Oil	42.3	GJ/t	20.2	74.1	0.99	CS, LT (Lithuania) = D, IPCC 1996, Vol. 2, Table 1-2
Residual Fuel Oil (heavy fuel oil)	40.15	GJ/t	21.1	77.4	0.99	D, IPCC 1996, Vol. 2, Table 1-2
Recycled Waste Oil	20.18	GJ/t	20.2	74.1	1	PS, Kunda Nordic Cement
Lubricants	40.19	GJ/t	20.0	73.3		D, IPCC 1996, Vol. 2, Table 1-2
Bitumen	40.19	GJ/t	22.0	80.7		D, IPCC 1996, Vol. 2, Table 1-2
Solid fuels						
Coal	27.25	GJ/t	26.8	98.3	0.98	D, IPCC 1996, Vol. 2, Table 1-2
Coke Oven Coke	28.50	GJ/t	29.50	108.2	0.98	D, IPCC 1996, Vol. 2, Table 1-2
Oil Shale$_{FB}$ (Fludised Bed Combustion)	8.9	GJ/t	26.94	98.8	0.98	CS, MoE 2006
Oil Shale$_{PC}$ (Pulverised Combustion)	8.9	GJ/t	27.85	102.1	0.98	CS, MoE 2006
Milled Peat	10.0	GJ/t	28.9	106.0	0.99/0.97*	CS, FI (Finland) = D, IPCC 1996, Vol. 2, Table 1-2
Sod Peat	12.0	GJ/t	27.82	102.0	0.99/0.97*	CS, FI (Finland)
Peat Briquette	16.0	GJ/t	26.45	97.0	0.97	CS, FI (Finland)
Oil Shale semi-coke gas (SHC technology, Narva plant)	46.173	GJ/1000 m^3	16.63	60.98	0.995	CS, Expert Estimation 2012
Oil Shale semi-coke gas (VKG plant)	42.293	GJ/1000 m^3	19.112	70.07	0.995	CS, Expert Estimation 2012
Oil Shale generators gas (VKG)	3.194	GJ/1000 m^3	50.322	184.514	0.995	CS, Expert Estimation 2012
Oil Shale semi-coke gas (Kiviõli plant)	28.107	GJ/1000 m^3	18.594	68.178	0.995	CS, Expert Estimation 2012
Oil Shale generator gas (Kiviõli plant)	2.638	GJ/1000 m^3	52.45	192.32	0.995	CS, Expert Estimation 2012
Gas Gasoline	44.0	GJ7t	19.9	72.97	0.99	CS, LT (Lithuania)

Fuels	NCV average	Unit	CEF tC/TJ	CO_2 EF CO_2/TJ	Oxidation factor	Source of emission factor
Waste Oils	16.0	GJ/t	20.1818	74.0	1	PS, Kunda Nordic Cement
Other Fossil based Solid Waste (MSW)	19.0	GJ/t	21.8182	80.0	1	PS, Kunda Nordic Cement
Plastic Waste	21.0	GJ/t	20.4545	75.0	1	PS, Kunda Nordic Cement
Gaseous fuels						
Natural Gas	33.6	GJ/1000 m^3	15.07	55.3	0.995	CS, RUS (Russian)
Biomass fuels						
Solid Biomass (solid, includes e.g. firewood, wood chips, sawdust pellets, briquettes, etc.)	6.9 – 16.9	GJ/m^3s	29.9	109.6	0.98	D, IPCC 1996, Vol. 2, Table 1-2
Black Liquor	13.4	GJ/t	29.9	109.6	0.98	D, IPCC 1996, Vol. 2, Table 1-2
MSW biomass fraction	19.0	GJ/t	30.0	110.0	0.98	CS, Kunda
Biogas (landfill gas and biogas from wastewater treatment)	18.8	GJ/1000 m^3	14.89	54.6	0.995	D, IPCC2006, Chp. 2, Table 2.2, p.2.17

* oxidation factor of peat is 0.99 for electricity generation and 0.97 for other sectors
D - IPCC default value; CS – country specific; PS – plant specific; EE – expert estimation (Annex 2)

Sources:

IPCC 1996: Greenhouse Workbook, Vol. 2, 1996.

MoE 2006: Method for determining the amount of carbon dioxide discharged into the atmosphere. The Regulation of the Minister of the Environment. State Gazette No 22, 11.2006, 85, 1546 (in Estonian).

RUS (Russia) – Greenhouse Gas Emissions in Russian Federation 1990–2009 (2011).

Estonia uses Finnish carbon EFs of milled peat (corresponds with IPCC default value), sod peat and peat briquette, because the IPCC methodology does not give CEF values for sod peat and peat briquette. The calorific values of these peat fuels are practically the same. NCV of milled peat is in Estonia 10.0 MJ/kg (in Finland 10.1 MJ/kg) and NCV of sod peat is 12.0 MJ/kg (12.3 MJ/kg in Finland, see NIR Finland 1990-2011). The only difference is in the NCV value of peat briquette, in Estonia 16.0 but in Finland 20.9 MJ/kg, but this difference could be explained. In Estonia, the net calorific value of peat briquette is given at the moisture content about 14-16% (Q^r) but in Finland for the dray matter of peat briquette (Q^d). When to convert the calorific value as received to the calorific value of dray matte the Finnish and Estonian NCVs of peat briquette will be relatively the same.

In current submission, the Estonian country specific carbon emission factor has been implemented in the calculations for gasoline. This country specific carbon emission factor is calculated using weighted average method using CEFs of countries, that Estonia imports gasoline from

Calorific values of different fuels are mainly received from Statistics Estonia excluding oil shale semi-coke and generator gas (calculated by expert) and waste fuels that are plant specific.

CH_4 and N_2O emission factors of different fuels are presented in Table 3.14 below.

Table 3.14. CH_4 and N_2O emission factors by fuel, kg/TJ

Fuels	Energy Industry		Manufacturing Industry		Source
	CH_4	N_2O	CH_4	N_2O	
Liquid fuels					
LPG (Liquefied Petrol Gas)	1	0.1	5	0.1	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Gasoline	3	0.6	2	0.6	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Jet Kerosene	3	0.6	2	0.6	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Aviation Gasoline	3	0.6	2	0.6	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Gasoil (light fuel oil)	3	0.6	2	0.6	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Gasoil (for non-road use)	3	0.6	2	0.6	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Shale Oil	3	0.6	2	0.6	CS, MoE 2006
Diesel Oil	3	0.6	2	0.6	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Residual Fuel Oil (heavy fuel oil)	3	0.6	2	0.6	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Recycled Waste Oil	30	0.6	4	0.6	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Solid fuels					
Coal	1	1.4	10	1.4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Coke Oven Coke			10	1.4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Oil Shale $_{PC}$*	0	0	10	1.4	CS, A.Ots/ D, IPCC 2006
Oil Shale $_{FBC}$**	0	0.82			CS, EE/ D, IPCC 2006
Milled Peat	30	4	30	4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Sod Peat	30	4	30	4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Peat Briquette	30	4	30	4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Oil Shale Semi-coke	1	0.1			D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Oil Shale Generator Gas	1	0.1	5	0.1	D, IPCC 1996, Vol. 2, Table 1-7, 1-8 (of natural gas)
Other Fossil based Waste (MSW)			30	4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Plastic Waste			30	4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Gaseous fuels					
Natural Gas	1	0.1	5	0.1	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Biomass fuels					
Solid Biomass (solid, includes e.g. firewood, bark, chips, sawdust and	30	4	30	4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8

Fuels	**Energy Industry**		**Manufacturing Industry**		**Source**
	CH_4	**N_2O**	**CH_4**	**N_2O**	
other industrial wood residues, pellets and briquettes)					
Black Liquors	30	4	30	4	D, IPCC 1996, Vol. 2, Table 1-7, 1-8
Biogas (landfill gas and biogas from wastewater treatment)	1	0.1			D, IPCC 1996, Vol. 2, Table 1-7, 1-8

*Source:*A.Ots (2006). Oil Shale; ** Expert estimation*

Emission Factors of Indirect Greenhouse Gases from Fuel Combustion

The NOx, CO and NMVOC emission factors used in the Estonian inventory are mainly taken from the Revised IPCC 1996 Guidelines, but some emission factors and new data from national research were used as well. (See Table 3.15, Table 3.16, Table 3.17).

Table 3.15. NOx from fuel combustion (kg/TJ)

	Coal	***Natural Gas***	***Oil***	***Wood***	***Oil Shale****	***Peat/ Briquette***
Energy Industries	300	150	200	100		300
- pulverized combustion					110	
- fluidized bed combustion					0.06	
Manufacturing and Construction	300	150	200	100	110	300

Table 3.16. CO from fuel combustion (kg/TJ)

	Coal	***Natural Gas***	***Oil***	***Wood***	***Oil Shale****	***Peat/ Briquette***
Energy Industries	20	20	15	1 000	26	1 000
Manufacturing and Construction	150	30	10	2 000	87	4 000

Table 3.17. NMVOC from fuel combustion (kg/TJ)

	Coal	***Natural Gas***	***Oil***	***Wood***	***Oil Shale****	***Peat/ Briquette***
Energy Industries	5	5	5	50		100
- pulverized combustion					60	
- fluidized bed combustion					50	
Manufacturing and Construction	20	5	5	50	50	100

*Source: IPCC 1996 Default values; * Country specific- (Procedure…, 2004)*

Activity data

Activity data for GHG emission calculations are collected from several data sources. The main fuel consumption data by fuel types and final consumption sectors, including sub-sectors is received from the Energy Department of Statistics Estonia. This data is also presented in the database of SE and added to the *Estonian National Inventory Report 1990–2011 (Annex 4).* Some detailed data (i.e. technology specific – pulverised and fludised bed combustion of oil shale consumption in Narva power plants; shale oil and semi-coke gas production by the Narva Oil Plant) are obtained from the energy company Eesti Energia AS. Data on oil shale, shale oil and semi-coke and generator gas consumption in Kiviõli and VKG Oil Plants are obtaned directrly from the oil plants.

Fuel consumption in Energy Industries (CRF 1.A 1) and Manufacturing Industries and Construction (CRF 1.A 2) in 1990–2011 are presented in the Table 3.18 and on Figure 3.16 and Figure 3.17.

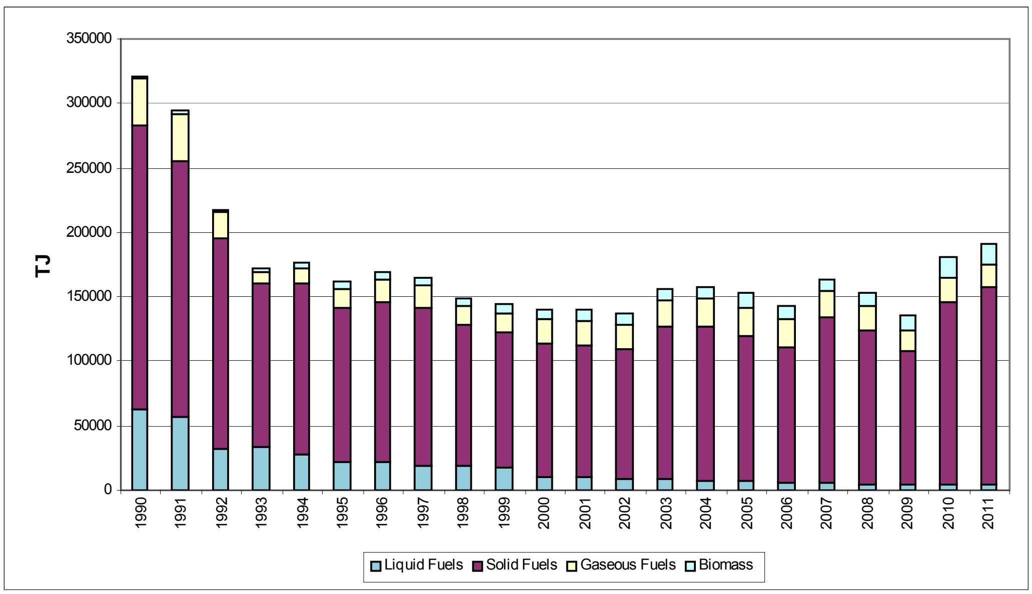


Figure 3.16. Trend of fuel consumption in Energy Industries, TJ

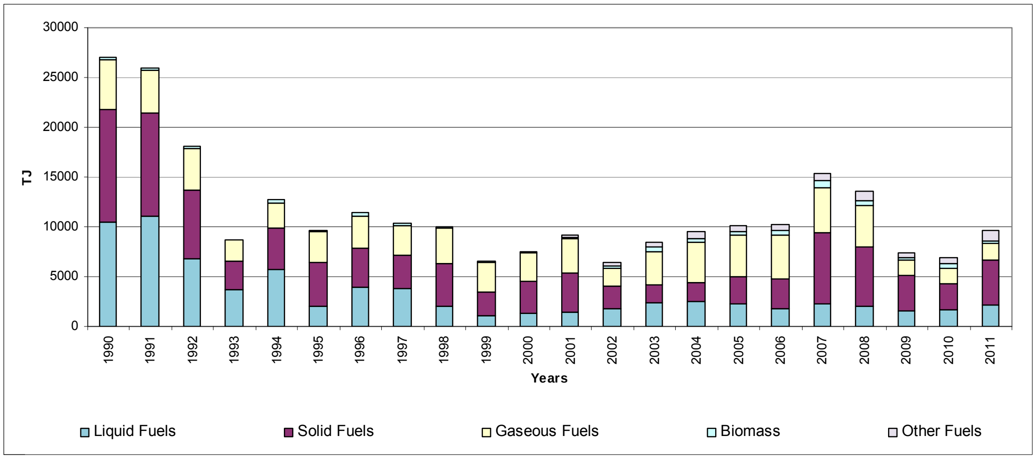


Figure 3.17. Trend of fuel consumption in Manufacturing Industries and Construction, TJ

Table 3.18. Fuel consumption in Energy Industries (CRF 1.A 1) and Manufacturing Industries and Construction (CRF 1.A 2) in 1990–2011 (TJ)

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1.A.1 Energy Industries Total	321 221	294 135	217 684	171 954	176 223	161 469	169 488	164 806	149 199	143 825	139 953
Liquid Fuels	63 128	56 624	32 265	33 241	28 090	21 247	21 224	18 641	19 139	17 841	9 705
Solid Fuels	219 842	198 182	163 140	127 753	133 028	120 937	124 839	123 388	108 929	104 121	104 206
Gaseous Fuels	35 808	36 750	19 800	8 705	11 116	14 302	17 162	16 632	14 561	14 734	18 872
Biomass	2 443	2 579	2 479	2 255	3 989	4 983	6 263	6 145	6 570	7 129	7 170

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
1.A.1 Energy Industries Total	140 341	137 599	155 995	157 975	152 780	142 405	162 907	153 310	135 700	179 846	189 960
Liquid Fuels	9 823	8 638	8 116	7 408	7 167	5 648	5 421	4 714	4 557	5 001	4 518
Solid Fuels	101 869	100 366	119 473	119 010	112 259	105 670	128 098	118 978	103 040	140 259	150 947
Gaseous Fuels	20 141	19 719	19 470	21 646	21 914	21 991	21 240	19 771	16 351	18 273	16 624
Biomass	8 508	8 876	8 936	9 911	11 440	9 097	8 148	9 847	11 752	16 313	17 871

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
1.A.2 Manufacturing Industries and Construction Total	27 080	25 980	18 067	8 696	12 690	9 649	11 432	10 311	9 970	6 510	7 559
Liquid Fuels	10 464	11 069	6 813	3 644	5 732	1 996	3 906	3 759	2 002	1 129	1 306
Solid Fuels	11 268	10 332	6 921	2 920	4 152	4 441	4 005	3 366	4 355	2 287	3 177
Gaseous Fuels	5 099	4 311	4 094	2 083	2 547	3 058	3 217	3 046	3 477	2 966	2 929
Biomass	249	268	239	49	259	154	304	140	136	128	139
Other Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	8

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
1.A.2 Manufacturing Industries and Construction Total	9 123	6 395	8 210	9 558	10 121	10 241	15 378	13 594	7 415	6 889	9 694
Liquid Fuels	1 426	1 836	2 166	2 450	2 227	1 801	2 212	1 983	1 595	1 717	2 131
Solid Fuels	3 986	2 225	1 769	1 995	2 747	2 911	7 183	6 038	3 487	2 556	4 543
Gaseous Fuels	3 424	1 824	3 401	4 027	4 206	4 474	4 525	4 134	1 609	1 553	1 663
Biomass	152	162	480	308	331	454	692	492	201	499	236
Other Fuels	135	348	394	778	610	601	766	947	523	564	1 121

3.2.5.3. Uncertainties and time series consistency

Uncertainty evaluation of CO_2 emission has been conducted for four fuel types used in Estonia in 2011: liquid, solid, gaseous fuels and other fuels. The availability of data allows the estimation of uncertainty by a fuel type rather than by a sector in fuel combustion in Estonia (Metrosert AS, 2007).

Incomplete details of source-specific measurement data of activities and emission factors lead to the approach to estimate quantitative uncertainty of CO_2 emission in Estonia in 2010 by using available estimates and the combination of available measured data;

Data has been obtained from database of SE.[2]

In estimation of uncertainty two main components have been considered:

- Uncertainty component due to measurement procedure which provides the comparability of results.
- Uncertainty component due to spread (dispersion) of the input quantity which, in some cases, indicates the level of disaggregating of the data.
  The calculation formula of combined uncertainty in emission u_E is

$$u_E = \sqrt{u_{AD}^2 + u_{EF}^2}\ .$$

Where u_{AD} is the uncertainty estimation of activity data and u_{EF} is the uncertainty estimation of emission factor. In obtaining expanded uncertainty the coverage factor k=2 has been used to provide approximately 95% confidence level of the results

$$U_E=2\cdot u_E.$$

The uncertainty in CO_2 emission due to fuel combustion in category Energy was evaluated separately by fuel types. The key points of the evaluation are listed below

- Liquid Fuels

All liquid fuels, except shale oil and residual fuel are imported to Estonia. Quality requirements for liquid fuels and instrumentation were used in evaluation of uncertainty of activity data and emission factors.

- Solid Fuels

There are two fuel types produced locally: oil shale and peat. The largest contribution to the uncertainty is caused by fluctuation in emission factors of those fuels.

- Gaseous Fuels

The gaseous fuels are imported to Estonia. Quality requirements for gaseous fuels and instrumentation were used in evaluation of uncertainty of activity data and emission factors.

- Other Fuels

[2] Statistics Estonia / Endla 15, 15174 Tallinn / Statistical information: Tel: + 372 625 9300, e-mail stat@stat.ee/ Contact Centre of respondents: Tel: +372 625 9100, e-mail klienditugi@stat.ee.

For calculation of uncertainty in CO_2 emission due to other fuel (waste fuel) combustion in category Energy, Finnish uncertainty factors were used. The contribution to total uncertainty of fuel combustion from this type is rather small.

The uncertainties factors of carbon emission factors and activity data due to fuel combustion are presented in the Table 3.19. The largest uncertainty contribution of 60% was caused by incomplete data of emission factor of other fuels (waste fuels).

Table 3.19. Estimated relative uncertainties of CO_2 emission due to fuel combustion in Estonia in 2011

GHG Source and Sink Categories	Gas	Uncertainty of activity data, %	Uncertainty of emission factor, %	Combined relative uncertainty, %
1.A. Fuel Combustion				
Liquid Fuels	CO_2	1.7	1.8	2.5
Solid Fuels	CO_2	3.3	38.9	39.0
Gaseous Fuels	CO_2	1.4	3.6	3.9
Other Fuels*	CO_2	5	60	60.21

*Source: IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

In estimation of uncertainties in greenhouse gases CH_4 and N_2O the IPCC[3] default values for activity data (5% and 10%) and for CH_4 emission factors (25–150%) were used. In estimation of N_2O emission factor uncertainties (50–125%) IPCC default and some Finnish values were used (see Table 3.20).

Table 3.20. Summary of uncertainty estimates non-CO_2 (CH_4 and N_2O) emission factors and activity data (95% confidence interval)

Source and Sink	GHG	Activity data uncertainty U_A	Emission factor uncertainty U_E	Reference U_A. U_E
1.A.1 Energy Industries				
Liquid, solid and gaseous fuels	CH_4	5%	50%	U_A – IPCC Good, Table 2.6, p. 2.41 U_E – IPCC Good, Table 2.5, p. 2.41
	N_2O	5%	60%	U_A – IPCC Good, Table 2.6, p. 2.41 U_E –Finnish
Biomass	CH_4	5%	60%	U_A – IPCC Good, Table 2.6, p. 2.41 U_E – Finnish
	N_2O	5%	60%	U_A – IPCC Good, Table 2.6, p. 2.41 U_E – Finnish
1.A.2. Manufacturing Industries and Constructions				
Liquid, solid and gaseous fuels	CH_4	5%	50%	U_A – IPCC Good, Table 2.6, p. 2.41 U_E – IPCC Good, Table 2.5, p. 2.41
	N_2O	5%	60%	U_A – IPCC Good, Table 2.6, p. 2.41 U_E – Finnish

[3] Intergovernmental Panel on Climate Change Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.

Biomass	CH_4	5%	60%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
	N_2O	5%	60%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
Other Fuels	CH_4	5%	60%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
	N_2O	5%	60%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
1.A.3. Transport				
Liquid and solid fuels	CH_4	5%	40%	IPCC Good .... p. 2.49
	N_2O	5%	50%	IPCC Good .... p. 2.49
Biomass	CH_4	5%	100%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
	N_2O	5%	150%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
1.A.4. Other Sectors				
Liquid, solid and gaseous fuels	CH_4	5%	50%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – IPCC Good, Table 2.5, p. 2.41
Solid and gaseous fuels	N_2O	5%	50%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
Liquid fuels	N_2O	5%	75%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
Biomass	CH_4	10%	150%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
	N_2O	10%	150%	**U_A** – IPCC Good, Table 2.6, p. 2.41 **U_E** – Finnish*
1.B. FUGITIVE EMISSIONS from FUELS				
1.B.2.b Natural Gas	CH_4	10%	25%	IPCC Good .... p. 2.92

*Source: NIR Finland 1990–2011, www.unfccc.int

In the current inventory submission all uncertainty factors and references have been over checked and some U_E and U_A values revised. In the previous inventory submission some of the uncertainty factor values and references were incorrect. As the Good Practice Guidance does not give CH_4 emission factors uncertainty estimations (U_E) for biomass, and also for N_2O emission factors (U_E) for biomass and fossil fuels, those factors have been taken from the Finnish 2011 national inventory.

Detailed uncertainty estimations by source-categories are presented in Annex 7.

3.2.5.4. Source-specific QA/QC and verification

There are several QC procedures, which are used. The most resource demanding is the checking the fuel consumption data received from SE.

Fuel consumption data in natural units (in tons or thousand cubic meters, etc) and year average calorific value data of fuels are received from SE by special request of the Ministry of Environment. Fuel consumption data in energy units (in TJ-s) are available in the statistical database on the website of SE (www.stat.ee). Before entering the fuel consumption data into emission calculation tables we check first the current year data by multiplying fuel amounts in natural units with NCV and compare the result with fuel consumption data in TJ-s presented in the statistical database. Sometimes there are some small differences due the rounding. The second step is checking all previous year activity data because statistical office sometimes corrects also the old data. The third step is the checking of national energy balance data with IEA data. There are some differences between National and IEA energy data but they are not very big. IEA use constant NCV-s of fuels but National energy data in TJ-s are calculated using year specific NCV. Some differences are also in reporting of heat produced. In IEA statistic only fuels used for sold heat produced by DH power plants and autoproducers are reported in Energy conversion sector, but fuels used for heat production by autoproducers and used by themselves (own consumption) is reported under the final consumption. In the national energy balance only fuels used for heating technological processes is reported under the final consumption of fuels of the sector.

After the fuel consumption data, emission factors of fuels will be checked. If there is some new research on estimation of country specific emission factors available all necessarily corrections will be made for whole time series. In 2013 inventory submission carbon emission factors of oil shale semi-coke, semi-coke gas and oil shale generator gas have been revised for the year 2011. Carbon emission factors of oil shale semi-coke gas and oil shale generator gas have been left the same for the period 1990-2010 as they were in 2012 inventory submission.

In 2012 inventory submission Energy Sector CO_2 emission factors were compared also with EF-s used by Emission Trading System (ETS) enterprises.

There is a more comprehensive list about Tier 1 and 2-level QC activities in the Energy sector in the internal documentation (in Estonian).

3.2.5.5. Source-specific recalculations

1. In the CRF source category 1.A.1.a Electricity and Heat Production – Liquid Fuels, the CEF of Jet Kerosene has been corrected. In previous submission, the used CEF of Jet Kerosene in expert's calculation sheets was 19.6 tC/TJ, which is not in accordance with the IPCC1996 Guidelines. In current submission, the used CEF of Jet Kerosene is corrected to 19.5 tC/TJ in the calculations, which is in accordance with the IPCC1996 Guidelines.

	CEF, tC/TJ	
	2012 submission	2013 submission
Jet Kerosene	19.6	19.5

2. In the CRF source category 1.A.1.a Electricity and Heat Production – Biomass, the following activity data has been revised due to corrections in national energy balance of Statistics Estonia:

	Year	2012 submission	2013 submission
Biomass, TJ	2002	112	87
	2004	84	94
	2006	154	174
	2008	82	119

	Year	2012 submission	2013 submission
	2009	117	105
	2010	179	155

3. In the CRF source category 1.A.1.a Electricity and Heat Production – Solid Fuels, the activity data has been corrected in carbon balance. In previous submission, there were some entry-mistakes in calculation sheets.

	Year	2012 submission	2013 submission
Oil shale semi-coke gas Narva, TJ	1991	371	385
	1992	540	620
	1993	700	1 059
Oil shale semi-coke gas VKG, TJ	2010	3 310	343
Oil shale semi-coke gas Kiviõli, TJ	2010	198	32

4. In the CRF source category 1.A.1.a Public Electricity and Heat Production – Solid Fuels, a new fuel has been taken into account due to new Carbon Balance – Gas Gasoline. It is a by-product of shale oil production. NCV and CEF of Gas Gasoline are the same as Gasoline (44MJ/kg and 18.9 tC/TJ).

	Year	Consumption,TJ
Gas gasoline	1990	954
	1991	807
	1992	867
	1993	984
	1994	971
	1995	965
	1996	1 035
	1997	1 030
	1998	605
	1999	455
	2000	768
	2001	859
	2002	904
	2003	948
	2004	965
	2005	973
	2006	1 082
	2007	1 141
	2008	1 197
	2009	1 298
	2010	1 578

5. In the CRF source category 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries – Solid Fuels, the carbon emission factors of semi-coke have been revised due to new carbon balance:

	Year	2012 submission	2013 submission
CEF of semi-coke in Narva Oil Plant, tC/TJ	1990	7.068	5.442
	1991	7.372	5.546
	1992	6.316	3.809
	1993	6.518	2.959
	1994	6.586	4.904
	1995	6.755	5.018
	1996	5.937	4.140
	1997	6.085	4.376
	1998	6.161	4.476
	1999	7.055	5.422
	2000	8.292	6.732
	2001	7.633	5.932
	2002	7.853	6.197
	2003	8.159	6.503
	2004	7.494	5.848
	2005	7.459	5.822
	2006	6.648	4.988
	2007	6.776	4.974
	2008	7.272	5.547
	2009	8.066	6.415
	2010	8.289	6.615
CEF of semi-coke in VKG Oil Plant, tC/TJ	2010	18.159	12.081
CEF of semi coke in Kiviõli Oil Plant, tC/TJ	2010	4.581	6.288

6. In the CRF source category 1.A.2.a Iron and Steel – Solid Fuels, the following activity data has been revised due to corrections in national energy balance of Statistics Estonia:

	Year	2012 submission	2013 submission
Coke, TJ	2007	NO	10
Coal, TJ	2007	19	1

7. In the CRF source category 1.A.2.b Non-Ferrous Metals – Solid Fuels the oxidation factor of Coal has been corrected:

	Oxidation factor	
	2012 submission	2013 submission
Coal	0.99	0.98

8. In the CRF source category 1.A.2.f Other – Liquid Fuels/Biomass/Solid Fuels, the following activity data has been revised due to corrections in national energy balance of Statistics Estonia:

	Year	2012 submission	2013 submission
Light Fuel Oil, TJ	2003	574	573
Gasoline, TJ	2003	212	161
Solid Biomass, TJ	2007	442	434
Peat, TJ	2009	105	NO

9. In the CRF source category 1.A.2.f Other – Other Fuels, the CEF of Waste Oils has been corrected:

	CEF, tC/TJ	
	2012 submission	2013 submission
Waste Oils	20.182	20.1818

10. In the CRF source category 1.A.1.c Manufacture of Solid Fuels and Other Energy Industries – Solid Fuels, the following activity data has been revised due to new information obtained from shale oil production companies:

	Year	2012 submission	2013 submission
Oil Shale consumption for shale oil production, TJ	2010	18 245	17 155

11. In the CRF source categories 1.A.1 Energy Industries – Liquid Fuels, and 1.A.2 Manufacturin Industries and Construction – Liquid Fuels, the Estonian Country-Specific CEF of gasoline has been implemented:

		CEF, tC/TJ	
	Year	2012 submission	2013 submission
Gasoline	1990	19.90	19.50
	1991	19.90	19.50
	1992	19.90	19.50
	1993	19.90	19.50
	1994	19.90	19.50
	1995	19.90	19.51
	1996	19.90	19.49
	1997	19.90	19.52
	1998	19.90	19.60
	1999	19.90	19.55
	2000	19.90	19.27
	2001	19.90	19.34
	2002	19.90	19.71
	2003	19.90	19.79
	2004	19.90	19.79
	2005	19.90	19.27
	2006	19.90	19.03

		CEF, tC/TJ	
	Year	2012 submission	2013 submission
	2007	19.90	19.06
	2008	19.90	19.19
	2009	19.90	19.40
	2010	19.90	19.77
	2011	19.90	19.78

3.2.5.6. Source-specific planned improvements

It is planned to evaluate and implement country specific emission factors for different fuels used in Estonia (e.g. fuels used in key categories, fuels produced in Estonia). Currently the process is underway, but it is not clear, to which fuels the country specific emission factors will be developed. Some of the emission factors are already developed and implemented (e.g. motor fuels in road transportation, oil shale gases).

3.2.6. Transport (CRF 1.A.3)

An efficient transport system is an importand prerequisite for economic and social development. Transport also has an important social function – to satisfy movement needs. In the Estonian economy, transport and its support activites account for 9% of total employment. Compared to 2010, the financial results of Estonian transport Enterprises improved in 2011.

3.2.6.1. Source category description

In 2011, the greenhouse gas emissions from transport sector amounted to 2 259.87 Gg CO_2 equivalent. The share of the transport sector of the energy sector was 12.11% and of the total greenhouse gas emissions approximately 10.8% in 2011.

Emissions from Transport (CRF 1.A 3) include all domestic transport sectors (Table 3.21):

- Civil Aviation (CRF 1.A.3.a)
- Road Transport (CRF 1.A.3.b)
- Railways (CRF 1.A.3.c)
- Domestic navigation (CRF 1.A.3.d)

Table 3.21. Reporting categories in the transport sector

CRF source category	Description	Remarks
CRF 1.A.3		
1.A.3.a Civil Aviation	Jet and turboprop powered aircraft (turbine engine fleet) and piston engine aircraft.	Emissions from helicopters are not calculated separately.
1.A.3.b Road Transport	Transportation on roads by vehicles with combustion engines: passengers cars, vans, buses, lorries, motorcycles and mopeds.	Farm and forest tractors are included in CRF 1.A.4.c Agriculture/Forestry/Fishery. Fuel consumption and emissions from military vehicles are included in

CRF source category	Description	Remarks
		category 1.A.5 Other. Fuel consumption and emissions from military cares are included in category 1.A.3.b Road.
1.A.3.c Railways	Railway transport operated by steam and diesel locomotives.	Coal was used for locomotives in 1990–2002 and in 2006.
1.A.3.d Navigation	Merchant ships, passenger ships, technical ships, pleasure and tour ships and other inland vessels.	Fishing boat emissions are included in the CRF 1.a.4.c.

The trend of the emissions of these categories is given in Figure 3.19. In the Figure 3.18 emissions of the transport sector are given by greenhouse gases.

CO_2 emission trend decreased strongly after 1991. The reason of the decrease was the rapid increase of fuel prices after regaining independency in Estonia in 1991 and also difficulties in fuel supply. Estonia imported in the beginning of 90s all transport fuels from Russia. The bottom was reached in year 1992 and after that increase has been fairly constant reaching the 1990 emission level in 2007. The increase has happened mainly in the road transport. In 2010 emissions from transportation sector increased comparing with previous year. The reason for this increase was the perking up of the economic environment after economic depression in 2008 and 2009 (see Figure 3.19). In 2011, the emissions grew about 0.52% compared to 2010. This increase took place mainly due to decrease in number of public transport users and the increase of transported goods on road transport.

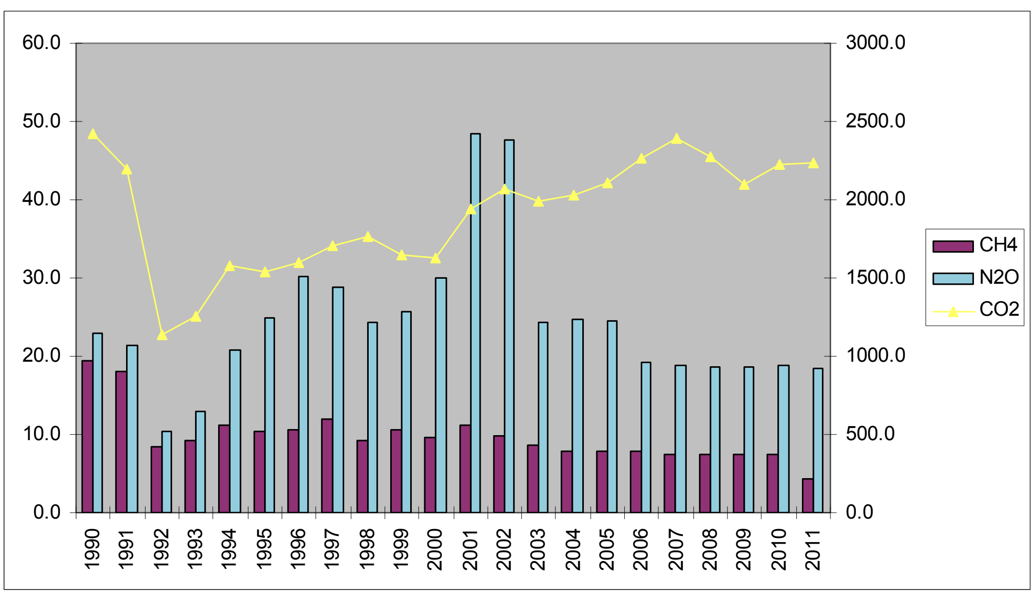


Figure 3.18. Emissions from transport sector by gas in 1990–2011, Gg CO_2 equivalent

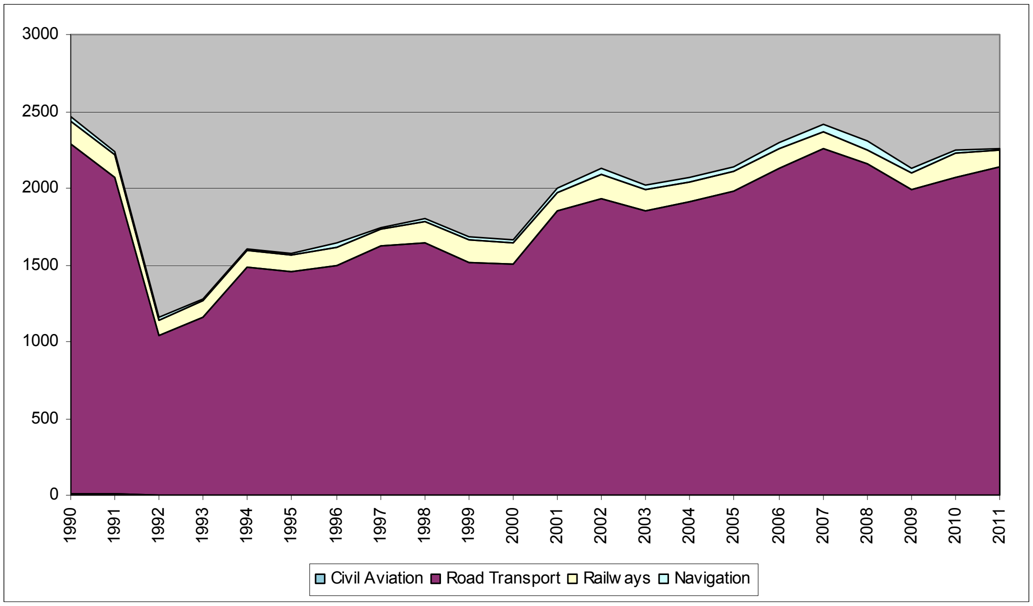


Figure 3.19. Emissions from transport by subcategory in 1990–2011, Gg CO_2 equivalent

Road transportation is the most important emission source in transport sector covering over 90% of sector's emissions (see Figure 3.19).

Table 3.22. Emissions from the transport sector in 1990–2011 by sub-categories, (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.3 Transport Total, CO_2 eq	2 460.48	2 240.09	1 155.68	1 279.27	1 605.90	1 574.96	1 639.91	1 746.98	1 798.44	1 679.01	1 667.13
1.A.3.a Civil Aviation, CO_2	5.69	5.69	1.90	3.85	2.59	3.54	3.20	3.58	2.58	2.72	2.50
1.A.3.b Road Transport, CO_2	2 236.11	2 027.32	1 014.87	1 128.73	1 447.57	1 415.44	1 455.71	1 576.51	1 612.10	1 479.58	1 466.13
1.A.3.c Railways, CO_2	154.52	148.91	104.44	108.71	111.25	108.25	118.38	107.17	131.94	143.71	135.64
1.A.3.d Navigation, CO_2	21.86	18.74	15.62	15.77	12.49	12.32	21.85	18.84	18.48	16.65	23.17
1.A.3 Transport Total, CH_4	0.92	0.86	0.41	0.44	0.53	0.50	0.50	0.57	0.43	0.51	0.46
1.A.3 Transport Total, N_2O	0.07	0.07	0.03	0.04	0.07	0.08	0.10	0.09	0.08	0.08	0.10

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.3 Transport Total, CO_2 eq	1 996.39	2 125.21	2 019.37	2 066.19	2 137.38	2 296.24	2 420.77	2 303.92	2 126.40	2 248.24	2 259.87
1.A.3.a Civil Aviation, CO_2	2.46	2.55	2.38	3.38	1.75	1.30	1.34	2.31	1.76	1.80	2.77
1.A.3.b Road Transport, CO_2	1 787.11	1 870.63	1 817.68	1 880.22	1 948.09	2 097.99	2 226.83	2 133.38	1 967.59	2 040.88	2 113.72
1.A.3.c Railways, CO_2	125.50	161.56	140.27	123.85	130.08	135.88	112.04	82.20	107.28	155.82	105.74
1.A.3.d Navigation, CO_2	21.85	33.00	25.96	26.03	25.00	34.10	54.26	59.83	23.61	23.39	14.74
1.A.3 Transport Total, CH_4	0.53	0.47	0.42	0.38	0.37	0.37	0.36	0.36	0.36	0.36	0.21
1.A.3 Transport Total, N_2O	0.16	0.15	0.08	0.08	0.08	0.06	0.06	0.06	0.06	0.06	0.06

Table 3.23. Fuel consumption in transportation sector in 1990–2011, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.3.a Civil Aviation											
Aviation Gasoline	78	81	26	53	35	46	43	48	35	37	34
1.A.3.b Road Transport											
Gasoline	21 406	19 259	9 020	9 632	12 339	10 557	11 558	12 847	12 353	11 816	11 872
Diesel Oil	9 500	8 787	4 966	5 976	7 563	8 989	8 570	8 940	9 862	8 615	8 540
LPG	139	92	90	27	166	17	14	19	11	10	10
1.A.3.c Railways											
Coal	119	143	49	53	55	39	59	37	14	3	6
Diesel Oil	1 951	1 843	1 360	1 413	1 445	1 425	1 537	1 413	1 781	1 956	1 842
1.A.3.d Domestic Navigation											
Diesel Oil	298	256	213	215	170	168	298	257	252	227	316

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.3.a Civil Aviation											
Aviation Gasoline	33	34	32	45	24	17	18	31	24	24	37
1.A.3.b Road Transport											
Gasoline	14 148	12 981	12 438	11 995	12 249	13 323	13 977	13 845	12 661	11 745	11 144
Diesel Oil	10 697	12 726	12 488	13 797	14 795	15 974	17 091	15 843	14 612	16 302	17 868
LPG	9	18	11	8	8	4	2	5	4	5	6
1.A.3.c Railways											
Coal	8	1	NO	NO	NO	0.4	NO	NO	NO	NO	NO
Diesel Oil	1 701	2 202	1 913	1 689	1 774	1 853	1 528	1 121	1 463	2 125	1 442
1.A.3.d Domestic Navigation											
Diesel Oil	298	450	354	355	341	465	740	816	322	319	201

3.2.6.2. Civil Aviation

In 2011 a record number of passangers passed through airports. The passenger traffic volume of Estonian airports was nearly 2 million, which is 36% more than in 2010. The number of passengers transported on domestic flights was 61 700, which is 11% more than in 2010. Also, new lines were launched and there were more scheduled flights per week than the year before. Cargo and mail services through airports increased by 56% and 22% respectively, amounting to about 18 400 tonnes in total.

The emissions from civil aviation (CRF 1.A.3.a) include all domestic civil aviation transport within Estonian flight information regions, mostly islands (see Figure 3.20). Helicopters are not included in the calculations due to the small number of flights and the lack of emission factors. However, the fuel consumption of helicopters is included as part of the sector 1.A.3.a (Table 3.22).

The share of the civil aviation from the transport sector was only 0.12% and the amount of emissions was 2.8 Gg of CO_2 equivalents in 2011. The corresponding figure was 5.76 Gg (CO_2 equivalent) in 1990. See the Figure 3.20 and Table 3.22.

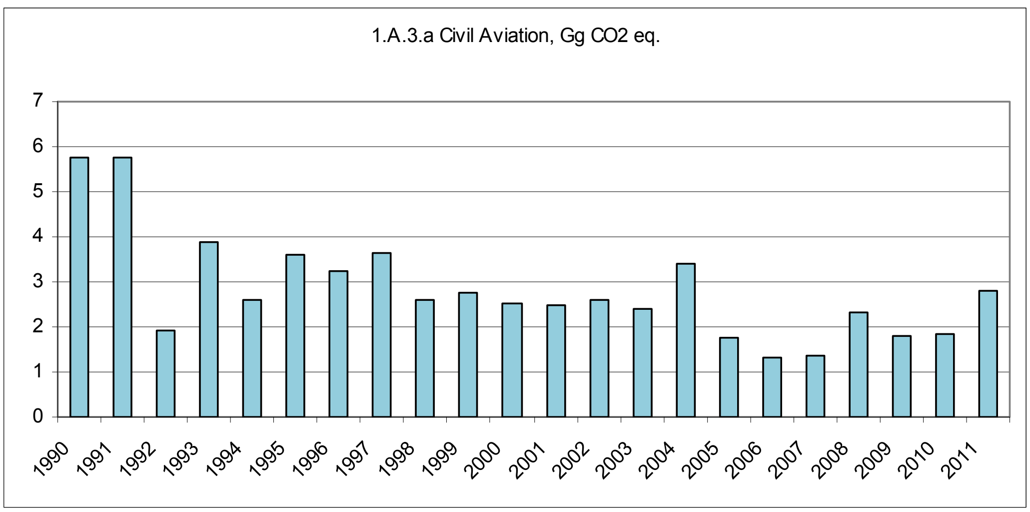


Figure 3.20. GHG emissions from civil aviation in 1990–2011, Gg CO_2 equivalent

Methods

For estimation of emissions from Civil Aviation the *Tier 2* approach was used. Operations of aircraft were divided into LTO and Cruise phases. The Tier 2 approach breaks the calculation of emissions from aviation into the following steps:

1. *Total Emissions = LTO Emissions + Cruise Emissions*
2. *LTO Emissions = Number of LTOs * Emission Factor of LTOs*
3. *Cruise Emissions = (Total Fuel Consumption – LTO Fuel Consumption) * EF Cruise*

Activity data

The activity data on aviation gasoline used in national aviation are obtained from Statistics Estonia and presented in the Table 3.23. In the National Energy Balance sheet aviation fuels are not presented separately for national and international fights, but this data still exist in the database of SE. Ministry of Environment asks every year the detailed data on aviation fuel use for GHG inventory submission. Data are collected from different fuel supply companies by special statistical questionnaire "Transport Fuels" were fuel use should be reported separately for national and international use.

To separate the fuel consumption further into landing and take-off (LTO) phase and the cruise phase we use following principle:

For the LTO phase, fuel consumed is based on representative aircraft type group data. The energy use by aircraft is calculated for both domestic and international LTOs by multiplying the LTO fuel consumption factor for each representative aircraft type by the corresponding number of LTOs (eq 1).

The cruise energy use is estimated as the difference between the total fuel use from aviation fuel sale statistics and the total calculated LTO fuel use (eq 2).

1. $LTO_{Fuel\ Consumption} = Number\ of\ LTOs_{by\ aicraft\ type} * Fuel\ Consumption\ per\ LTO_{by\ aicraft\ type}$, *(eq.1)*
2. $Cruise_{Fuel\ Consumption} = Total_{Fuel\ Consumption} - LTO_{Fuel\ Consumption\ Cruise}$, *(eq. 2)*

Number of LTO's.

Detailed aircraft type data with take-off and landing activity is supplied by airports. Estonian aircraft movement statistics count landing and take-off as two different activities. However methodology defines both one landing and one take-off as a full LTO cycle. Therefore statistical aircraft movement data is divided by two.

The methodology needs information of the number of LTO's grouped by representative aircraft types. This kind of detailed knowledge is hard to obtain (individual aircraft with their specific engines) and therefore data is aggregated level for practical reasons. Assumptions are made if there is missing data in some situations.

In spite of the different levels of aviation statistics it is possible to divide the air traffic activity into the number of LTOs per aircraft type by using different statistical sources. Estonian emission calculations are based on the EMEP/EEA methodology and other referred sources in guidebook (IPCC, FOCA, ICAO engine database etc.).

A complete calculation has been carried out by EEIC for the years 1992–2010. There has been done extrapolation for 1990 and 1991 (see Table 3.24).

Table 3.24. Number of LTO-cycles

	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Domestic LTO	2 249	2 398	2 366	3 754	4 819	4 516	4 922	4 672	4 778	4 255	8 720
International LTO	5 247	5 595	5 520	8 760	11 243	10 537	11 484	10 901	12 303	10 408	15 894

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Domestic LTO	8 025	6 243	7 740	7 219	7 958	8 212	7 598	7 637	8 320
International LTO	14 040	15 868	17 907	15 460	17 078	20 501	14 122	14 855	17 334

Emission factors and other parameters

1) Cruise emission factors of the CO_2, CH_4, N_2O, NOx, CO, NMVOC and SO_2 used in the calculation of emissions from national aviation are taken from the EMEP/EEA air pollutant emission inventory guidebook 2009 (chapter: 1.A.3.a Aviation, table 3–3, p.18).

2) LTO emission factors of the CO_2, CH_4, N_2O, NOx, CO, NMVOC and SO_2 used in the calculation of emissions from national aviation are taken from the EMEP/EEA air pollutant emission inventory guidebook 2009 (chapter: 1.A.3.a Aviation, table 3–3, p.18) and other referred sources in guidebook (IPCC, FOCA, ICAO engine database etc). The share of different aircraft types varies every year and due to that the average emission factor changes from year to year. In the Table 3.25 is presented average emission factors for 2010 emission calculations.

Table 3.25. Emission factors used in the calculation of emissions from national aviation (1.A.3.a)

	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2
	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t
Cruise*	3 150.0	0.0	0.1	10.3	2.0	0.1	1.0
LTO**	3 218.2	0.5	0.1	6.0	103.3	5.1	0.9

**Table 3-3, p.18 (average fleet); **Average emission factors in 2010*

Emission factors in kg per ton of aviation gasoline (Table 3.25) are converted to kg/TJ using net average calorific value of aviation gasoline (43 MJ/kg) (see Table 3.26).

Table 3.26. Emission factors of national aviation (1.A.3.a)

	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2
	t/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ	kg/TJ
Cruise*	73.3	0	2.3	238.5	46.3	2.3	23.3
LTO**	74.8	11.6	2.3	137.0	3255.3	211.4	15.9

3.2.6.3. Road transportation

Road transport (CRF 1.A.3.b) includes all transportation on the roads in Estonia. The types of vehicles with combustion engines are: passenger 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 the source-category 1.A.3.c Agriculture.

Road transport is the most important emission source in the transport sector. The emissions from road transportation were 2 136.12 Gg (CO_2 equivalent) in 2011, it is about 94.52% of total transport sector emissions, 11.45% of the Energy sector and

10.19% of the total Estonian GHG emissions. In 2011 the GHG emissions of the road transport sector were about 6.2% lower than in 1990 (2 277.61 Gg CO_2 eq.).

The trend of CO_2 emissions follows in general the fuel consumption trend in the road transportation sector. The lowest emission level in the road transportation was achieved in 1992/1993, it was caused by rapid increase of fuel prices after regaining independency in 1991 and also with difficulties in fuel supply (Estonia imported in the beginning of 90s all transport fuels from Russia). The second decrease in the emission trend was in 1999/2000 and it was connected with economic crises in Russia (fuel supply problems). In 2007 the emissions from road transport were on the level of 1990, but since 2008 a small decrease of emissions (in 2008/2007 about 6% and in 2009/2008 about 7%) started which reflects the overall economic depression in Estonia. In 2011, GHG emissions from road transportation increased about 3.4% compared to 2010 (see Figure 3.21).

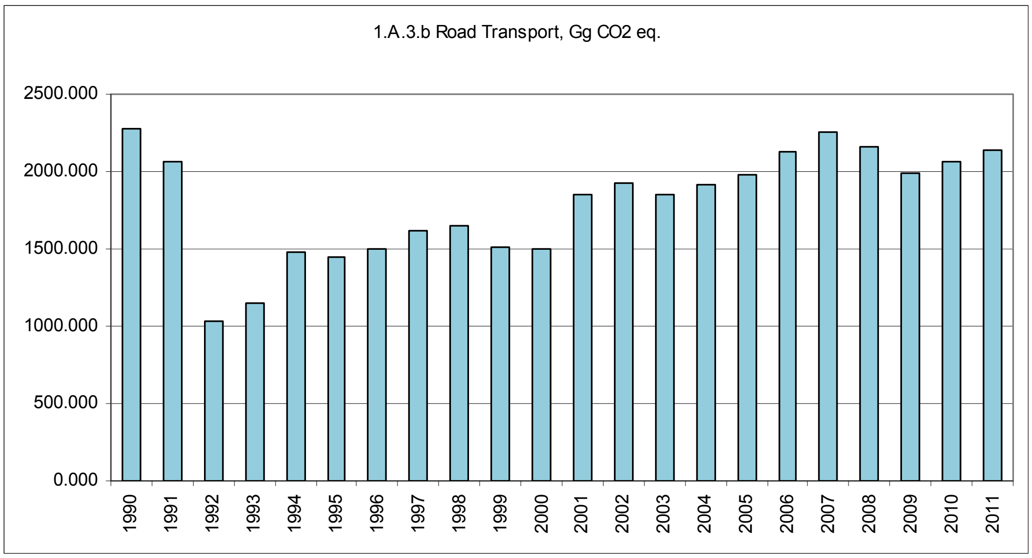


Figure 3.21. Emissions from the road transportation in 1990–2011, Gg CO_2 equivalent

Methods

Emission estimations from road transportation are made using the IPCC1996 Tier 1 method (for CO_2 emissions) and COPERT IV model for CH_4 and N_2O emissions which corresponds to the IPCC Tier 3 method. The same model was also used for the calculation of SO_2, CO, NOx and NMVOC emissions. CH_4 and N_2O emissions of the combustion of LPG are calculated using IPCC1996 Tier 1 method because the Copert model doas not include LPG fuel.

Calculation of CO_2 emissions from road transportation is based on fuel consumption of road vehicles and fixed emission factors.

In the current inventory report the emissions of CO_2 is calculated on basis of the amounts and type of fuel combusted and its carbon content. The *Tier 1* approach calculates CO_2 emissions by multiplying the estimated fuel sold with a country-specific emission factor. This approach can be expressed as:

$$Emission = \sum_{a} \left[Fuel_{a} \bullet EF_{a} \right]$$

where:
Emission = emissions of CO_2 (Gg)
$Fuel_a$ = fuel sold (TJ)
EF_a = emission factor (kg/TJ). This is equal to the carbon content of the fuel multiplied by 44/12.
a = type of fuel (e.g. petrol, diesel, LPG etc).

The emission equation of Tier 3 of CH_4 and N_2O:

$$Emission = \sum_{a,b,c,d} \left[Distance_{a,b,c,d} \bullet EF_{a,b,c,d} \right] + \sum_{a,b,c,d} C_{a,b,c,d}$$

where:
Emission = emission or CH_4 or N_2O
$EF_{a.b.c.d}$ = emission factor (kg/km)
$Distance_{a.b.c.d}$ = distance traveled (VKT) during thermally stabilized engine operation phase for a given mobile source activity (km)
$C_{a.b.c.d}$ = emissions during warm-up phase (cold start)
a = fuel type (e.g. diesel, gasoline, LPG, etc)
b = vehicle type
c = emission control technology (such as uncontrolled, catalytic converter, etc.)
d = operating conditions (e.g. urban or rural road type, climate, or other environmental factors).

N_2O and CH_4 emissions are calculated for gasoline and diesel vehicles separately. The kilometrage (km/y) of each automobile type and model on different road types and in different speed classes are multiplied with corresponding CH_4 and N_2O emission factor. Calculations are made by using COPERT 4 model, which is based on EMEP/EEA air pollutant emission inventory guidebook – 2009 sector 1.A.3.b Road transport[4]. The calculation model COPERT IV is located in the Estonian Environment Information Centre.

COPERT 4 is a software tool used world-wide to calculate air pollutant and GHG emissions from road transport. The development of COPERT is coordinated by the European Environment Agency, in the framework of the activites of the European Topic Centre for Air Pollutant and Climate Change Mitigation. Necessary input data for the model in order to calculate emissions: number of vehicles, annual mileage per vehicle, annual statistical fuel consumption, speed (urban, rural, highway), driving share (urban/rural/highway), monthly minimum and maximum temperatures, monthly reid vapo pressure (RVP) etc. COPERT 4 contains 240 individual vehicle types. The vehicle classes are defined by the vehicle category (passenger car, light duty vehicle, etc.) fuel type, weight class, environmental class and in some instances the engine type and/or the emission control technology (e.g. “Euro” standards). Estonia divides its vehicle stock into 110 vehicle types.

QA/QC on input data collection of COPERT model includes: vehicle data and annual mileage per vehicle are collected from the Estonian Road Administration.

[4] http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-b-road-transport.pdf.

Meteorological data is provided by the Meteorological and Hydrological Institute and data pertaining to fuel consumption by Statistics Estonia. QA/QC plan consists of six parts: 1)Stakeholder engagement (stakeholders=e.g. suppliers of data, reviewers, recipients); 2)Data collection, which includes activity data collection. Before using activity data, common statistical quality checking related to the assesment of trends is carried out; 3)Data manipulation (common statistical quality chekcing is carried out); 4) Inventory compilation; 5)Reporting; 6)Archiving.

Road vehicles are classified according to their level of emission control technology, which is actually defined in terms of the emission legislation with which they are compliant. So therefore the emission factor values are differentiated per vehicle category and Euro standard. N_2O emission factors depend on vehicle category and also on fuel sulphur content[5].

Activity data

The activity data in CO_2 calculation is the amount fuel consumed in road traffic. Data on motor fuel consumption is received from the Statistics Estonia and are presented in the Table 3.23. The definition of consumption of fuel on the country level is based on fuel sales.

For obtaining more detailed activity data (distance travelled, emission control technology, vehicle type, operating conditions, etc.) for CH_4 and N_2O emission calculations the Estonian Environment Information Centre has concluded a contract to the Estonian Motor Vehicle Registration Centre.

In the Table 3.28 number of vehicles, in the Table 3.29 road traffic kilometrage and on the Figure 3.22 road traffic kilometrage per vehicle in 1990–2011 are presented.

There has been a small amount of biofuels used in Estonia in recent years, but the share has been very small (less than 1%), taking into account the energy content. The data on biofuels production and inland consumption are received from the Estonian Environmental Information Centre. The biofuels consumption figures in PJ are reported in Table 3.23 and in tons in Table 3.27.

Table 3.27. Consumption of pure bioethanol and biodiesel in Estonia, 2005–2011

	Bioethanol consumption, kt	**Biodiesel consumption, kt**
2005	NO	0.17
2006	NO	1.23
2007	0.02	0.56
2008	2.15	3.15
2009	0.15	1.82
2010	6.86	3.57
2011	5.93	0.72

[5] *Additional information about hot emission factors may be obtained from following Guidebook pages: N_2O emission factors on pages 76-81 and CH_4 emission factors by legislative steps are available on pages 68-69 (Tier 3 method).*

In the current inventory report the emissions from the use of bioethanol and biodiesel are reported separately from the fossil based diesel oil and gasoline emissions.

The use of LPG in road transport in Estonia is very small and it is not included into COPERT model. The emissions are calculated separately based on activity data obtained from annual energy statistics.

Table 3.28. Number of vehicles in Estonia, thousand vehicles

	Passenger cars	Buses	Lorries and special vehicles	Motorcycles and Mopeds	Trailers	Total Vehicles
1990	241	8	68	106	17	439
1991	261	9	77	100	16	463
1992	284	8	75	100	36	503
1993	317	9	74	97	37	535
1994	338	6	54	2	17	417
1995	383	7	66	3	24	483
1996	407	7	71	5	29	519
1997	428	7	77	5	33	549
1998	451	6	81	6	36	580
1999	459	6	81	7	37	590
2000	464	6	82	7	38	596
2001	407	6	81	7	37	537
2002	401	5	80	7	37	531
2003	434	5	83	8	40	571
2004	471	5	86	9	43	614
2005	494	5	86	10	46	642
2006	554	5	93	13	53	718
2007	524	4	80	15	53	676
2008	552	4	83	18	60	717
2009	546	4	81	19	62	712
2010	553	4	81	20	66	723
2011	574	4	84	23	70	756

Source: Statistics Estonia.

Table 3.29. Road traffic kilometrage in Estonia (Million km/y)

	Cars	Vans	Lorries	Buses	MC+Mopeds	Vehicles total
1990	5 601	687	1 363	221	317	**8 190**
1991	5 612	668	1 020	176	230	**7 707**
1992	2 278	347	678	105	230	**3 638**
1993	2 620	378	679	152	223	**4 053**
1994	4 225	422	679	165	5	**5 495**
1995	3 880	447	631	211	8	**5 177**
1996	4 172	495	657	194	10	**5 528**
1997	4 396	555	725	199	13	**5 888**
1998	3 165	456	839	226	10	**4 696**
1999	4 012	512	709	193	15	**5 441**
2000	4 126	505	725	175	16	**5 547**

2001	5 271	729	844	167	16	**7 028**
2002	5 177	873	871	183	17	**7 120**
2003	5 219	825	764	178	19	**7 006**
2004	5 420	958	767	176	33	**7 354**
2005	5 802	959	724	175	11	**7 670**
2006	6 451	950	767	175	19	**8 362**
2007	6 990	978	777	185	28	**8 958**
2008	6 865	966	817	174	30	**8 852**
2009	6 547	727	675	142	27	**8 118**
2010	6 518	764	808	155	27	**8 272**
2011	6 633	817	889	155	25	**8 519**

Source: Estonian Environment Information Centre

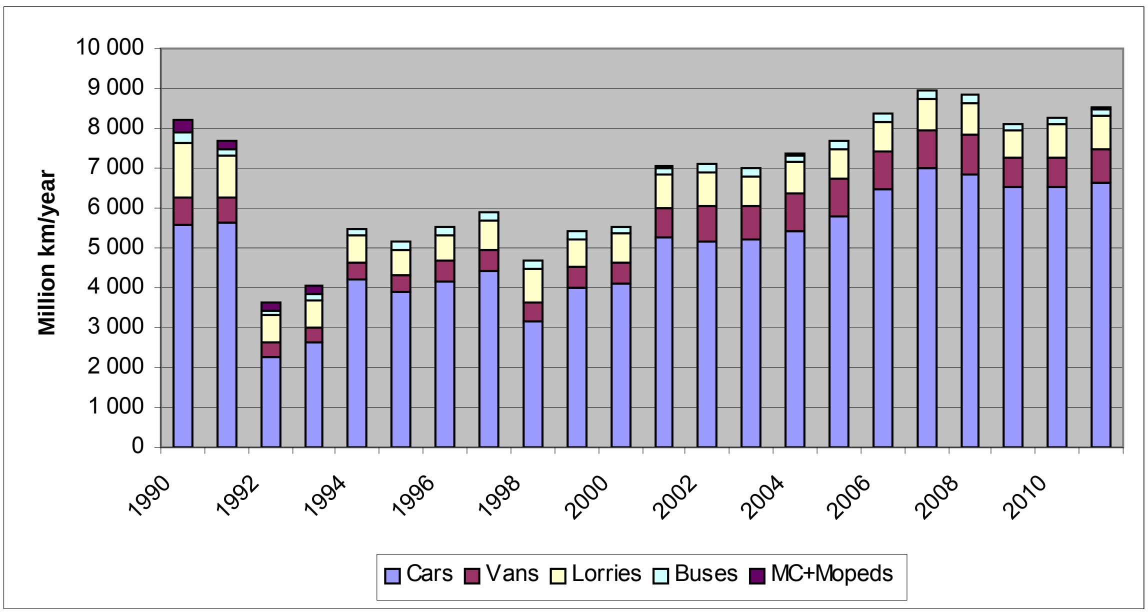


Figure 3.22. Road traffic kilometrage per vehicle in 1990–2011, Million km/y

Emission factors and other parameters

CO_2 emission factors of Gasoline, LPG and Diesel oil for road transportation are presented in Table 3.30. Estonia developed and applied in 2013 its own country specific CEFs for Gasoline, LPG and Diesel oil for road transportation. The CEFs for these fuels are calculated using weighted average method using CEFs of countries, that Estonia imports its fuel from. Since there was no import data for the years 1990–1994, then these values are calculated based on the data of 1995–1997.

Table 3.30. Carbon emission factors for fuels used in road transportation, (tC/TJ)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Gasoline	19.50	19.50	19.50	19.50	19.50	19.51	19.49	19.52	19.60	19.55	19.27
Diesel oil	20.01	20.01	20.01	20.01	20.01	20.00	20.02	20.01	20.01	20.01	20.01

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
LPG	17.48	17.48	17.48	17.48	17.48	17.72	17.79	17.44	17.21	17.10	17.10
	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Gasoline	19.34	19.71	19.79	19.79	19.27	19.03	19.06	19.19	19.40	19.77	19.78
Diesel oil	19.97	19.96	19.97	19.95	19.95	19.94	19.94	19.95	19.91	19.89	19.92
LPG	17.03	17.06	17.10	17.05	17.03	17.03	17.04	17.29	17.30	17.30	17.21

Oxidation factor for all fuels in road transportation are equal to 1.

The CO_2 emission factor for bioethanol is 0.698 t CO_2/t and for biodiesel 0.978 t CO_2/t.

For bioethanol and biodiesel, the CH_4 and N_2O emission factors of 3 kg/TJ and 0.6 kg/TJ respectively are used (IPCC2006 emission factors for gasoline and diesel). CH_4 and N_2O emission are calculated using COPERT model (see page 108). CH_4 and N_2O emission factors used in COPERT are described in the EMEP/EEA airpollutant emission inventory guidebook, Chapter 1.A.3.b Road transport GB2009 update May 2012. Since different EURO class vehicles have different emission factors, then the CH4 and N2O emissions are highly dependant on the share of vehicles used in road transportation.

3.2.6.4. Railway

There were 304 diesel locomotives, 23 electric railcars, 32 diesel railcars, 217 passenger wagons and 18 995 freight wagons registered in the Railway Traffic Register at the end of 2011 (Statistical Yearbook 2012).

Railway transportation in Estonia is a small emission source in transport sector. The emissions of railway transportation were 106.16 Gg of CO_2 equivalents in 2011. The share of GHG emissions from railway transport was about 4.7% of the total transport sector emissions. In 1990 the corresponding figure was 155.16 Gg (CO_2 equivalent).

All non-electric locomotives in Estonia use diesel oil in Estonia. From 1990 to 2002 there were also coal burning locomotives used in Estonia. Since 2002 there is no coal burning locomotives in operation.

Compared to other countries, the rail transport of passengers in Estonia is used seldom and also the rail network density (in meters per km^2) is one of the smallest in Europe.

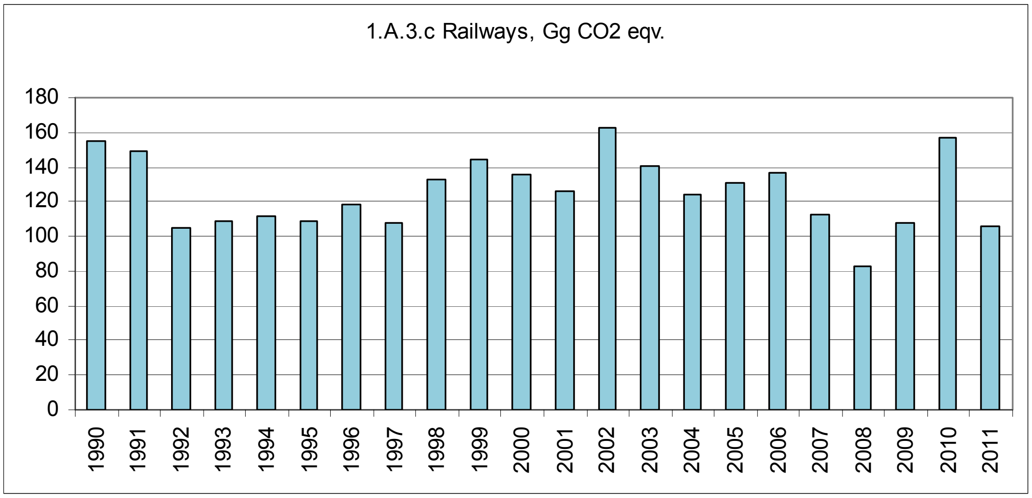


Figure 3.23. Emissions from the rail transportation in 1990–2011, Gg CO_2 equivalent

The trend of CO_2 emissions follows in general the fuel consumption trend in the rail transportation sector (Figure 3.23). The rail transport is used mostly for transport of goods. The lowest emission level in the rail transportation was achieved in 2008, it was caused by rapid decrease of amount of goods carried by Estonian transport enterprises. The decrease in the goods transported by rail that started in 2007 has kept falling and the freight turnover was at the same level as it was ten years ago. The volume of transit goods decreased by 29% (mainly coal and oil product transit). The rail passanger traffic was disturbed due to capital repair of railways in 2008. In 2009, GHG emissions from road transportation increased about 30% compared to 2008 and in 2010 by 46% compared to 2009 due to increase of the volume of transit goods. In 2009 the volume of transit goods inceased by 8% compared to 2008 and in 2010 by 11% compared to 2009. Compared to 2010, 20% more goods were posted abroad by rail and 40% more goods were received from abroad in 2011(Statistical Yearbook 2012).

Methods

Emissions of railway transportation are calculated by multiplying the estimated fuel (diesel oil, coal, etc) with a default IPCC 1996 emission factor (Tier 1).

Activity data

The activity data on fuel consumption used in railway transportation are obtained from the Statistics Estonia and presented in the Table 3.23.

Emission factors and other parameters

Emission factors of the CO_2. CH_4, and N_2O used in the calculation of emissions from railway transportation are taken from the Revised IPCC1996 Guidelines, emission factors of NOx, CO and NMVOC for coal from EMEP/EEA Guidelines and SO_2 EF is country specific (an expert estimation). The values of EF are presented in the Table 3.31.

Table 3.31. Emission factors used in the calculation of emissions from railway transportation (1.A.3.c)

Fuel	NCV average. GJ/t	GHG	EF	Oxi-dation factor	Source
Diesel Oil	42.3	CO_2	20.2 tC/TJ	0.99	IPCC1996, Vol.2, Table 1-2
		CH_4	5 kg/TJ		IPCC1996, Vol.3, Table 1-7
		N_2O	0.6 kg/TJ		IPCC1996, Vol.3, Table 1-8
		NOx	1 500 kg/TJ		IPCC1996, Vol.3, Table 1-49
		CO	1 000 kg/TJ		IPCC1996, Vol.3, Table 1-49
		NMVOC	200 kg/TJ		IPCC1996, Vol.3, Table 1-49
		SO_2	141.2 kg/TJ		CS, EE
Coal	27.16	CO_2	26.8 tC/TJ	0.98	IPCC1996, Vol.2, Table 1-2
		CH_4	10 kg/TJ		IPCC1996, Vol.3, Table 1-7
		N_2O	1.4 kg/TJ		IPCC1996, Vol.3, Table 1-8
		NOx	173 kg/TJ		EMEP/EEA/small combustion, Table 3_7, p.5
		CO	931 kg/TJ		EMEP/EEA/small combustion, Table 3_7, p.5
		NMVOC	88.8 kg/TJ		EMEP/EEA/small combustion, Table 3_7, p.5
		SO_2	1 028 kg/TJ		CS, EE

**EE - expert estimation*

3.2.6.5. Domestic Navigation

In the Estonian Register of Ships 29 inland waterway vessels were registered at the end of 2011 (Statistical Yearbook 2012).

Domestic navigation in Estonia is also a small emission source in transport sector. The emissions of domestic navigation were 14.80 Gg of CO_2 equivalent in 2011 (0.65% of the total transport sector emissions). In 1990 the corresponding figure was 21.95 Gg in CO_2 equivalent.

Emissions from deep sea fishing are not included in the reporting for national navigation, because the deep sea fishing vessels buy their fuel abroad. Therefore, the emissions are reported as international bunkers for the neighbouring Parties.

The trend of GHG emissions from the Domestic Navigation is presented on the Figure 3.24.

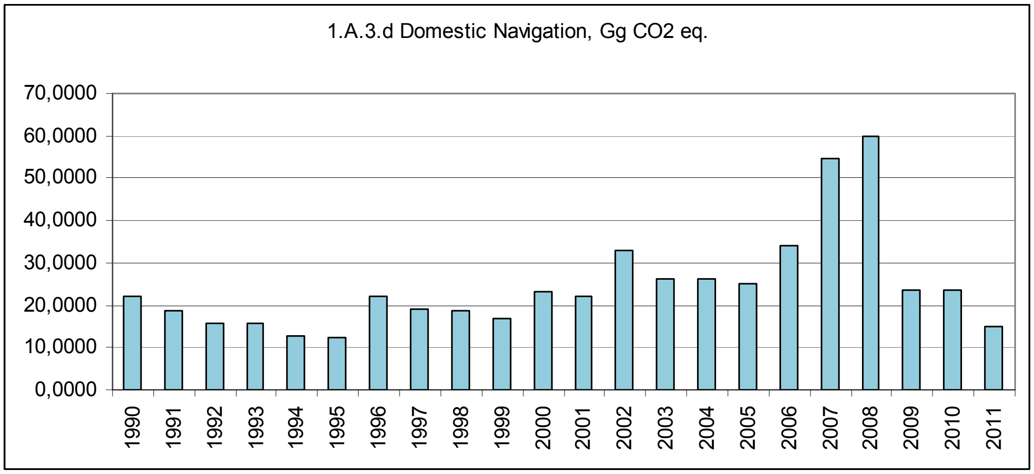


Figure 3.24. Emissions from the National Navigation in 1990–2011, Gg CO_2 equivalent

Methods

Emissions from domestic navigation are calculated by multiplying the estimated fuel (diesel oil) with a default IPCC1996 emission factor.

Activity data

The activity data on fuel consumption used in domestic navigation are obtained from the Statistics Estonia and presented in the Table 3.23.

Emission factors and other parameters

CO_2, CH_4 and N_2O emission factors for diesel oil and coal and NOx, CO and NMVOC EF for diesel oil used in the calculation of emissions are taken from the Revised IPCC 1996 Guidelines. NOx, CO and NMVOC EF for coal are taken from the EMEP/EEA Gudelines, SO_2 EFs are country specific. All emission factors are presented in the Table 3.32.

Table 3.32. Emission factors used in the calculation of emissions from domestic navigation (1.A.3.d)

Fuel	NCV average . GJ/t	GHG	EF	Oxi-dation factor	Source
Diesel Oil	42.3	CO_2	20.2 tC/TJ	0.99	IPCC1996, Vol.2, Table 1-2
		CH_4	5 kg/TJ		IPCC1996, Vol.3, Table 1-7
		N_2O	0.6 kg/TJ		IPCC1996, Vol.3, Table 1-8
		NOx	1 500 kg/TJ		IPCC1996, Vol. 3, Table 1-9
		CO	1 000 kg/TJ		IPCC1996Vol. 3, Table 1-10
		NMVOC	200 kg/TJ		IPCC1996Vol. 3, Table 1-11

Fuel	NCV average . GJ/t	GHG	EF	Oxi-dation factor	Source
		SO_2	141.2 kg/TJ		CS, EE

3.2.6.6. Source-specific recalculations

1. In the CRF source category 1.A.3.b – Liquid Fuels – LPG, the following recalculations have been made due to implementation of Estonian Country-Specific CEF:

		CEF, tC/TJ		CO2 emissions, Gg	
	Year	2012 submission	2013 submission	2012 submission	2013 submission
LPG	1990	17.20	17.48	8.68	8.91
	1991	17.20	17.48	5.74	5.90
	1992	17.20	17.48	5.62	5.77
	1993	17.20	17.48	1.69	1.73
	1994	17.20	17.48	10.36	10.64
	1995	17.20	17.72	1.06	1.10
	1996	17.20	17.79	0.87	0.91
	1997	17.20	17.44	1.19	1.21
	1998	17.20	17.21	0.69	0.69
	1999	17.20	17.10	0.62	0.63
	2000	17.20	17.10	0.62	0.63
	2001	17.20	17.03	0.56	0.56
	2002	17.20	17.06	1.12	1.13
	2003	17.20	17.10	0.69	0.69
	2004	17.20	17.05	0.50	0.50
	2005	17.20	17.03	0.50	0.50
	2006	17.20	17.03	0.25	0.25
	2007	17.20	17.04	0.12	0.12
	2008	17.20	17.29	0.31	0.32
	2009	17.20	17.30	0.25	0.25
	2010	17.20	17.30	0.31	0.32

2. In the CRF source category 1.A.3.b – Liquid Fuels – Gasoline, the following recalculations have been made due to implementation of Estonian Country-Specific CEF:

		CEF, tC/TJ		CO2 emissions, Gg	
	Year	2012 submission	2013 submission	2012 submission	2013 submission
Gasoline	1990	19.90	19.50	1 561.95	1 530.18
	1991	19.90	19.50	1 405.30	1 376.72
	1992	19.90	19.50	658.13	644.74
	1993	19.90	19.50	702.82	688.53
	1994	19.90	19.50	900.35	882.04
	1995	19.90	19.51	770.30	755.18
	1996	19.90	19.49	843.33	825.80
	1997	19.90	19.52	937.39	919.28
	1998	19.90	19.60	901.36	887.89

		CEF, tC/TJ		CO2 emissions, Gg	
	Year	2012 submission	2013 submission	2012 submission	2013 submission
	1999	19.90	19.55	862.17	846.99
	2000	19.90	19.27	866.26	838.99
	2001	19.90	19.34	1 032.31	1 003.49
	2002	19.90	19.71	947.18	937.95
	2003	19.90	19.79	907.53	902.62
	2004	19.90	19.79	875.21	870.41
	2005	19.90	19.27	893.74	865.56
	2006	19.90	19.03	972.11	929.55
	2007	19.90	19.06	1 019.91	976.90
	2008	19.90	19.19	1 014.47	974.22
	2009	19.90	19.40	924.12	900.47
	2010	19.90	19.77	870.52	851.59

3. In the CRF source category 1.A.3.b – Liquid Fuels – Diesel, the following recalculations have been made due to implementation of Estonian Country-Specific CEF:

		CEF, tC/TJ		CO2 emissions, Gg	
	Year	2012 submission	2013 submission	2012 submission	2013 submission
Diesel oil	1990	20.20	20.01	696.59	697.01
	1991	20.20	20.01	644.32	644.71
	1992	20.20	20.01	364.14	364.36
	1993	20.20	20.01	438.20	438.47
	1994	20.20	20.01	554.54	554.88
	1995	20.20	20.00	659.13	659.16
	1996	20.20	20.02	628.37	629.00
	1997	20.20	20.01	655.55	656.02
	1998	20.20	20.01	723.11	723.52
	1999	20.20	20.01	631.74	631.96
	2000	20.20	20.01	626.20	626.51
	2001	20.20	19.97	784.35	783.06
	2002	20.20	19.96	933.17	931.55
	2003	20.20	19.97	915.71	914.37
	2004	20.20	19.95	1 011.67	1 009.31
	2005	20.20	19.95	1 085.37	1 082.03
	2006	20.20	19.94	1 174.74	1 168.18
	2007	20.20	19.94	1 254.83	1 249.81
	2008	20.20	19.95	1 170.51	1 158.84
	2009	20.20	19.91	1 076.55	1 066.88
	2010	20.20	19.89	1 195.37	1 188.98

3.2.6.7. Source-specific planned improvements

It is planned to evaluate and implement country specific emission factors for different fuels used in Estonia (e.g. fuels used in key categories, fuels produced in Estonia). Currently the process is underway, but it is not clear, to which fuels the country specific emission factors will be developed. Some of the emission factors are already developed and implemented (e.g. motor fuels in road transportation, oil shale gases).

3.2.7. Other Sectors (CRF 1.A.4) and Other (CRF 1.A.5)

3.2.7.1. Source category description

Sub-category CRF 1.A.4 includes emissions from the small combustion of fuels in the following sectors:

- 1.A.4.a Commercial/Institutional
- 1.A.4.b Residential (Households)
- 1.A.4.c Agriculture/Forestry/Fisheries

These sector cover mainly fuels used in heating of buildings, but also emissions from heating of agricultural buildings, off-road machinery in agriculture and forestry as well fishing boats are included in this source category.

In 2011, emissions of the CRF sub-category CRF 1.A.4 Other Sectors were 640.59 Gg in CO_2 equivalent, it is about 3.43% of the energy sector's emissions and 3.06% of total GHG emissions in Estonia. Corresponding emissions were 2 008.42 Gg of CO_2 equivalent in 1990 (see Figure 3.25 and Table 3.33).

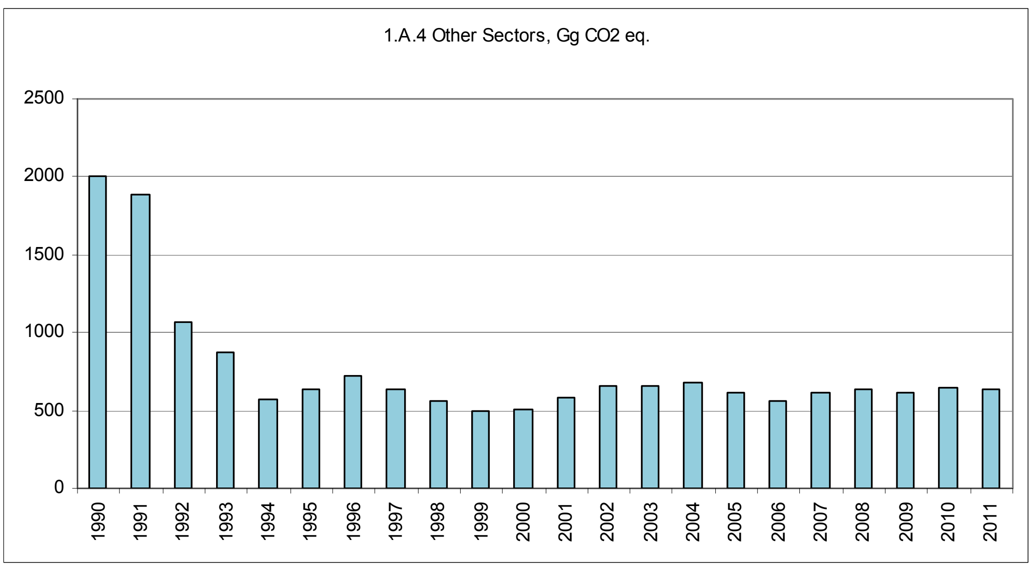


Figure 3.25. Trend of GHG **e**missions in the CRF category 1.A.4 Other Sectors, Gg CO_2 eq

The sub-category CRF 1.A.4.a contains GHG emissions from commercial and institutional subsectors including: wholesale and retail trade; repair of motor vehicles; hotels and restaurants; financial intermediation; real estate, renting and business activities; public administration and defence; compulsory social security; education; health and social work; other community, social and personal service activities, etc.

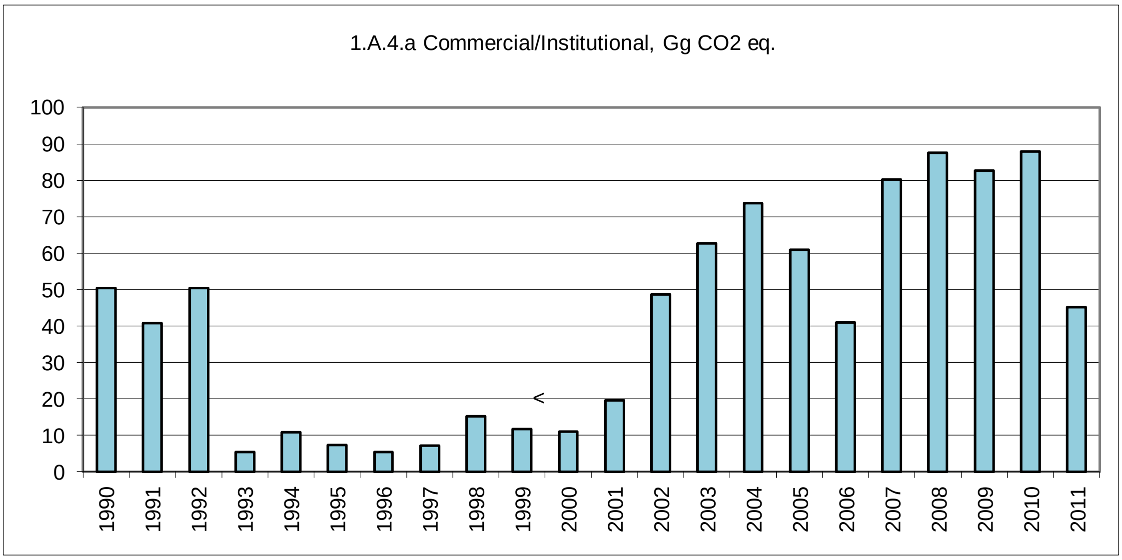


Figure 3.26. Trend of GHG emissions in the CRF category 1.A.4.a Commercial/Institutional, Gg CO_2 eq

The decreasing trend of GHG emissions in the beginning of 90s (since 1993 up to 2000) is logical and reflects the general economical development trend after regaining independence in 1991. The increase of emission trend in 2001 is connected with big growth of some sub-sectors like financial intermediation; real estate, hotels and restaurants, etc. The rapid decrease in 2006 was caused by structural changes of used fuels – use of wood fuels decreased about 72% when at the same time the use of gaseous fuels increased by 12% compared to 2006. Since 2007 the GHG emission trend is pretty stable (see Figure 3.26). In 2011 the decrease in use of natural gas in commercial/institutional led to decrease of GHG emissions. GHG emissions decreased about 48.6% compared to previous year.

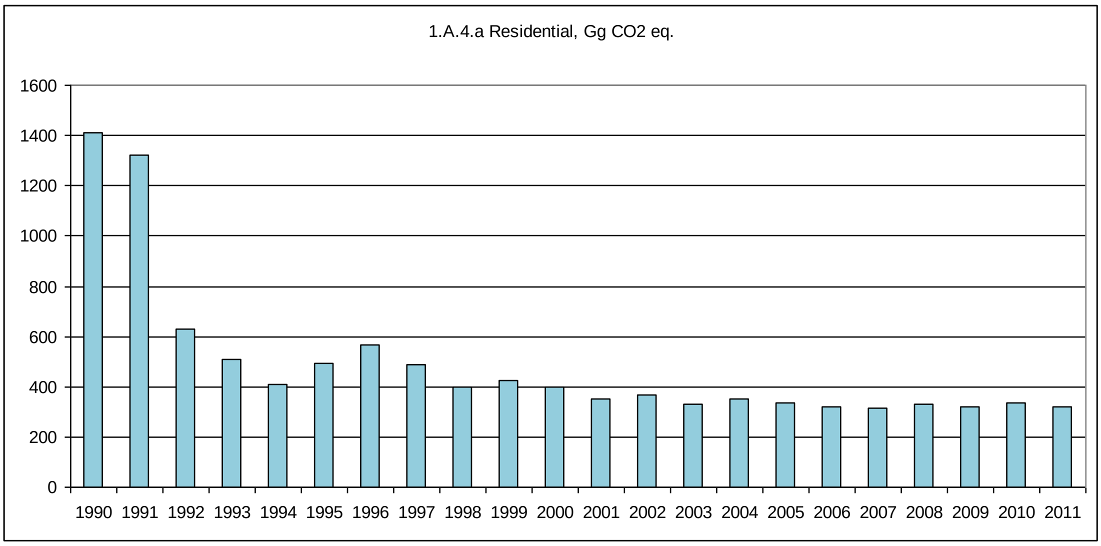


Figure 3.27. Trends of GHG emissions in the CRF categories 1.A.4.b Residential, Gg CO_2 eq

The source-category 1.A.4.b includes GHG emissions from fuel combustion in households. The overall trend of GHG emissions is decreasing and follows the fuel consumption trend of the sector. The decreasing trend is logical because of energy efficiency and saving measures, renovation of houses, building more new houses, etc. But the most important reason for the decrease of GHG emissions is a big change in the fuel consumption structure in the residential sector. Consumption of fuel oils decreased rapidly after 1991 but consumption of wood fuels increased in last years more than three times compared to 1990/1991 (see Figure 3.27).

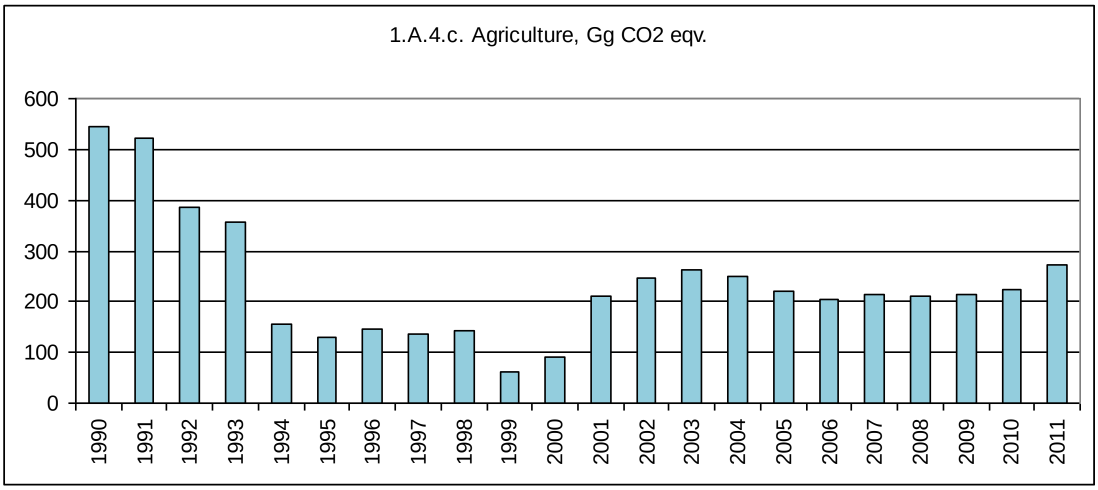


Figure 3.28. Trends of GHG **e**missions in the CRF categories 1.A.4.c Agriculture, Gg CO_2 eq

Under source-category 1.A.4.c Agriculture, GHG emissions from fuel combustion in agriculture, fishing and hunting are reported. The trend of GHG emissions follows the fuel consumption trend of the sector and reflects the whole sector development trend. The number of farms decreased since 1994 drastically and reached the bottom in 1999. Since 2002 the production in agriculture stabilised and small fluctuation in different years is explained mainly with different weather conditions (see Figure 3.28). The increase of emissions in 2011 is explained with the growth in production of agricultural products, since the use of fuels also increased.

The values of CO_2 IEFs of liquid fuels in the Other Sector are between 71.69 t/TJ (in 1999) and 73.48 t/TJ (in 1993) and the values of CO_2 IEF of solid fuels are between 94.68 t/TJ (in 1994) and 96.00 t/TJ (in 2004). The trends are fluctuating due to changes in the contribution of different solid and liquid fuels over time.

Sub-category CRF 1.A.5 includes emissions from military use of fuels (see Table 3.34).

The emissions of the CRF 1.A.5 were 20.18 Gg CO_2 equivalent in 2011, it is about 0.11% of the energy sector's emissions and 0.1% of total GHG emissions in Estonia. Corresponding emissions were 44.36 Gg of CO_2 equivalent in 1990.

3.2.7.2. Methodological issues

Methods

Emissions from sub-category CRF 1.A.4 and CRF 1.A.5 are calculated by using the methodology of the IPCC1996 and 2006 Guidelines.

Activity data

The activity data for source categories CRF 1.A 4 and CRF 1.A.5 are taken from annual energy statistics . It covers fuel used in commercial/institutional and residential and agricultural/forestry/fisheries sectors. Activity data on liquid fuels (gasoline and diesel oil) reported under source-category 1.A.5./Military are taken from the Commercial/Institutional sector of the national energy balance. Same small amounts of gasoline and diesel used in military passanger cars are taken off and reported under category 1.A.3.c road transportation. Activity data on fuel amounts used for military passanger cars are collected from the Ministry of Defence.

The fuel consumption data by main fuel groups for CRF 1.A4 are presented in the Table 3.35 and Figure 3.29. Fuel consumption data of the source category CRF 1.A.5 Other/Military are presented in the Table 3.36.

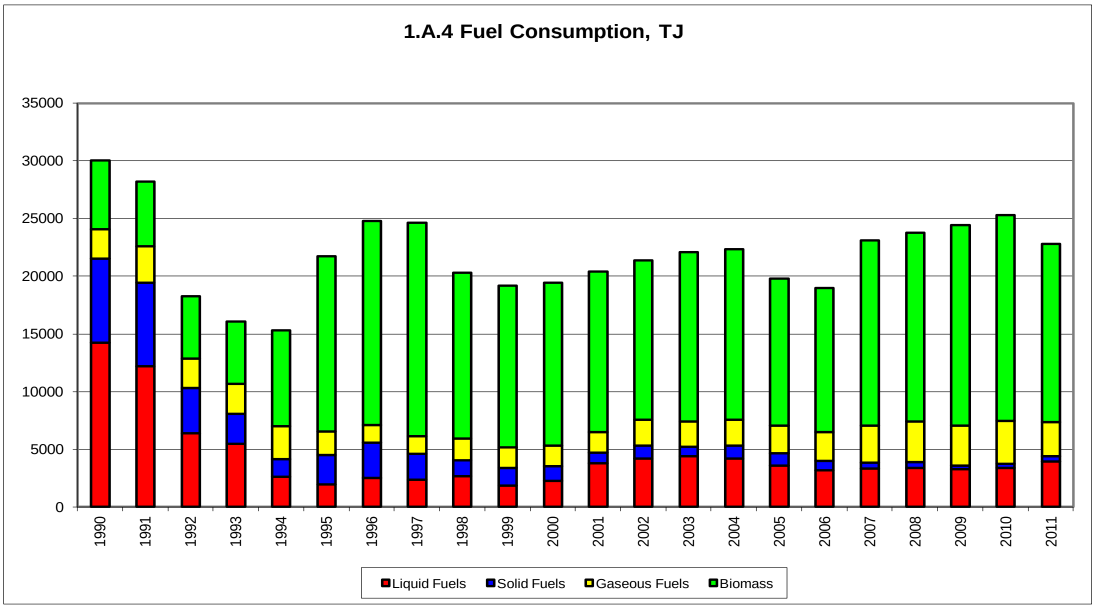


Figure 3.29. Fuel Consumption in the CRF category 1.A.4 Other Sectors, PJ

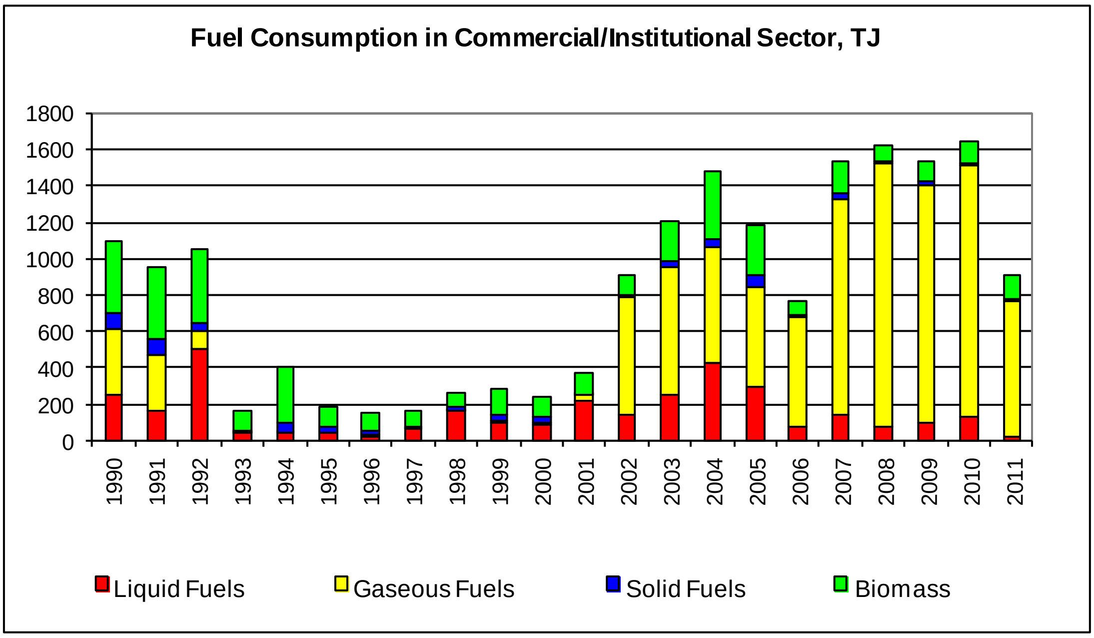


Figure 3.30. Fuel consumption by main fuel groups in Commercial/Institutional sector, PJ

The fuel consumption trend of the Commercial/Institutional sector shows the big increase of the natural gas use since 2002. The increase of the natural gas consumption is connected with the construction boom which started in 2002 in Estonia. Lot of new logistics buildings and hypermarkets (using gas heating) were built.

Consumption of other fuels: liquid, solid and biomass fuels were more stable, some fluctuations are in the liquid fuel consumption trend in 1992, 2001 and 2004 (see Figure 3.30).

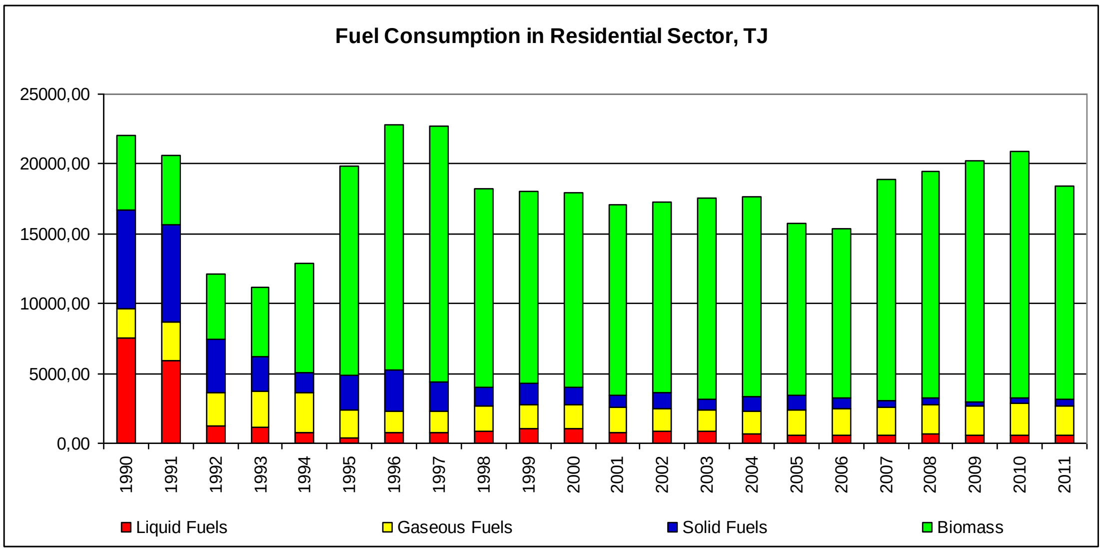


Figure 3.31. Fuel consumption by main fuel groups in Residential sector, PJ

In the Figure 3.31 the fuel consumption trend by main fuel groups of the Residential sector is presented. The most dominating fuel of the sector is biomass (used for space heating). The big increase in the use of biomass in residential sector started in the middle of the nineties when several different biofuels conversion projects were launched to replace fossil fuel with biomass. The increase of the biomass consumption trend in 1996/1997 is connected with the methodology change of the SE and decreases in 2005/2006 with warm winters. Since 2007 the use of biofuels in residential sector is slightly increasing. Due to warmer-than-average winter, the use of biomass in households for heating decreased in 2011.

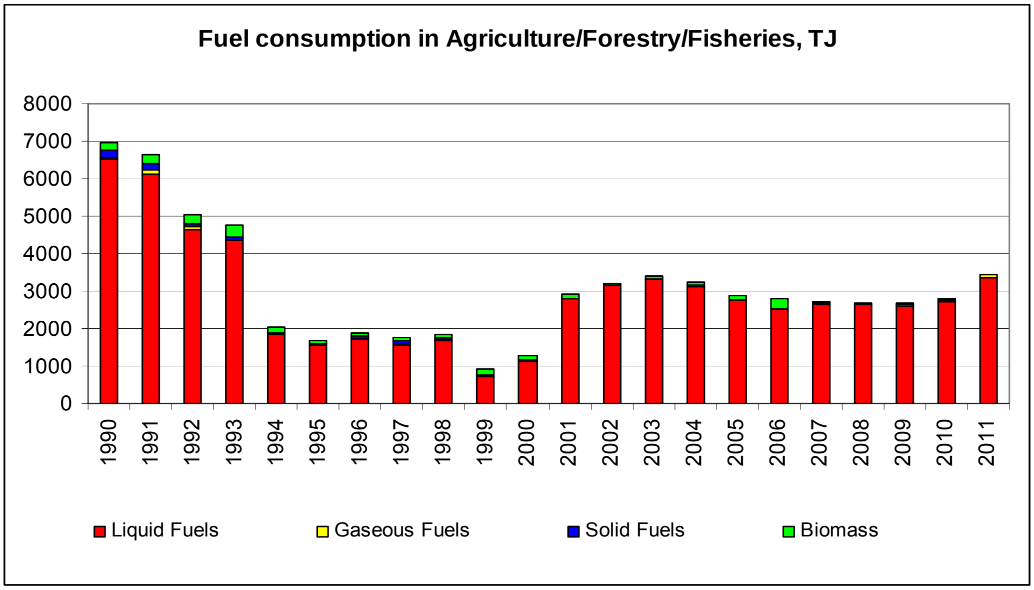


Figure 3.32. Fuel consumption by main fuel groups in Agriculture/Forestry/Fisheries, TJ

In the Figure 3.32 fuel consumption trend by main fuel group of the Agriculture/Forestry/Fisheries sector is presented. The main fuel group in agriculture is liquid fuels, the other fuel groups have a small share in the sector and the consumption trend has been quite stable since 2001.

The amount of liquid fuels used in agriculture has been decreased since 1990 up to 1999 almost 60%, mostly due to the decreasing of whole agricultural production caused by the structural changes in the economy after 1991 when Estonia became independent. After 2000 the agricultural production started to increase bringing together the increase of liquid fuel consumption. Fuel consumption has been quite stable through the years 2005–2010. Due to growth in production of agricultural products, the use of liquid fuels also increased in 2011.

Table 3.33. Emissions from Other Sectors (incl. Commercial/Institutional, Residential and Agriculture) in 1990–2011, (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.4 Other Sectors Total, CO_2 eq	2 008.42	1 881.57	1 067.97	871.86	575.28	630.99	716.45	633.25	559.15	498.74	502.00
1.A.4.a Commercial/Institutional, CO_2 eq	50.39	40.79	50.46	5.36	10.81	7.32	5.37	7.19	15.16	11.74	11.10
1.A.4.b Residential, CO_2 eq	1 413.31	1 320.15	629.95	508.19	408.66	494.20	564.46	489.39	399.76	425.85	400.50
1.A.4.c Agriculture/Forestry/ Fisheries, CO_2 eq	544.72	520.63	387.56	358.31	155.81	129.46	146.63	136.67	144.23	61.15	90.39

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.4 Other Sectors Total, CO_2 eq	579.96	661.83	655.00	677.66	617.04	563.75	611.79	631.49	613.86	646.10	640.59
1.A.4.a Commercial/Institutional, CO_2 eq	19.54	48.63	62.70	73.66	60.89	40.91	80.12	87.63	82.57	87.90	45.22
1.A.4.b Residential, CO_2 eq	349.99	368.01	329.66	354.00	335.99	319.44	316.62	332.18	318.33	335.15	321.39
1.A.4.c Agriculture/Forestry/ Fisheries, CO_2 eq	210.44	245.19	262.64	249.99	220.15	203.41	215.05	211.68	212.97	223.05	273.98

Table 3.34. Emissions from CRF 1.A.5 Other in 1990–2011, (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.5 Other Total, CO_2 eq	44.36	54.36	34.85	11.01	11.19	29.31	16.55	13.94	17.51	17.50	17.17

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.5 Other Total, CO_2 eq	18.86	14.97	19.35	28.27	35.46	32.21	31.16	10.97	29.66	41.58	20.18

Table 3.35. Fuel consumption in CRF categories 1.A 4 Other Sectors, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.4 Other Sectors Total	30 039	28 235	18 257	16 112	15 318	21 746	24 828	24 652	20 336	19 179	19 435
Liquid Fuels	14 269	12 218	6 415	5 495	2 644	1 980	2 529	2 376	2 662	1 864	2 270
Solid Fuels	7 280	7 248	3 928	2 574	1 515	2 547	3 037	2 233	1 423	1 549	1 266
Gaseous Fuels	2 552	3 145	2 520	2 618	2 870	2 010	1 550	1 549	1 839	1 754	1 779
Biomass	5 938	5 624	5 394	5 425	8 289	15 209	17 712	18 494	14 412	14 012	14 120

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1.A.4 Other Sectors Total	20 421	21 409	22 124	22 384	19 826	18 983	23 146	23 786	24 436	25 337	22 804
Liquid Fuels	3 793	4 213	4 408	4 204	3 606	3 212	3 350	3 389	3 273	3 390	3 958
Solid Fuels	953	1 108	803	1 134	1 050	780	502	498	342	372	478
Gaseous Fuels	1 780	2 262	2 233	2 260	2 434	2 516	3 232	3 528	3 442	3 722	2 955
Biomass	13 895	13 826	14 680	14 786	12 736	12 474	16 062	16 371	17 379	17 853	15 413

Table 3.36. Fuel consumption in CRF categories 1.A 5 Other, TJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.5 Liquid Fuels	596	730	467	148	150	393	222	187	235	235	230

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.A.5 Liquid Fuels	253	201	259	379	475	432	418	147	398	557	270

Emission Factors

Both, IPCC and national (country specific) emission factors are used. Estonia uses Finnish CH_4 and N_2O EF for sod peat and peat briquettes, because IPCC 1996 Revised Guideline does not give EFs of different peat fuels (see Table 3.37). CH_4 and N_2O EFs for oil shale were taken from the IPCC2006 Guideline because IPCC1996 Revised Guideline gives no EF for these fuels.

Table 3.37. Emission factors of small combustion of fuels, kg/TJ

	CH_4	N_2O	NOx	CO	NMVOC	Source[6]
Oil	10	0.6	100	20	5	IPCC1996, Vol.3, Tables 1-7 – 1-11
LPG	5	0.1	100	20	5	IPCC1996, Vol.3, Tables 1-7 – 1-11
Natural Gas	5	0.1	50	50	5	IPCC1996, Vol.3, Tables 1-7 – 1-11
Coal (commercial)	10	1.4	100	2 000	200	IPCC1996, Vol.3, Tables 1-7 – 1-11
Coal (residential, agriculture)	300	1.4	100	2 000	200	IPCC1996, Vol.3, Tables 1-7 – 1-11
Oil Shale (commercial)	10	1.5	110	87	60	IPCC2006 (for CH_4 and N_2O) CS, (Procedure, 2004) for NOx, CO and NMVOC
Oil Shale	300	1.5	110	87	60	IPCC2006 (for CH_4 and N_2O) CS, (Procedure, 2004) for NOx, CO and NMVOC
Peat/Briquette	50	4	100	5 000	600	CH_4 FIN, other EFs IPCC1996 (other biomass)
Wood	300	4	100	5 000	600	IPCC1996, Vol.3, Tables 1-7 – 1-11

Under the CRF source category 1.A.4.c Agriculture/Mobile emissions from off-road agricultural transport are estimated. In the Table 3.38 emission factors of motor fuels used for off-road transportation and fishing and leasure boats are presented.

Table 3.38. Emission factors for agricultural off-road fuels

	CO_2	CH_4	N_2O	NOx	CO	NMVOC	Source
Motor Gasoline	19.03-19.79	80	2	1 200	1 000	200	For CO_2 - Estonian Country-Specific, for Other -

[6] Revised IPCC1996 Guidelines for National Greenhouse Gas Inventories, Reference Manual, Table 1-7, Table 1-8, Table 1-9, Table 1-19, Table 1-11, pages 1.35-1.42.

							IPCC2006, Chapter 3, Table 3.3.1
Diesel Oil	20.2	4.15	28.6	1 200	1 000	200	IPCC2006, Chapter 3, Table 3.3.1

Under the CRF source category 1.A.5 Other/Mobile emissions from military fuel use are estimated. In the Table 3.39 emission factors of motor fuels used in military are presented.

Table 3.39. Emission factors for military fuels (CRF 1.A.5), kg/TJ

	CO_2 (t C/TJ)	**CH_4**	**N_2O**	**NOx**	**CO**	**NMVOC**	**Source**
Motor Gasoline	19.03-19.79	3.8	5.7	600	8 000	1 500	IPCC2006, Chapter 3, Table 3.2.3. (CEF: Estonian Country-Specific)
Diesel Oil	20.2	3.9	3.9	800	8 000	1 500	IPCC2006, Chapter 3, Table 3.2.3; (CEF: IPCC1996)

3.2.7.3. Source-specific recalculations

1. In the CRF source category 1.A.4.a Commercial/Institutional – Solid Fuels, the N_2O emission factor of Sod Peat has been corrected. In previous submission, the used N_2O emission factor of Sod Peat in expert's calculation sheets was 50 kg/TJ, which is not in accordance with the IPCC1996 Guidelines. In currect submission, the used N_2O emission factor of Sod Peat is corrected to 4 kg/TJ, which is in accordance with the IPCC1996 Guidelines.

	N_2O EF, kg/TJ	
	2012 submission	**2013 submission**
Sod Peat	50	4

2. In the CRF source category 1.A.4.a Commercial/Institutional – Gaseous Fuels, the following activity data has been revised due to corrections in national energy balance of Statistics Estonia:

	Year	**2012 submission**	**2013 submission**
Natural Gas, TJ	2006	605.405	605.4

3. In the CRF source categories 1.A.4.a Commercial/Institutional, 1.A.4.b Residential and 1.A.4.c Agriculture/Forestry/Fisheries - the oxidation factor of Biomass has been corrected. In previous submission, the used oxidation factor of Biomass in expert's calculation sheets was 0.97, which is not in accordance with the IPCC1996

Guidelines. In current submission, the used oxidation factor of Biomass is corrected to 0.98, which is in accordance with the IPCC1996 Guidelines.

	Oxidation factor	
	2012 submission	2013 submission
Biomass	0.97	0.98

4. In the CRF source categories 1.A.4.b Residential and 1.A.4.c Agriculture/Forestry/Fisheries, the Estonian Country-Specific CEF of gasoline has been implemented:

		CEF, tC/TJ	
	Year	2012 submission	2013 submission
Gasoline	1990	19.90	19.50
	1991	19.90	19.50
	1992	19.90	19.50
	1993	19.90	19.50
	1994	19.90	19.50
	1995	19.90	19.51
	1996	19.90	19.49
	1997	19.90	19.52
	1998	19.90	19.60
	1999	19.90	19.55
	2000	19.90	19.27
	2001	19.90	19.34
	2002	19.90	19.71
	2003	19.90	19.79
	2004	19.90	19.79
	2005	19.90	19.27
	2006	19.90	19.03
	2007	19.90	19.06
	2008	19.90	19.19
	2009	19.90	19.40
	2010	19.90	19.77
	2011	19.90	19.78

3.2.7.4. Source-specific planned improvements

It is planned to evaluate and implement country specific emission factors for different fuels used in Estonia (e.g. fuels used in key categories, fuels produced in Estonia). Currently the process is underway, but it is not clear, to which fuels the country specific emission factors will be developed. Some of the emission factors are already developed and implemented (e.g. motor fuels in road transportation, oil shale gases).

3.3. Fugitive Emissions from fuels (CRF 1.B)

3.3.1. Solid Fuels (CRF 1.B.1)

In Estonia oil shale is mined for energy generation and shale oil production. The amounts of oil shale mined in 1990–2010 are presented in Table 3.40. There are no coal mines in Estonia.

Unlike coal mines there is no CH_4 emissions from oil shale mines, because methane is non-existent in Estonian Oil Shale (see the Explanation Letter from the Department of Mining of the Tallinn University of Technology in Annex 2).

Table 3.40. Oil shale production in Estonia, million tons

Year	Mt	Year	Mt
1990	22.49	**2001**	9.89
1991	19.61	**2002**	10.51
1992	17.03	**2003**	12.61
1993	14.26	**2004**	11.74
1994	14.02	**2005**	12.35
1995	12.10	**2006**	11.98
1996	13.07	**2007**	13.99
1997	12.86	**2008**	13.71
1998	10.91	**2009**	12.60
1999	9.60	**2010**	15.11
2000	9.97	**2011**	15.86

Source: Table KK501 Exstraction of mineral resources,Statistical Data base of the Statistics Estonia, www.stat.ee

Data presented in Table 3.40 is not the same what data on oil shale production in National Energy balance Sheet but show the decrease of oil shale reserves. Estonian oil shale active reserves are estimated according to the energy raiting of the bed >35 GJ/m^2 (cut-off grade).

3.3.2. Oil and Natural Gas (CRF 1.B.2)

Sources of fugitive emissions within oil and gas systems include releases during normal operation, such as emissions associated with 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.

3.3.2.1. Source category description

Under fugitive emissions from fuels Estonia reports CH_4 emissions from: oil storage and natural gas distribution.

Natural gas is imported into Estonia from Russia and from the Inchukalns underground gas storage in Latvia.

AS Eesti Gaas has two gas metering stations on the border of Estonia (in Värska and Karksi) where the volumes of imported gas are measured. Gas is distributed to customers through gas pipelines, distribution stations and gas pressure reducing stations.

There are no compressor stations in Estonia and it means that there is no fugitive CO_2 emission from gas distribution in Estonia. CO_2 forms from natural gas consumption in compressor stations.

Map of high-pressure gas distribution pipelines

In 2011, fugitive emissions from oil and natural gas were 3.58 Gg CH_4 (75.14 Gg CO_2 eq.). It is about 0.40% of the energy sector's emissions and 0.36% of total GHG emissions in Estonia. Corresponding emissions were 181.10 Gg CO_2 equivalent in 1990.

3.3.2.2. Methodological issues

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

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

Activity data

The activity data for sub-category CRF 1.B.2 is taken from the annual energy statistics (National Energy Balace Sheet).

Emission factors and other parameters

Emission factors for calculating emissions of oil and gas activities are based on the default factors given in the Revised IPCC 1996 Guidelines and also Finland's National Inventory Report (see Table 3.41).

Emissions from natural gas storage was not estimated due to no natural gas storage facilities in Estonia. Estonia uses storage facilities located in Latvia.

Table 3.41. CH_4 emission factors for fugitive emissions from oil and gas activities

	Emission Factor	Unit	Source
OIL			
Transport of oil products	745	kg CH_4/PJ	D, IPCC1996, Reference Manual, P.1.121, Table 1-58.
Storage of oil products	150	kg CH_4/PJ	D, IPCC1996, Reference Manual, P.1.121, Table 1-58.
GAS			
Distribution of natural gas	165 016	kg CH_4/PJ	CS, FI (Finland)

3.3.2.3. Quantitative overview

In the Table 3.42 CH_4 emissions from oil and gas activities are presented.

Table 3.42. CH_4 emissions from Oil and Gas activities, Gg CO_2 equivalent

	Fugitive emissions Gg CO_2 eq	**1.B.2 Oil and Natural Gas**	**1.B.2.A Total Oil**	1.B.2.A.3 Transport	1.B.2.A.4 Storage	**1.B.2.B Natural Gas**	1.B.2.B.4 Distribution
	Gg CO_2 eq	Gg CH_4	Gg CH_4	Gg CH_4	Gg CH_4	Gg CH_4	Gg CH_4
1990	**181.36**	**8.64**	**0.18**	0.14	0.04	**8.45**	8.45
1991	**181.16**	**8.63**	**0.15**	0.12	0.03	**8.48**	8.48
1992	**105.81**	**5.04**	**0.09**	0.07	0.02	**4.95**	4.95
1993	**53.53**	**2.55**	**0.09**	0.07	0.02	**2.46**	2.46
1994	**76.31**	**3.63**	**0.10**	0.08	0.02	**3.53**	3.53
1995	**86.47**	**4.12**	**0.09**	0.07	0.02	**4.02**	4.02
1996	**94.96**	**4.52**	**0.08**	0.07	0.02	**4.44**	4.44
1997	**92.89**	**4.42**	**0.11**	0.09	0.02	**4.31**	4.31
1998	**88.17**	**4.20**	**0.11**	0.08	0.02	**4.09**	4.09
1999	**85.92**	**4.09**	**0.11**	0.08	0.02	**3.98**	3.98
2000	**97.21**	**4.63**	**0.05**	0.04	0.01	**4.58**	4.58
2001	**105.15**	**5.01**	**0.09**	0.07	0.02	**4.92**	4.92
2002	**87.71**	**4.18**	**0.06**	0.05	0.01	**4.12**	4.12
2003	**97.33**	**4.63**	**0.10**	0.08	0.02	**4.54**	4.54
2004	**113.78**	**5.42**	**0.06**	0.05	0.01	**5.36**	5.36
2005	**117.29**	**5.59**	**0.06**	0.05	0.01	**5.52**	5.52
2006	**118.99**	**5.67**	**0.07**	0.06	0.02	**5.59**	5.59
2007	**118.70**	**5.65**	**0.09**	0.07	0.02	**5.56**	5.56
2008	**113.58**	**5.41**	**0.08**	0.06	0.02	**5.33**	5.33
2009	**77.78**	**3.70**	**0.08**	0.07	0.02	**3.62**	3.62
2010	**83.31**	**3.97**	**0.08**	0.06	0.02	**3.89**	3.89
2011	**75.14**	**3.58**	**0.07**	0.06	0.01	**3.50**	3.50

3.3.2.4. Uncertainties and time-series consistency

To estimate the uncertainties of this category the IPCC Tier1 method was used.

Uncertainties of activity data (±10) and emission factors (±25) were taken from the IPCC 2000. Good Practice Guidance.

3.3.2.5. Source specific recalculations

In the CRF source category 1.B.2.B.5 Other Leakage – notation key “IE” used in previous submission has been corrected to “NO” since no natural gas transmission occurs in Estonia (UN ERT recommendation during in-country review in Estonia in September 2012).

3.3.2.6. Source-specific planned improvements.

For the next inventory submission Estonia plans to evaluate and implement country specific emission factor for fugitive methane emissions from natural gas distribution.

4. INDUSTRIAL PROCESSES (CRF 2)

4.1. Overview of the sector

4.1.1. Description and quantitative overview

Emissions from Industrial Processes sector in Estonia are divided into following emission categories: Mineral products (CRF 2.A), Chemical industry (CRF 2.B), Consumption of halocarbons and SF_6 (CRF 2.F) and other production (CRF 2.D). Under Mineral products Estonia reports emissions from cement, lime, glass, bricks and tiles production as well as emissions from lightweight gravel production and soda ash use. Also NMVOC emissions from road paving with asphalt are reported in this category. Emissions from ammonia production are reported under Chemical industry. CRF category 2.F covers emissions of F-gases from refrigeration and air-conditioning, foam blowing, aerosols and electrical equipment, as well as some smaller sources, such as fire extinguishers and other. Under Other production (CRF 2.D) Estonia reports NMVOC emissions from the pulp and paper and food industries.

Industrial GHG emissions contribute to 2.93% of the total anthropogenic GHG emissions in Estonia (Figure 4.1). As outlined in the inventory for 2011 the most important greenhouse gas emissions from industrial processes in Estonia are the CO_2 emissions from the cement and lime production with 1.99% and 0.11% and HFC emissions from Refrigeration and Air-Conditioning Equipment with 0.71%. F-gas emissions comprised together 0.77% of the total GHG emissions.

Industrial CO_2 emissions have fluctuated strongly since 1990 (Figure 4.2 and Table 4.1) having the lowest value in 1993. The decrease in the emissions during early 1990's was caused by the transition from planned economy to a market economy after 1991, when Estonia became independent. This led to decrease in industrial production, and to an overall decrease in emissions from industrial processes between 1991 and 1993. In 1994 the economy began to recover and also the production increased. Since 1995 (the base year for F-gases under the Kyoto Protocol) emissions of F-gases have significantly increased. In 2002 and 2003 there were reconstructions in ammonia production plant, which strongly decreased the industrial processes emissions in the corresponding years. In 2009, industrial processes sector was affected by the economic recession. Decline in production was mainly caused by the insufficient demand both in domestic and external markets. Increase in 2011 emissions was caused by increase of cement production. Compared to 2010, the emissions from industrial processes increased by 24% in 2011.

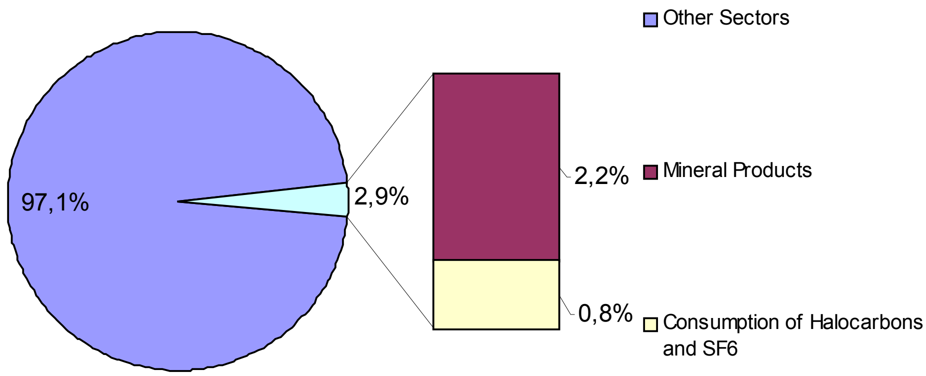


Figure 4.1. Emissions from industrial processes compared with total emissions in 2011

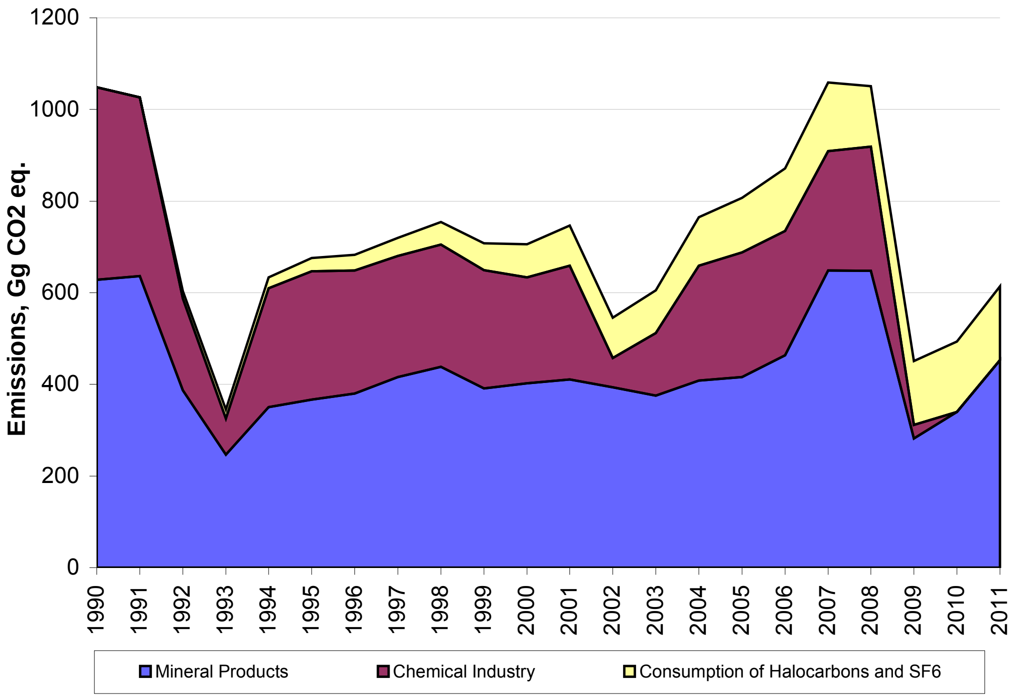


Figure 4.2. Emissions from industrial processes in Estonia in 1990–2011 (Gg CO_2 equivalent)

Table 4.1. Trend in the greenhouse gas emissions from industrial processes (Gg CO_2 equivalent)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.A Mineral Products	628	636	387	246	350	367	380	416	438	391	402	411	394	376	408	416	463	649	648	282	339	453
2.B Chemical Industry	420	391	200	79	259	280	269	264	267	258	231	248	64	137	251	272	272	260	271	30	NO	NO
HFCs	NO	NO	16	18	21	25	31	36	46	56	70	85	87	92	105	118	135	149	131	138	153	159
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.07	0.06	0.04	NO	NO	NO
SF_6	NO	0.05	0.09	1.45	3.11	3.22	3.49	2.99	2.99	3.01	2.73	1.74	1.44	1.33	1.08	1.08	1.15	0.97	1.35	1.44	1.81	1.82
Total	**1048**	**1027**	**603**	**345**	**633**	**676**	**683**	**720**	**754**	**708**	**706**	**746**	**545**	**605**	**765**	**807**	**871**	**1059**	**1051**	**451**	**494**	**614**

Key categories

Key categories in industrial processes in 2011 by level (L) and trend (T) are summarised in Table 4.2 (without LULUCF) in accordance with IPCC Tier 2 method.

Table 4.2. Key categories in Industrial processes (CRF 2) in 2011 (without LULUCF)

IPCC code	IPCC source category	Gas	Identification criteria
2.B.1	Ammonia Production	CO_2	T

4.2. Mineral Products (CRF 2.A)

In this category non-fuel emissions from cement production (2.A.1), lime production (2.A.2), soda ash use (2.A.4.2) and other (2.A.7) are reported. In the source category other (2.A.7), emissions from glass production (2.A.7.1), bricks and tiles production (2.A.7.2a) and lightweight gravel production (2.A.7.2b) are reported. In addition, NMVOC emissions from road paving with asphalt are reported under Mineral products. Emissions from Limestone and Dolomite Use are reported as included elsewhere (allocation 2.A.1, 2.A.2 and 2.A.7). CO_2 emissions from the use of limestone are reported accordingly under CRF categories 2.A.1, 2.A.2, 2.A.7.1, 2.A.7.2a and 2.A.7.2b. CO_2 emissions from the use of dolomite are reported under CRF categories 2.A.7.2a and 2.A.7.2b accordingly.

CO_2 emissions from mineral products have fluctuated since 1990 (Table 4.3) having the lowest value in 1993, after what the trend of CO_2 emissions have stabilized (except a rise in 2007–2008 and sudden decrease in 2009). The decrease in the emissions during early 1990's was caused by the transition from planned economy to market economy after 1991 when Estonia became independent. This led to decrease in industrial production, and to an overall decrease in emissions from mineral products between 1991 and 1993. In 1994 the economy began to recover and also production increased. Sudden increase in 2007–2008 emissions was caused by increase of cement production (in 2007 Kunda Nordic Cement AS renovated third kiln). In 2009, mineral products sector was affected by the economic recession. Decline in production was mainly caused by the insufficient demand both in domestic and external markets. Increase in 2010 and 2011 emissions was caused by increase of cement production.

Table 4.3. CO_2 emissions from Mineral products (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.A.1 Cement production	483	479	315	228	330	348	361	396	404	361	374	380	356	335	365	373	414	597	603	257	310	416
2.A.2 Lime production	131	143	65	16	14	13	12	12	20	15	13	13	18	20	22	24	27	28	25	16	18	23
2.A.4.2 Soda ash use	0.31	0.25	0.13	0.09	0.26	0.26	0.28	0.58	1.02	0.89	1.12	0.97	0.94	0.41	0.55	0.37	0.66	0.47	0.28	0.13	0.14	0.52
2.A.7.1 Glass production	1.2	1.2	0.8	2.3	3.3	4.0	3.4	5.6	7.4	6.4	7.3	7.3	8.7	8.9	9.1	8.0	9.3	10.5	8.7	7.6	9.6	10.9
2.A.7.2a Bricks and tiles production	12.3	12.5	6.3	0.03	2.9	2.2	2.2	1.7	1.4	2.8	1.4	2.4	2.3	2.7	2.8	2.5	3.2	5.8	4.9	1.1	1.6	2
2.A.7.2b Lightweight gravel production	NO	NO	NO	NO	NO	NO	NO	NO	4.7	5.0	6.0	7.5	7.4	8.5	8.9	7.9	9.8	7.7	5.8	NO	NO	NO
Total	**628**	**636**	**387**	**246**	**350**	**367**	**380**	**416**	**438**	**391**	**402**	**411**	**394**	**376**	**408**	**416**	**463**	**649**	**648**	**282**	**339**	**453**

4.2.1. Cement Production

4.2.1.1. Source category description

In cement production 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, calcites, 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.

In Estonia, there is only one plant producing clinker and cement – Kunda Nordic Cement AS. Cement is produced in Kunda by standard wet process. The clinker burning process takes place in rotary kilns. Dust caught with rotary kilns electric filters is party directed into kiln and partly into dust silo. In production process the most important fuels are oil shale, coal and pet coke. Also different alternative fossil fuels are used, such as waste oil, plastics.

4.2.1.2. Methodological issues

Methods

Emissions from cement production were calculated using Tier 2 methodology from the good practice guidance (IPCC 2000, equation 3.1 page 3.10 and equation 3.3 page 3.12). This method assumes that all of the CaO is from a carbonate source (e.g. $CaCO_3$).

According to the Tier 2 method:

$$\text{Emissions} = EF_{clinker} \bullet \text{Clinker Production} \bullet \text{CKD Correction Factor}$$

Emission factors

Emission factors used in calculating the emissions from cement production are plant-specific provided by the industry (i.e. production plants). Emission factors vary slightly due to the parameters affecting them from year to year (Table 4.5).

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

Activity data

In calculating the emissions from cement production the amount of clinker produced annually is used as activity data. The clinker production data was received directly from the plant – Kunda Nordic Cement AS – throughout the time series. Data on the cement kiln dust was also provided by the plant.

CKD correction factors were calculated by dividing the total CO_2 process emissions (emissions from clinker production and cement kiln dust, but not emissions from the biological substance) with CO_2 emissions from the clinker production. The total CO_2 emissions from process and emissions from clinker production and cement kiln dust were provided by the plant for all of the years. Each year has a different CKD correction factor due to different amounts of cement kiln dust (calcination rate of

CKD and CaO content of the clinker). The calcination rate of CKD was 82% in years 1990–2006, and 79% in years 2007–2011. Data on clinker production as well as CKD correction factors between 1990–2011 are presented in Table 4.5.

4.2.1.3. Uncertainties and time-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The uncertainty of activity data (±2%) and emission factors (±5%) were taken from the IPCC Good Practice Guidance. The uncertainty of activity data took into account the fact that clinker production data is collected on plant-level. Plants generally do not weight clinker better than this.

The uncertainty of emission factor took into account the following error sources:

- Error associated with assuming that all CaO in clinker is from calcium carbonate;
- Uncertainty of plant-level data on CaO content of clinker. This is the best case error of chemical analysis on a production basis.

4.2.1.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

The emissions of last seven years (including 2011 emissions) have been compared with EU ETS data (as recommended by the UNFCCC review team). Differences between those two figures have been less than 0.1%.

4.2.1.5. Source-specific recalculations

No source-specific recalculations have been done.

4.2.1.6. Source-specific planned improvements

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

4.2.2. Lime Production

4.2.2.1. Source category description

CO_2 emissions from lime production are due to calcination of calcium and magnesium carbonates at high temperatures. In Estonia there are currently two lime production plants: Nordkalk AS and Limex AS.

4.2.2.2. Methodological issues

Methods

Emissions from lime production are calculated by multiplying emission factors with activity data. Activity data are collected mainly directly from the industry but in the earlier years (1990–1996) industrial statistics have also been used. Emission factors are calculated by the industry or are based on IPCC's default factors. The methods for calculating emissions from lime production are consistent with the IPCC Tier 1 level method.

Emission factors

There are three different emission factors used to calculate emissions from lime production. Two emission factors are received directly from the plants, based on the actual CaO and MgO contents. From Limex AS emission factor has been available since 1994 (production in Limex AS started in 1994). From Nordkalk AS emission factor based on actual CaO and MgO content has been available since 2005. As this emission factor differs strongly from default emission factor, emission factors for 1990–2004 are established as a mean value from emission factors in 2005–2008. Third emission factor used is IPCC default value for quicklime. This value is applied to those companies that were closed before 1996, as no better data is available.

Activity data

Activity data (Table 4.5) for lime production is collected mainly directly from the industry and taken partly from industrial statistics (1990–1996). Since 1997 there have been two lime producing plants in Estonia and therefore activity data is collected directly from the industry (1997–2011). From 1990–1996 there were more producing plants and therefore industrial statistics have also been used. From 1990–1996 activity data is collected on one hand directly from plants producing lime nowadays, on the other hand industrial statistics have been used to calculate emissions from plants closed during 1990–1996.

4.2.2.3. Uncertainties and time-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

Since the activity data was prepared in cooperation with manufacturers the rate of emissions is considered sufficiently precise. The activity data uncertainty was estimated at ±5% and emission factors uncertainty at ±5%. The uncertainty of plant-level data was taken into consideration when estimating the uncertainty of activity data.

4.2.2.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

The emissions from bigger plant (responsible more than 99% of the lime production emissions in Estonia) have been compared with EU ETS data. Differences have been less than 0.1% (2005–2011).

4.2.2.5. Source-specific recalculations

No source-specific recalculations have been done.

4.2.2.6. Source-specific planned improvements

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

4.2.3. Soda Ash Use

4.2.3.1. Source category description

Soda ash (= sodium carbonate) is used in glass production, rare earth metals separation, rare metals production and in processes of electrolyte neutralisation and lead paste desulphurisation in Estonia. According to the information received from industry, CO_2 emissions do not occur from lead paste desulphurisation. Emission from sodium carbonate used in glass production are reported under category glass production (CRF 2.A.7.1). The usage of soda ash in rare earth metals separation and rare metals production started in 1970 in Estonia. The usage of soda ash in electrolyte neutralisation process started in 2003 in Estonia.

4.2.3.2. Methodological issues

Methods

Emissions from soda ash use are calculated by multiplying emission factors with the amount of used soda ash. Activity data are gathered directly from the industry. The method for calculating emissions from soda ash use is consistent with the IPCC 1996 Tier 1 level method.

Emission factors

Emission factors for calculating CO_2 emissions from soda ash use are based on the IPCC default factors (IPCC 1996 workbook, page 2.8). For the calculation of CO_2 emissions from soda ash use, emission factor 0.415 t of CO_2 per tonne of soda ash is used.

Activity data

The consumption of sodium carbonate was used as activity data when calculating emissions from soda ash use. Activity data was collected directly from plants.

4.2.3.3. Uncertainties and time-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The uncertainty of emission factor for this source category is relatively low, as the emission factor is the stoichometric ratio reflecting the amount CO_2 released upon calcinations of the carbonate. The emission factor uncertainty was estimated ±5%.

The uncertainty of activity data is greater than the uncertainty of emission factor and is estimated at ±10%.

4.2.3.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

The investigation over the possibilities to cross-check soda ash use on an annual basis was made as the encouragement of the UNFCCC review team. Statistics Estonia was contacted to get national data about soda ash use, imports and exports (no production of soda ash in Estonia). The results of the investigation indicated that Statistics Estonia do not collect nor publish national data about soda ash use; Statistics Estonia have national data about soda ash imports and exports.

A cross-check of soda ash was made for one year (2011), based on total soda ash use included in the inventory against the total national soda ash imports obtained from Statistics Estonia. In 2011 total national soda ash imports were higher than soda ash use reported in the inventory. In 2008–2010, soda ash use reported in the inventory was significantly higher than national soda ash imports obtained from Statistics Estonia. Differences in soda ash use included in the inventory and soda ash imports obtained from Statistics Estonia are mainly due to not all imported soda ash is used same year. In addition, inventory take into consideration that CO_2 emissions do not occur from lead paste desulphurisation. Therefore, the amount of soda ash, which is used in lead paste desulphurisation, is subbtraced from total amount of soda ash use.

4.2.3.5. Source-specific recalculations

Activity data in 1990–2010 was recalculated due to data about soda ash use was included by one plant. Activity data was collected directly from plant for the years 1999 and 2002–2010. Activity data for the years 1990–1998 and 2000–2001 is based on interpolation of the Statistics Estonia data of ferrous metals. The difference between 2012 Submission emissions and 2013 Submission emissions from soda ash use in 1990–2010 is shown in Table 4.4.

Table 4.4. CO_2 emissions from soda ash use in 2012 Submission and 2013 Submission

Year	**Soda ash use, kt (the 2012 submission)**	**Reported emissions of CO_2, Gg (the 2012 submission)**	**Soda ash use, kt (the 2013 submission)**	**Recalculated emissions of CO_2, Gg (the 2013 submission)**
1990	NO	NO	0.74	0.31
1991	NO	NO	0.61	0.25
1992	NO	NO	0.32	0.13
1993	NO	NO	0.22	0.09
1994	NO	NO	0.63	0.26
1995	NO	NO	0.61	0.26
1996	NO	NO	0.68	0.28
1997	NO	NO	1.41	0.58
1998	NO	NO	2.47	1.02
1999	NO	NO	2.15	0.89
2000	NO	NO	2.70	1.12
2001	NO	NO	2.33	0.97
2002	NO	NO	2.26	0.94
2003	0.01	0.004	0.99	0.41
2004	0.08	0.03	1.33	0.55
2005	0.16	0.07	0.89	0.37
2006	0.18	0.07	1.58	0.66
2007	0.21	0.09	1.13	0.47
2008	0.21	0.09	0.67	0.28
2009	0.18	0.07	0.32	0.13
2010	0.20	0.08	0.35	0.14

4.2.3.6. Source-specific planned improvements

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

4.2.4. Road Paving with Asphalt

4.2.4.1. Source category description

In this source category NMVOC emissions from road paving with asphalt are reported. The NMVOC emissions are calculated at the Estonian Environment Information Centre.

4.2.4.2. Methodological issues

NMVOC emissions from road paving with asphalt were calculated using Tier 1 default approach from the EMEP/EEA Guidebook (EMEP/EEA, 2009).

According to the Tier 1 method:

$$E_{pollutant} = AR_{production} \bullet EF_{pollutant}$$

Where:

$E_{pollutant}$ = the emissions of the specified pollutant
$AR_{production}$ = the activity rate for the road paving with asphalt
$EF_{pollutant}$ = the emission factor for this pollutant

The annual weight of asphalt used in road paving was used as activity data when calculating NMVOC emissions from this source category. Activity data was received from the Estonian Asphalt Pavement Association for the years 1990–2011.

Default NMVOC factors are taken from EMEP/EEA air pollutant emission inventory guidebook – 2009. For the calculations of NMVOC emissions from road paving with asphalt, emission factor 16 g of NMVOC per Mg of asphalt was used.

4.2.4.3. Uncertainties and time-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The data on road paving with asphalt is deemed precise because the relevant association provided it. The uncertainty of activity data is estimated at ±10%. The uncertainty of emission factor is greater than the uncertainty of activity data and is estimated at ±50%.

4.2.4.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.2.4.5. Source-specific recalculations

No source-specific recalculations have been done.

4.2.4.6. Source-specific planned improvements

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

4.2.5. Glass Production

4.2.5.1. Source category description

Under this source category, Estonia reports CO_2 emissions from flat glass and container glass production. Currently only container glass is produced in Estonia and there is one production plant – O-I Production Estonia AS (previously Järvakandi Klaas AS). O-I Production Estonia AS started to produce container glass in 1992, and flat glass was produced in Estonia from 1990 to 1996.

4.2.5.2. Methodological issues

Methods

There are two methods in use for calculating CO_2 emissions from glass production, both methods are consistent with Tier 1. Process emissions in container glass production are generated from limestone and soda ash use and they are calculated by multiplying emission factors with the amount of carbonates used. Activity data (1993–2011) was collected directly from glass producing company – O-I Production Estonia AS.

Emissions from flat glass production were calculated using Tier 1 methodology from the IPCC 2006 Guidelines (equation 2.10, page 2.28). This method was used since carbonates used in flat glass manufacturing are not known and only national-level production statistics was available.

According to the Tier 1 method:

$$CO_2 \text{ Emissions} = M_g \bullet EF \bullet (1 - CR)$$

Where:

CO_2 Emissions = emissions of CO_2 from glass production, tonnes
M_g = mass of glass produced, tonnes
EF = default emission factor for manufacturing of glass, tonnes CO_2/tonne glass
CR = cullet ratio for process (default), fraction.

Emission factors

Emission factors for calculating emissions from limestone and soda ash use are based on the IPCC default factors (1996 Revised Guidelines). For the calculation of CO_2 emissions from limestone use, emission factor 0.44 t of CO_2 per tonne of limestone is used. For the calculation of CO_2 emissions from soda ash use, emission factor 0.415 t of CO_2 per tonne of soda ash is used.

Emission factors for calculating emissions from flat glass production are based on the IPCC default factors (IPCC 2006, equation 2.13, page 2.29). For the calculation of CO_2 emissions from flat glass, emission factor 0.20 t of CO_2 per tonne of glass is used.

Activity Data

The consumption of limestone and sodium carbonate has been used as activity data when calculating emissions from container glass production. Activity data was collected directly from glass producing plant- O-I Production Estonia AS (Table 4.5).

Activity data for calculating emissions from flat glass production are based on national statistics, however the numbers were corrected for the quantity of culled used in glass production. The default cullet ratio of 50 percent was taken into account and national level data on the mass of flat glass produced was multiplied by 0.20 • (1 – 0.50) = 0.10 tonnes CO_2/tonnes glass produced (IPCC 2006, page 2.30).

4.2.5.3. Uncertainties and time-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

Since the activity data was prepared in cooperation with manufacturer the rate of emissions is considered sufficiently precise. The activity data uncertainty was estimated at ±10% and emission factors uncertainty at ±10%.

4.2.5.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.2.5.5. Source-specific recalculations

No source-specific recalculations have been done.

4.2.5.6. Source-specific planned improvements

Estonia investigates possibilities to develope country-specific EFs for Glass Production for future submissions as the encouragement of the UNFCCC review team.

Table 4.5. Activity data and emission factors for cement, lime, glass production and soda ash us

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.A.1																						
Clinker production, kt	790	773	517	378	540	571	591	651	659	590	620	629	590	560	623	635	705	1 043	1 040	449	537	719
$EF_{clinker}$, t/t	0.549	0.557	0.548	0.542	0.549	0.547	0.546	0.543	0.546	0.546	0.538	0.538	0.538	0.538	0.542	0.547	0.547	0.546	0.548	0.548	0.549	0.549
CKD correction factor	1.113	1.113	1.113	1.113	1.113	1.113	1.121	1.121	1.121	1.121	1.121	1.122	1.122	1.113	1.081	1.073	1.073	1.048	1.058	1.046	1.054	1.054
2.A.2																						
Lime production, kt	185	207	92	21	18	16.8	17.4	18.9	31.6	23.4	19.9	19.9	28.3	30.7	34.3	37.2	41.5	43.4	39.5	24.2	26.9	35.8
IEF_{lime}, t/t	0.71	0.69	0.70	0.76	0.77	0.75	0.72	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.65	0.64	0.64	0.64	0.66	0.66	0.65
2.A.4.2																						
Soda ash use, kt	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.01	0.08	0.16	0.18	0.21	0.21	0.18	0.20	0.20
$EF_{default}$, t/t	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415
2.A.7.1																						
Container glass production, kt	NO	NO	0.6	10.8	20.6	27.9	35	53	57.9	53.6	59.1	59.2	56.1	61.9	66.8	62.1	70.5	76	65.7	63	81.6	81.4
Limestone consumption, kt	NO	NO	0.15	1.71	3.2	3.86	4.15	7.96	8.2	7.9	8.99	9.65	8.79	8.97	9.46	8.64	10.37	11.85	9.82	7.9	11.17	12.41
$EF_{default}$, t/t	NA	NA	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Sodium carbonate consumption, kt	NO	NO	0.31	2.4	2.58	2.9	3.8	5.1	9.13	7.0	8.1	7.35	11.65	11.9	12.0	10.2	11.38	12.74	10.47	9.89	11.25	13.04
$EF_{default}$, t/t	NA	NA	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415
Flat glass production, kt	12.3	12	5.9	5.5	8.5	11.2	0.02	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
$EF_{default}$ x (1 - CR), t/t	0.1	0.1	0.1	0.1	0.1	0.1	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

4.2.6. Bricks and Tiles Production

4.2.6.1. Source category description

In bricks and roof tiles production process-related CO_2 emissions result from the calcination of carbonates in the clay. Carbonates are heated to high temperatures in a kiln, producing oxides and CO_2.

4.2.6.2. Methodological issues

Methods

Emissions from ceramic bricks and roof tiles production were calculated using Tier 1 methodology from the IPCC 2006 Guidelines (equation 2.14 page 2.34). According to the Tier 1 method:

$$CO_2 \text{ Emissions} = M_c \bullet (0.85\, EF_{ls} + 0.15\, EF_d)$$

Where:

CO_2 Emissions = emissions of CO_2 from other process uses of carbonates, tonnes
M_c = mass of carbonate consumed, tonnes
EF_{ls} or EF_d = emission factor for limestone or dolomite calcinations, tonnes CO_2/tonne carbonate

Emission factors

Emission factors for calculating emissions from limestone and dolomite use are based on the IPCC default factors (IPCC 2006, page 2.7, table 2.4). For the calculation of CO_2 emissions from limestone use, emission factor 0.44 t of CO_2 per tonne of limestone is used. For the calculation of CO_2 emissions from dolomite use, emission factor 0.477 t of CO_2 per tonne of dolomite is used.

Activity data

Mass of carbonates consumed has been used as an activity data when calculating CO_2 emissions from production of bricks and roof tiles (see Table 4.6). Data on the amount of clay used in bricks production was directly collected from the plants from 1992 to 2011. The amount of clay consumed in bricks production in 1990–1992 was calculated by multiplying production with a default loss factor of 1.1. In 1993, only two small plants produced ceramic bricks in Estonia. Data on the amount of clay used in production of roof tiles has been directly collected from the plant since 1997 (production of ceramic roof tiles began in 1997).

As no other information was available, default carbonate content of 10 percent was applied for clays. It was assumed that 85 percent of carbonates consumed are limestone and 15 percent of carbonates consumed are dolomite (IPCC 2006, page 2.36).

For the years 1992–2011 data about bricks production was directly collected from the plants. The amounts of bricks produced between years 1990–2000 were taken from industrial statistics for one company. Data on production of ceramic roof tiles was received directly from the plant for all the years (Table 4.6).

4.2.6.3. Uncertainties and time-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The uncertainty of emission factor for this source category is relatively low, as the emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon calcinations of the carbonate. The emission factor uncertainty was estimated at ±5%.

The uncertainty of activity data is greater than the uncertainty of emission factor and is estimated at ±10%. The uncertainty of activity data took into account the uncertainty associated with weighting and proportioning the carbonates in clay and the uncertainty associated with the assumption of a default breakdown of limestone and dolomite of 85%/15%.

4.2.6.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.2.6.5. Source-specific recalculations

No source-specific recalculations have been done.

4.2.6.6. Source-specific planned improvements

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

4.2.7. Lightweight Gravel Production

4.2.7.1. Source category description

In lightweight gravel production process-related CO_2 emissions result from the calcination of carbonates in the clay. Carbonates are heated to high temperatures in a kiln, producing oxides and CO_2. In lightweight gravel production plant dolomite is used as a flux. Therefore, CO_2 emissions occur from carbonates in the clay as well from dolomite used as a flux. In 2009–2011, there was no production of lightweight gravel in Estonia.

4.2.7.2. Methodological issues

Methods

Emissions from lightweight gravel production were calculated using Tier 1 methodology from the IPCC 2006 Guidelines (equation 2.14 page 2.34). According to the Tier 1 method:

$$CO_2 \text{ Emissions} = M_c \bullet (0.85\ EF_{ls} + 0.15\ EF_d)$$

Where:

CO_2 Emissions = emissions of CO_2 from other process uses of carbonates, tonnes
M_c = mass of carbonate consumed, tonnes
EF_{ls} or EF_d = emission factor for limestone or dolomite calcinations, tonnes CO_2/tonne carbonate

Emission factors

Emission factors for calculating emissions from limestone and dolomite use are based on the IPCC default factors (IPCC 2006, page 2.7, table 2.4). For the calculation of CO_2 emissions from limestone use, emission factor 0.44 t of CO_2 per tonne of limestone is used. For the calculation of CO_2 emissions from dolomite use, emission factor 0.477 t of CO_2 per tonne of dolomite is used.

Activity data

Mass of carbonates consumed has been used as an activity data when calculating CO_2 emissions from lightweight gravel production (see Table 4.6). Data about the amount of clay used for lightweight gravel production was directly collected from the plant from 1998 to 2008. As no other information was available, default carbonate content of 10 percent was applied for clays. It was assumed that 85 percent of carbonates consumed are limestone and 15 percent of carbonates consumed are dolomite (IPCC 2006, page 2.36).

Data on production of lightweight gravel was received directly from the plant for all the years, 1998–2008 (Table 4.6).

4.2.7.3. Uncertainties and time-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The uncertainty of emission factor for this source category is relatively low, as the emission factor is the stoichiometric ratio reflecting the amount of CO_2 released upon calcinations of the carbonate. The emission factor uncertainty was estimated at ±5%.

The uncertainty of activity data is greater than the uncertainty of emission factor and is estimated at ±10%. The uncertainty of activity data took into account the uncertainty associated with weighting and proportioning the carbonates in clay and the uncertainty associated with the assumption of a default breakdown of limestone and dolomite of 85%/15%.

4.2.7.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.2.7.5. Source-specific recalculations

No source-specific recalculations have been done.

4.2.7.6. Source-specific planned improvements

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

Table 4.6. Activity data and emission factors for bricks, roof tiles and lightweight gravel production

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Limestone consumption, kt																						
2.A.7.2a																						
Bricks	23.48	23.86	12.08	0.06	5.61	4.18	4.14	2.67	2.48	5.13	2.27	3.7	3.5	4.31	4.62	3.86	5.33	10.15	8.66	1.78	3.09	3.77
Roof tiles	NO	NO	NO	NO	NO	NO	NO	0.56	0.27	0.28	0.43	0.85	0.89	0.88	0.79	0.95	0.72	0.99	0.77	0.38	NO	NO
2.A.7.2b																						
Lightweight gravel	NO	NO	NO	NO	NO	NO	NO	NO	8.29	8.55	9.46	11.44	11.16	13.4	14.18	12.65	14.87	11.89	8.84	NO	NO	NO
Dolomite consumption, kt																						
2.A.7.2a																						
Bricks	4.14	4.21	2.13	0.01	0.99	0.74	0.73	0.47	0.44	0.9	0.4	0.65	0.62	0.76	0.81	0.68	0.94	1.79	1.53	0.31	0.54	0.67
Roof tiles	NO	NO	NO	NO	NO	NO	NO	0.1	0.05	0.05	0.08	0.15	0.16	0.16	0.14	0.17	0.13	0.17	0.14	0.07	NO	NO
2.A.7.2b																						
Lightweight gravel	NO	NO	NO	NO	NO	NO	NO	NO	2.3	2.5	3.8	5.16	5.21	5.5	5.57	4.83	6.82	5.21	4.01	NO	NO	NO
$EF_{limestone}$, t/t	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
$EF_{dolomite}$, t/t	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477	0.477

4.3. Chemical Industry (CRF 2.B)

4.3.1. Ammonia Production

4.3.1.1. Source category description

This category of the inventory includes the non-fuel emissions from ammonia production (Table 4.7). In Estonia there is only one ammonia production company – Nitrofert AS.

CO_2 emissions from ammonia production have decreased considerably since 1990, having the lowest values in 1993, 2002 and 2009. The decrease in the emissions during early 1990's was caused by the transition from planned economy to a market economy after 1991 when Estonia became independent. This led to decrease in industrial production, and to an overall decrease in emissions from industrial processes between 1991 and 1993. In 1994 the economy began to recover and production started to increase, emissions stabilized till 2002 and 2003, when there was sudden decrease in emissions. In 2002 and 2003 there were reconstructions in Nitrofert AS that strongly affected production. The lowest point in production and also in emissions was in 2009. In 2009, Nitrofert AS temporarily stopped production at the beginning of February. In 2010–2011, there was no production of ammonia in Estonia.

4.3.1.2. 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 Estonia part of the CO_2 from ammonia production is used as a raw material for urea (carbamide) production and part of it is sold to food companies. This carbon will be stored only for a short time and therefore those emissions are also taken into account.

Methods

There are two different methods in the IPCC 1996 Guideline (Workbook page 2.14) for calculation of CO_2 emissions from ammonia production: Tier 1a and Tier 1b method. Estonia uses method Tier 1a in calculating CO_2 emissions from ammonia production (Annex 3, Table A.3.2_1).

According to the Tier 1a method:

$$\text{Emissions, kg} = \text{Consumption of gas (m}^3\text{)} \cdot \text{carbon content of gas (kg/m}^3\text{)} \cdot 44/12$$

where carbon content of natural gas is plant specific.

Emission factors

Emission factors were calculated by dividing CO_2 emissions from technological process with amount of ammonia produced. As activity data is received directly from plant and emissions are calculated based on amount of natural gas used and carbon content of gas provided by industry, the emission factors for calculations of CO_2 emissions from ammonia production are plant specific throughout time series. In Estonia, ammonia production emission factors are, depending on the year, between 1.243–1.446 t CO_2/tonne NH_3 produced (Table 4.7).

Activity data

The annual ammonia production figures 1990–2011 have been obtained from the production plants and presented in Table 4.7.

4.3.1.3. Uncertainties and time-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

Since the activity data was prepared in cooperation with manufacturer, the rate of emissions is considered sufficiently precise. The activity data uncertainty was estimated at ±5% and emission factors uncertainty at ±10%.

4.3.1.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.3.1.5. Source-specific recalculations

No source-specific recalculations have been done.

4.3.1.6. Source-specific planned improvements

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

Table 4.7. Activity data, emission factors and CO_2 emissions from ammonia production in 1990–2011

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
2.B.1																						
Ammonia production, kt	294	270	140	55	180	201	203	206	211	199	177	183	47	98	202	213	211	202	209	23	NO	NO
$EF_{ammonia}$, t/t	1.43	1.45	1.43	1.43	1.44	1.39	1.33	1.28	1.27	1.29	1.31	1.36	1.35	1.39	1.24	1.28	1.28	1.29	1.29	1.31	NO	NO
CO_2 from ammonia production, Gg	420	391	200	79	259	280	269	264	267	258	231	248	64	137	251	272	272	260	271	30	NO	NO
including																						
CO_2 for carbamide production, Gg	140	130	68	26	82	90	83	67	50	65	61	63	39	54	98	150	157	155	147	15	NO	NO
CO_2 sold for food industry, Gg	2.75	2.68	1.37	0.23	0.45	1.66	1.76	2.14	2.32	2.64	4.16	6.83	1.89	3.2	6.05	6.05	7.07	7.10	7.77	1.05	NO	NO

4.4. Other Production (CRF 2.D)

4.4.1. Source category description

This source category includes the NMVOC emissions from the pulp and paper (2.D.1) and food (2.D.2) industries. In addition, NO_x, CO and SO_2 emissions from pulp and paper are reported under Other consumption. The non-fuel based CO_2 emissions 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.

4.4.2. Methodological issues

NMVOC emissions from the pulp and paper and food industry are calculated by Estonian Environmental Research Centre. Activity data of the years 1990–1994 is obtained from the annual proceeding of Statistics Estonia ‘Industry’ and of the years 1995–2011 from the electronic database on the website 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.

4.4.3. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.4.4. Source-specific recalculations

NMVOC emissions from food and drink were corrected for the years 1990 and 2010. The recalculations in 1990 and 2010 were due to corrections in food and drink production data. Every year Statistics Estonia gives out initial data and they have a practice to correct statistical data for previous years.

4.4.5. Source-specific planned improvements

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

4.5. Consumption of Halocarbons and SF_6 (CRF 2.F)

In 2011, greenhouse gas emissions under the category CRF 2.F emissions of Consumption of Halocarbons and SF_6 amounted to 161.19 Gg CO_2 equivalent, which is about 0.77% of the total greenhouse gas emissions in Estonia.

Under this category, Estonia reports HFC emissions from all refrigeration and air-conditioning equipment (CRF 2.F.1), HFC emissions from foam blowing and use of HFC-containing foam products (CRF 2.F.2), HFC emissions from fire extinguishers (CRF 2.F.3), HFC emissions from aerosols (CRF 2.F.4) and SF_6 emissions from electrical and other electrical equipment (CRF 2.F.8 and 2.F.9).

The consumption of Halocarbons and SF_6 in Estonia depends on import. F-gases are imported either in bulk by trade or industry for domestic productive consumption (manufacturing) – filling of newly manufactured products, refilling of equipment – or in imported preliminary and final products respective equipment already filled with F-gases.

The total emissions of F-gases have increased significantly since 1993 (see Table 4.8 and Figure 4.3), especially HFC emissions from refrigeration and air-conditioning equipment, which is the major source of halocarbons in Estonia (see Figure 4.4). The second largest source is foam blowing which shows relatively steady increase of emissions throughout the years, except 2 major decreases (in 2003 one of two big Estonian producers of One Component Foam replaced HFC-134a with HFC-152a, followed by the other producer starting from 2007. Due to much lower GWP of HFC-152a the emissions decreased suddenly in the corresponding years). All remaining sources are comparatively small emitters of fluorinated greenhouse gases.

Table 4.8. Actual emissions of HFCs, PFCs and SF_6, 1990–2011 (CO_2 equivalent Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
HFCs	NO	NO	16	18	21	25	31	36	46	56	70	85	87	92	105	118	135	149	131	138	153	159
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.07	0.06	0.04	NO	NO	NO
SF_6	NO	0.05	0.09	1.45	3.11	3.22	3.49	2.99	2.99	3.01	2.73	1.74	1.44	1.33	1.08	1.08	1.15	0.97	1.35	1.44	1.81	1.82
Total	**NO**	**0.05**	**16.02**	**19.51**	**23.78**	**28.59**	**34.08**	**39.37**	**48.91**	**58.66**	**72.27**	**87.21**	**87.95**	**93.25**	**105.70**	**119.24**	**136.54**	**150.01**	**132.70**	**139.59**	**154.38**	**161.19**

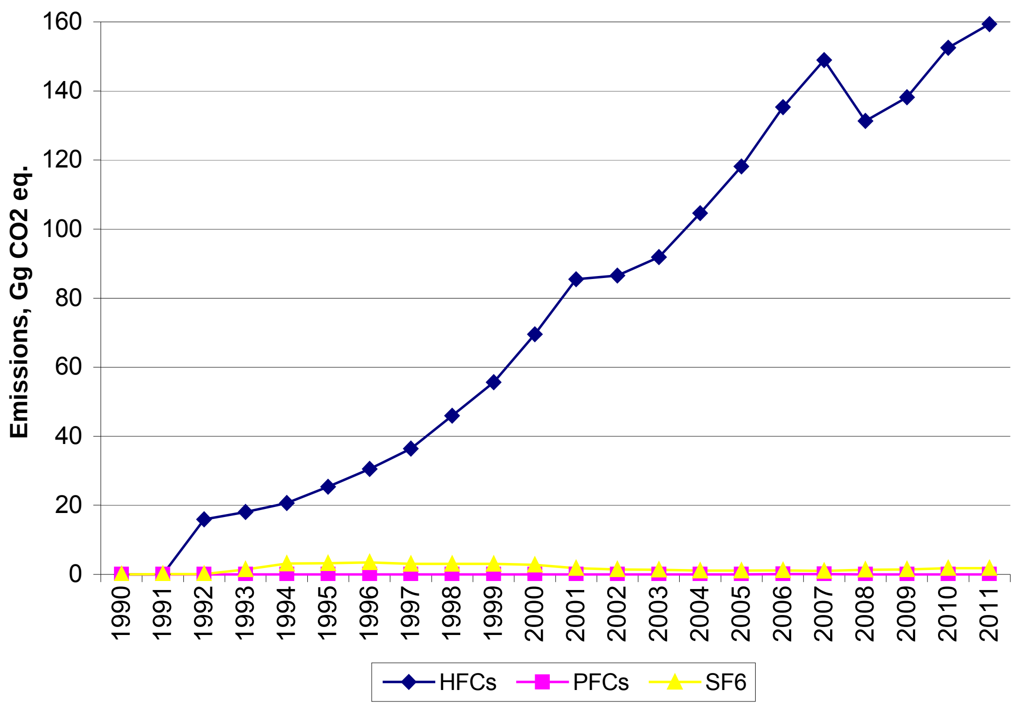


Figure 4.3. Actual emissions of HFCs, PFCs and SF_6, 1990–2011 (Gg CO_2 equivalent)

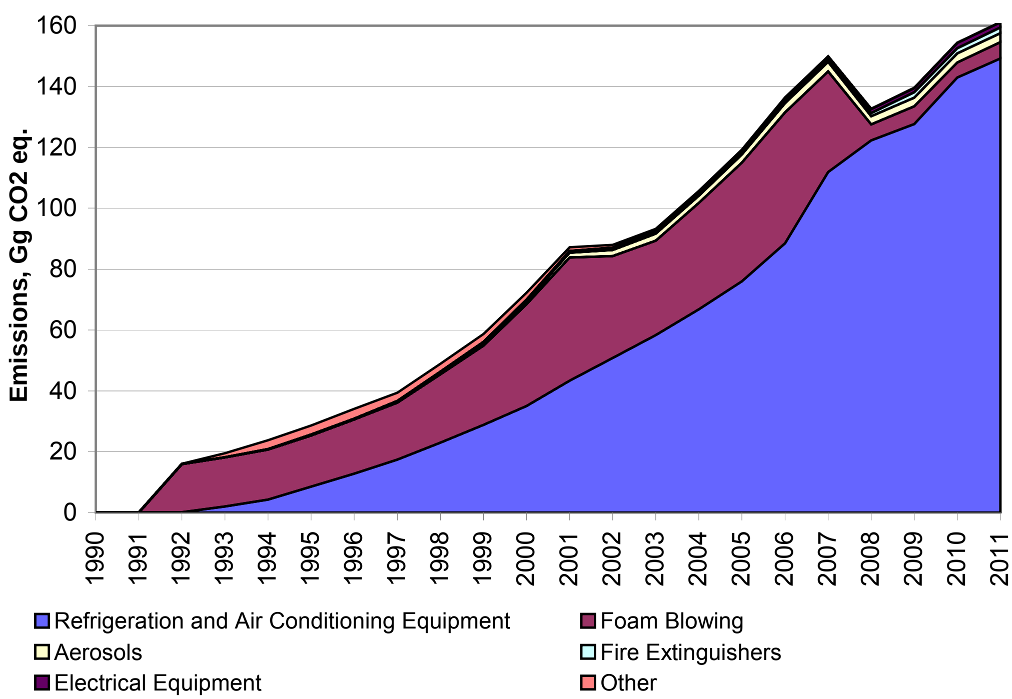


Figure 4.4. Actual emissions of F-gases by subcategory, 1990–2011 (Gg CO_2 equivalent)

In 2006, the first assessment of F-gas consumption in Estonia based on results from the Twinning Project EE2005/IB/EN/01 'Enhancing the capacity to reduce the emissions of fluorinated greenhouse gases in Estonia' (Twinning project between the Estonian Ministry of Environment and the German Ministry for the Environment, Nature Conservation and Nuclear Safety) was made. Within the project all sectors of possible F-gas consumption as described in the IPCC Guidelines for National Greenhouse Gas Inventories (2006 edition) were investigated. Experts had to start from zero with emissions estimation from Consumption of Halocarbons and SF_6. IPCC 2006 methodology was selected for Estonia due to it was appropriate with regard to the Estonian situation and the possibilities to get basic data. IPCC 2006 Guidelines have been also chosen as they reflect the most recently available knowledge on F-gases and the 2006 Guidelines allow for more complex modelling approaches, particularly at higher tiers[7].

The research has been bottom-up orientated. Manufacturers of and traders with F-gas containing goods, domestic and international suppliers of the Estonian market as well as consumers of such goods in industry and tertiary sector and the F-gas trade itself are the main sources of information, including experts from domestic and international companies, from associations, from academia and from public institutions (e.g. statistical office, car register, ship register etc.). Data collection and examination of data quality is carried out in a direct contact with the sources including visits at companies, factories etc. By this activity data, emission factors and emissions are determined methodologically as far as possible in a country specific way (Tier 2a and Tier 3 according to IPCC guidelines 2006).

Quality control of activity data, emission factors and data on measured emissions was made by the data collecting experts from the Estonian Environmental Research Centre.

4.5.1. Refrigeration and Air-Conditioning Equipment

Refrigeration and Air-Conditioning Equipment are responsible for about 92.59% of the Estonian F-gas emissions (149.25 Gg CO_2 equivalents). The big sub sectors are:

a) Domestic Refrigeration (fridges and freezers for domestic use),
b) Commercial Refrigeration (refrigeration units for supermarkets and smaller shops, restaurants etc.),
c) Transport Refrigeration (refrigerated vehicles and reefer containers),
d) Industrial Refrigeration (refrigeration units in the food and other industries),
e) Stationary Air-Conditioning (heat pumps and room air-conditioning systems),
f) Mobile Air-Conditioning (AC systems for passenger cars, trucks, buses, ships, railcars, wheel tractors/mobile machinery).

[7] Justification of the use of the methodology described in the 2006 IPCC Guidelines was included as the recommendation of the UNFCCC review team.

4.5.1.1. Domestic Refrigeration

4.5.1.1.1. Source category description

Refrigerators (fridges and freezers) for domestic use are not manufactured in Estonia but were imported from 1993–2009 (new and second hand). To some degree HFC-134a is used as refrigerant and as foam insulating gas. HFC-134a as refrigerant was introduced by industry at the end of 1993 as replacement for CFC-12. In the following years, its replacement by R-600A (isobutane) started in some countries (Germany) but not in all countries in Europe and North-America. According to Estonian experts there was no import of domestic refrigerators with refrigerant HFC-134a in 2011. The share of HFC-134a in the Estonian stock of fridges/freezers is estimated 12.5% (without new equipment in 2007–2011).

4.5.1.1.2. Methodological issues

In 2011 Estonia had – according to the statistical office – about 585 100 households. The number of domestic refrigerators is estimated at 576 323 and the number of newly imported fridges/freezers in 2011 is estimated at 50 650 (data from importers and EES Ringlus [Estonian Association for Recycling of Electrical and Electronic Equipment]). The share of fridges/freezers with HFC-134a in the stock is estimated by Estonian experts at 36 971 (12.5% without new equipment in 2007–2011) à 150 g HFC-134a refrigerant, in total 5 546 kg HFC-134a. In newly imported/bought systems in 2007–2009 – annually 172 265 units – some 1% contains HFC-134a, in total 258 kg HFC-134a. Lifetime of domestic refrigeration equipment in Estonia is calculated by industry at not less than 15 years.

Emission factors: EES Ringlus has reported in previous years that about 5% of fridges collected for recycling contained HFC-134a as refrigerant. In 2011, EES Ringlus estimated that about 6% of the original charge has already emitted by the time that fridges are collected for recycling. The annual operating emission rate is, following this information, 0.4%/year (EF_{op}). This country specific emission factor is within the value range given by IPCC guidelines, 0.1–0.5% (IPCC 2006, table 7.9, page 7.52 and IPCC 2000, table 3.22, page 3.106).

The number of refrigerators decommissioned per annum can be calculated (based on 15 years lifetime) at 35 045 from which 12 427 are collected by the recycling companies and sent for treatment to foreign countries; remaining 22 618 are disposed without refrigerant recovery. According to EES Ringlus experts estimates, this number in reality is not as high and could be maximum 13 000 units. If we assume (i) that 5% of these 13 000 non-collected refrigerators contain R-134a, and (ii) that in each of them 94% of the original 150 gram charge is left (6% already emitted), the disposal HFC-134a emissions are 91.65 kg ($EF_{disposal}$ = 100%).

Method according to IPCC guidelines 2006: Tier 2a with country specific EF.

- Country specific average refrigerant charge per unit: 150 g R-134a
- Country specific operating emission factor: 0.4%

The total 2011 amount of R-134a emissions is 0.11 tons (stock emissions: 23.22 kg, end-of-life emissions: 91.65 kg) representing 0.149 Gg CO_2 equivalent.

4.5.1.1.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts according to approach 1 of the 2006 IPCC Guidelines.

The data are based on direct information from industry, so that the UN of the activity data on the number of units (stock, annual importation, annual decommissioning) can be estimated to be relatively low (± 10%). The UN of the emission factor is assessed ± ~10%, so that the combined UN of the emissions (operating and disposal) is estimated to be ± 15%.

4.5.1.1.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.1.1.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.1.1.6. Source-specific planned improvements

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

4.5.1.2. Commercial Refrigeration

4.5.1.2.1. Source category description

Commercial refrigeration and its main sub sector, supermarkets, is one of the big application sectors of fluorinated refrigerants and emissions in Estonia. This category distinguishes between:

- Supermarkets and other food retail shops with mostly on-site assembled centralized systems; main HFC refrigerant: R-404A.
- Small shops and institutions with comparable refrigeration units (only one compressor and/or less than 15 kg refrigerant; this sub sector includes small shops with less than 3 kg refrigerant); HFC-refrigerants in use: mostly R-404A and R-134a.
- Refrigeration equipment for restaurants, hotels, pubs, canteens etc. (mostly small stand alone equipment for kitchens and cold rooms, 0.75 kg average refrigerant charge); HFC-refrigerants: 1/2 R-404A, 1/2 R-134a.
- Stand alone or plug-in equipment (mostly vending machines for shops, filling stations etc., on average 250 g R-134a/device).

The commercial refrigeration sector is dominated by the refrigerants R-404A, which make 91% of the 2011 HFC stock (mostly used in supermarket systems) and R-134a (about 8.3%, mainly used in vending machines, small shops and restaurants). Other HFC refrigerants (R-407C, R-410A, the R-152a containing mixture R-401A or the R-125 and R-134a containing mixture R-422A etc.) are only of less importance.

Estonian refrigeration equipment in general is quite modern because the change from the formerly so called open market system to the present-day supermarket system occurred during the last 15 years. The biggest sector with older equipment including second hand cabinets is the small shop sector.

The 2011 number of food retail supermarkets in Estonia – hypermarkets, supermarkets, discounters, department stores – was according to the Estonian Traders Association about 600, the number of small commercial and public customer orientated service institutions with refrigeration equipment (like small shops, medical institutions, hotels, restaurants, canteens etc.) according to other statistical sources more than 10 000. This includes according to expert calculation from refrigeration service companies about 7 000 small shops with less than 3 kg refrigerant charge plus about 4 000 hotels, bars, restaurants, pubs, canteens etc. with 0.75 kg refrigerants on average. The number of vending machines for cooling of beverages and other goods (stand alone equipment) was calculated at about 15 000 units.

4.5.1.2.2. Methodological issues

Supermarkets: The refrigeration systems of supermarkets are maintained by specialised service companies. Most of them install and service the systems, some are specialised on service activities. Service companies provided the activity data (stock, new installations in 2011, refilling data) on the HFC refrigerant consumption of their clients in the supermarket sector. The 2011 stock data compilation from the service companies (61.7 tons HFC) had to be completed in two cases by the assessment of the stock (additional 3.8 tons or 5.8% of the sum of 65.5 tons). This assessment was based on the refilling data. In this case the amount of HFC used for refilling is estimated to be in the order of 10% of the stock. The assessment is conservative and low with the aim not to overestimate the stock (the country specific emission rate EF_{op} is calculated higher [15%], see below).

According to Estonian experts the service companies covered – in terms of quantity of refrigerants – 90% of the supermarket HFC consumption. Thus 10% was added resulting in a total amount of 72.029 tons of HFC for the 2011 stock of supermarkets.

Small shops: Service companies submitted activity data about smaller shops. In one case the stock data had to be estimated by the inventory compilers (same method as with the supermarkets, based on a low refilling ratio of 10%). In this sub sector also a 10% surcharge was added (677 kg) resulting in a total stock of 7.445 tons HFC.

Restaurants etc.: The companies installing and servicing refrigeration equipment for restaurants, canteens and similar institutions did not provide stock data. The respective stock was estimated based on a number of 4 000 possible clients with on average 0.75 kg refrigerant quantity resulting in about 3 tons HFC-refrigerant. The percentage of R-134a is estimated by Estonian experts at 47% (1.41 tons), the percentage of R-404A with 47% (1.41 tons). Other HFC refrigerants (R-422A and R-422D) are only of less importance

The number of vending machines in Estonia (15 000 à 250 g refrigerant) was extrapolated on basis of data from the two biggest manufacturers of beer and other beverages delivering such machines to Estonian shops. The HFC-charge amounts to 3.84 tons R-134a.

The lifetime of refrigeration systems for supermarkets and small shops including kitchen systems in Estonia is according to experts from the mentioned companies on average about 15 years (vending machines shorter, 5–10 years). As 1993 was the starting point of using HFC-134a in commercial refrigeration, based on 15 years lifetime, first decommissioning emissions occurred in 2008. The amount of HFC-134a filled in new equipment in 1996 was decommissioned according to 15 years lifetime in 2011.

Emissions: The service companies were asked for 2011 stock data and refilling data of their clients. In 2011, more detailed research of refilling ratios was carried out in the supermarket sub sector. Seven service companies provided complete stock and refilling data with total refilling ratio 12.4%. When all companies are considered, amongst them also such ones without refilling data and incomplete stock, refilling ratio in commercial refrigeration sector is 11.5%. Complete 2011 stock (17.495 tons of HFC-404A) and refilling data was available about five supermarket chain systems – refilling ratio 14.2%.

Normally emissions are higher than the refilling ratio. A certain fraction of emissions is never replenished by refilling. Therefore an EF_{op} of 15% is applied to all sectors covering emissions from operating and servicing, except vending machines. The vending machines in Estonian market are modern and should be very tight; the emission rate EF_{op} is estimated at 1.5%/year. These emission factors are in the range of the IPCC guidelines 2006 (10–35% for medium and large commercial refrigeration and 1–15% for standalone commercial refrigeration)[8].

The EF_{manu} (filling of new equipment) is estimated at a low value of 0.5%, which is likewise in accordance with the IPCC Guidelines 2006 and IPCC Good Practice Guidance (IPCC 2006, table 7.9, page 7.52 and IPCC 2000, table 3.22, page 3.106). The EF_{disp} (disposal loss factor) is estimated at a value of 50%.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country specific EF_{manu} (filling): 0.5%.
- Country specific operating emission factor EF_{op}: 15% (vending machines: 1.5%)
- Country specific disposal emission factor EF_{disp}: 50%.

The total quantity of HFC filled into new commercial refrigeration equipment in 2011 amounts to 4.832 tons (4.527 tons R-404A and 0.305 tons R-134a). The manufacturing emissions from this filling are 24 kg. The HFC stock amounts to 86.307 tons (78.449 tons R-404A, 7.143 tons R-134a and small amounts of R-407C, R-410A, the R-152a containing mixture R-401A and the R-125 and R-134a containing mixture R-422A and R-422D). The stock emissions are in total 12.428 tons. The biggest part of them is HFC-404A (11.767 tons) and HFC-134a (0.553 tons), the emissions of the other HFC are only 0.108 tons. Amount of HFC-404A and HFC-134a filled in new equipment in 1996 was decommissioned according to 15 years lifetime in 2011. The amount of fluid remained at products at decommissioning amounts to 3.707 tons of HFC-404A and 0.633 tons of HFC-134a. The disposal emissions are in total 2.17 tons (1.853 tons of HFC-404A and 0.316 tons of HFC-134a).

The CO_2 equivalent of all 2011 HFC emissions is 45.780 Gg (45 780 tons).

8 Information about the development of the PLF for commercial refrigeration was included as the recommendation of the UNFCCC review team.

4.5.1.2.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. The combination of the individual uncertainties follows the approach 1 of the 2006 IPCC Guidelines.

The UN of the three activity data 'Filled in new manufactured products', 'HFC stock in operating systems' and 'Remained in products at decommissioning' is estimated ± 20% (0.2). The combination of this value with the respective emission factors (± 10%) results in the UN of manufacturing, operating and disposal HFC emissions of ± ~22%.

4.5.1.2.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.1.2.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.1.2.6. Source-specific planned improvements

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

4.5.1.3. Transport Refrigeration

4.5.1.3.1. Refrigerated Vehicles

Source category description

By 31.12.2011, 1 026 refrigerated vans and trucks and 1 151 refrigerated trailers were registered in Estonia. Most of these vehicles are second hand vehicles imported from Western Europe. Approximately half the refrigeration units fitted to the imported second-hand trucks and trailers are empty and are charged with refrigerant within the country. Only a small number of new vans are fitted with refrigeration units first in Estonia, and as a consequence, first-filled in the country. The refrigerants in use are R-134a in case of vans and smaller trucks, and the blend R-404A in case of bigger trucks and of trailers.

Methodological issues

The Estonian Motor Vehicle Registration Centre provided a list of all refrigerated vehicles registered at the end of 2011, subdivided in weight classes (N1, N2, and N3 according to 2001/16/EC), makes, models and production years dating back to 1995 and beyond.

Information on the types of refrigeration units of the Estonian vehicles, the HFC-types they are charged with, the refrigerant charges, the emissions and the frequency of refilling based on findings of the 2006/2007 investigation (information provided by the two biggest service companies for refrigerated vehicles, both linked to the leading international manufacturers of refrigeration units for trucks and trailers).

Investigation was conducted in attempt to improve the estimation on the number of the second hand vehicles with empty refrigeration units. It concluded that there is no better data available.

The share of older refrigeration units with non-HFC-refrigerants was estimated max. 7%. Vans and smaller trucks (class N1 and half of class N2 according to 2001/16/EC) run R-134a systems (average charge 2.0 kg/unit), bigger trucks (half of class N2 and the class N3) run R-404A systems (average charge 5.8 kg/unit). For trailers an average charge of 8.0 kg R-404A is supposed.

The Estonian experts estimate the emissions at first domestic filling (empty units of imported new and second-hand vehicles) at 1%, which is in accordance with the IPCC Guidelines 2006 (IPCC 2006, table 7.9, page 7.52) and IPCC Good Practice Guidance (IPCC 2000, table 3.22, page 3.106). These emissions are equated to the CRF emission category 'emissions from manufacturing'. The annual losses from the operating systems (emissions from stocks) including service emissions on refilling amount to average 30% (EF_{op} – operating emission factor) of the refrigerant stock in the refrigerated vehicles. This country specific emission factor is within the value range given by IPCC guidelines (IPCC 2006, table 7.9, page 7.52) and IPCC Good Practice Guidance (IPCC 2000, table 3.22, page 3.106).

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country-specific average refrigerant charges per unit: weight classes N1 and half N2: 2 kg; N3 and half weight class N2: 5.8 kg; trailers: 8.0 kg
- Country-specific manufacturing emission factor: 1%
- Country-specific operating emission factor: 30%
- Country-specific disposal emission factor: 30%.

The total 2011 quantity of HFCs filled in empty units of refrigerated vehicles in Estonia amounts to 48 kg R-134a and 771.8 kg R-404A, the 'manufacturing' emissions on these first fills are 0.48 kg R-134a and 7.72 kg 404A. The HFC stock in refrigerated vehicles amounts to 792 kg R-134a and 15 159 kg R-404A; the stock emissions are 237.6 kg R-134a and 4 547.6 kg R-404A. The amount of fluid remained at products at decommissioning amounts to 171.6 kg of R-404A and 150.2 kg of R-134a. The disposal emissions are 45.1 kg R-134a and 51.5 kg R-404A. The lifetime for refrigerated vehicles is according to experts about 10 years. According to product lifetime of 10 years, first decommissioning emissions of R-134a and R-404A occurred in 2003.

The CO_2 equivalent of all 2011 HFC emissions is about 15.4 Gg.

Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. The combination of the individual uncertainties follows the approach 1 of the 2006 IPCC Guidelines.

The UN of the two activity data 'First fill of empty systems' and 'HFC stock in operating vehicles' is estimated ± 8.5%, which is the combination of the individual UN of a) total registrations (new or operating) by weight categories in 2009 (± 1%), b) refrigerant charges (± 6%) and c) refrigerant split into R-134a and R-404A (± 6%).

The combination of the UN of new fill or of stock (± 8.5%) with the UN of the respective emission factors (± 5%) results in the UN of both manufacturing and operating HFC emissions of ± 10%.

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

Decommissioning emissions were recalculated for the years 2003–2010. According to product lifetime of 10 years for refrigerated vehicles, first decommissioning emissions occured in 2003.

Source-specific planned improvements

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

4.5.1.3.2. Reefer Containers

Source category description

Reefer containers are being transported on sea ships around the world, and HFC emissions from their refrigeration systems do not occur inside a particular country. As a consequence, it is plausible to attribute the emissions of the worldwide reefer container fleet to a particular nation according to the share of this country in world trade. Estonia's share in the world trade amounted according to the Statistical Office to 0.1% (0.09%), so that it is responsible of 0.09% of HFC stock and HFC emissions of the worldwide reefer container fleet.

Methodological issues

The starting point of the estimation is not country-specific but worldwide data. As this data for the 1995–2006 period was already available in the German F-gas inventory, own research on worldwide HFC stock and emissions was not necessary. Only the share of Estonia in the world trade had to be identified.

The worldwide HFC stock (German F-gas inventory) was estimated in three steps:

1. Annual number of 20 feet units (new manufactured, decommissioned, total stock).
2. Refrigerant charge per set (6 kg of 134a or 4 kg of 404A).
3. HFC-split between R-134a and R-404a (80% to 20%).

The emissions of R-134a and R-404A are calculated by means of emission factors. The operating emission factor is 10% (UNEP, 2002). The disposal emission factor is 30%, which lies at the upper boundary of the range given in IPCC Good Practice Guidance. (Manufacturing emissions are not distributed by world trade shares but are estimated in the (few) countries of container manufacturing).

Information about the 2011 share of Estonia in the world trade (both export and import) was given by Statistics Estonia.

Data on the worldwide reefer production are annually published by the information service *World Cargo News*.

Method according to IPCC Guidelines 2006: Tier 2a with international default EF.

The 2011 HFC stock emissions from reefer containers attributable to Estonia are 439.78 kg R-134a and 83 kg R-404A. The 2011 emissions from the decommissioning of reefer containers attributable to Estonia are 79.7 kg R-134a. The total is 964.8 t CO_2 equivalent or 0.96 Gg CO_2 equivalent. The lifetime for reefer containers is according to experts about 14 years. According to product lifetime of 14 years, first decommissioning emissions of R-134a occurred in 2007 and R-404A in 2011.

Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. The combination of the individual uncertainties follows the approach 1 of the 2006 IPCC Guidelines.

The UN of the basic activity data ‘worldwide HFC stock’ is the same as in the German inventory: ± 8.4%, which is the combination of the individual UN of a) number of units (± 3%), b) HFC-charges (± 5%), c) HFC-split (± 6%).

The UN of the Estonia share in world trade is estimated ± 3%, and the UN of the operating emission factor ± 5%. The combined UN of the HFC emissions (both 134a and 404A) can be calculated ± 10%.

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

No source-specific recalculations have been done.

Source-specific planned improvements

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

4.5.1.4. Industrial Refrigeration

4.5.1.4.1. Source category description

Industrial refrigeration is a big application sector of fluorinated greenhouse gases, mainly of HFC R-404A. The dominant application is the food industry (fish, meat, dairy, beverage industries, breweries, etc), which is Estonia’s most important industrial sector. The food industry’s dynamic may be exemplified by the fact that its output has tripled in the 1995–2005 decade (Ministry of Economic Affairs and Communications, 2006). The HFC consumption of other industries (e.g. chemical industry) is comparably small.

In contrast to commercial refrigeration, in industrial refrigeration non-HFC/HCFC refrigerants – especially NH_3 – play a major role than HFC. With regard to the HFC stock R-404A is the prevailing refrigerant with about 91.5%. Other HFC refrigerants (R-134a, R-407C, R-507A, R-410A, the R-152a containing mixture R-401A or the R-125 and R-134a containing mixture R-422A etc.) are of minor importance.

The refrigeration systems are very often served by bigger service companies; however, self-maintenance and cooperation with smaller (locally based) service companies is of more importance than in the supermarket and food retail sector.

4.5.1.4.2. Methodological issues

Information on potential HFC users in the food and other industries was compiled in cooperation with experts from refrigeration service companies specialized on industrial application. Food industry's basic data can be found in the statistics of the Veterinary and Food Board (VTA; cf. www.vet.agri.ee) because companies wishing to handle foodstuff must be approved by the VTA. Approved enterprises: fish industry – about 80 plants with chilling/freezing equipment; meat industry – 100 plants; dairy industry – 30 plants.

Service companies provided the activity data (stock, new installations in 2011, refilling data) on the HFC refrigerant consumption of their industrial clients. In one case the service company could not report on stock data. This data had to be completed by our assessment. (The assessment is based on the refilling data provided by the service companies, and the stock is assumed to be 10 times higher than the annual refills; same method as with the supermarket sector.

In addition to the service companies, approx. seventy companies from the fish, meat, dairy, bakery, beverages and other food-industries, and from several non-food industries (including e.g. ice rinks) were directly interviewed by dedicated questionnaires about their HFC refrigerant consumption.

As the refrigerant stock based on the data from service companies and directly interviewed industry covers the total stock to a certain part only, the remaining stock had to be estimated by us in cooperation with national sector experts. The thus assessed percentage of HFC stock in industrial refrigeration is 15.6 tons or 28.5% of the total HFC stock (54.7 tons, reported and assessed).

The average lifetime of industrial refrigeration systems in Estonia is about 15 years or more, according to experts from the mentioned companies. As 1993 was the starting point of using HFC-134a in industrial refrigeration, based on 15 years lifetime, first decommissioning emissions occurred in 2008. The amount of HFC-404A and HFC-134a filled in new equipment in 1996 was decommissioned according to 15 years lifetime in 2011.

Emissions: The service companies and the industrial companies surveyed by questionnaires were asked for 2011 stock and refilling data. Complete stock and refilling data for HFC-404A are available for 31 individual companies in the fish, meat, milk and other industry, with an HFC-404A stock of 13.573 tons. Detailed research indicated that the refilling ratios of the individual companies range from 0 to 68%. The average refilling rate is 13.6%.

As in the case of commercial refrigeration the emission factor (EF_{op}) for the stock is country specific, i.e. is based on the average refilling ratio in the industry, with 14%. This emission factor is in the range of the IPCC 2006 Guidelines and IPCC Good Practice Guidance (7-25% of the stock).

The EF_{manu} (filling of new equipment) is estimated at a low value of 0.5%, which is likewise in accordance with the IPCC Guidelines 2006 and IPCC Good Practice Guidance. The EF_{disp} (disposal loss factor) is estimated at a value of 50%, which is higher than the range given in IPCC Good Practice Guidance, 10 to 20 percent.

Method according to IPCC Guidelines 2006: Tier 2a with country specific EF.

- Country specific EF_{manu} (filling): 0.5%.
- Country specific operating emission factor EF_{op}: 14%.
- Country specific disposal emission factor EF_{disp}: 50%.

The total quantity of HFCs filled into new industrial refrigeration equipment in 2011 amounts to 7.795 tons (4.025 tons HFC-143a, 3.43 tons HFC-125, 0.326 tons HFC-134a and 0.014 tons of HFC-32). The manufacturing emissions from filling are 38.977 kg. The HFC stock amounts to 54.692 tons (26.26 tons HFC-143a, 23.877 tons HFC-125, 3.993 tons HFC-134a, 0.549 tons HFC-32 and small amount of HFC-152a). The stock emissions total 7.657 tons. The biggest parts of them are HFC-143a (3.676 tons), HFC-125 (3.343 tons) and HFC-134a (0.559 tons); the emissions of the other HFCs are only 0.079 tons. Amount of HFC-404A and HFC-134a filled in new equipment in 1996 was decommissioned according to 15 years lifetime in 2011. The amount of fluid remained at products at decommissioning amounts to 3.12 tons of HFC-404A and 0.049 tons of HFC-134a. The disposal emissions are in total 1.585 tons (1.56 tons of HFC-404A and 0.02 tons of HFC-134a).

The CO_2 equivalent of all 2011 HFC emissions is 29.351 Gg (29 351 tons).

4.5.1.4.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. The combination of the individual uncertainties follows the approach 1 of the 2006 IPCC Guidelines.

The UN of the three activity data ‘Filled in new manufactured products’, ‘HFC stock in operating systems’ and ‘Remained in products at decommissioning’ is estimated ± >25% (26%). This high value mainly results from the high share of estimations in the determination of total HFC stock. The combination of this value with the UN of the respective emission factors (± 15%) results in the UN of emissions of ± 30%.

4.5.1.4.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.1.4.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.1.4.6. Source-specific planned improvements

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

4.5.1.5. Stationary Air-Conditioning

4.5.1.5.1. Heat Pumps

Source category description

The use of heat pumps with HFC refrigerants – ground and air heat pumps – started in Estonia in 1993. Ground heat pumps generally operate with HFC-407C, air heat pumps with HFC-410A. In general, heat pumps are imported to the country and already charged with refrigerant. Only a small number of ground heat pumps was manufactured and filled with refrigerant in Estonia itself.

Methodological issues

The leading experts of the Estonian Heat Pump Association provided information on heat pumps in Estonia. In order to avoid double counting, the classification of heat pumps on the one hand and stationary respective room air-conditioning systems on the other hand was discussed together with experts from the Estonian Refrigeration Association. According to the experts the stock of installed heat pumps in Estonia amounts to approx. 60 017 systems in 2011 (7 388 ground, 51 900 air and 729 other heat pumps), 11 096 of them were installed in 2011. According to the experts 20 ground and 55 air HP went for decommissioning in 2011. The average charge was estimated at 2.0 kg for ground (and other HP), 1.0 kg refrigerant for air HP. The discussion with Estonian experts resulted in emission factors for manufacturing (EF_{manu}) of 2.0%, which lies above the value range proposed in IPCC Guidelines 2006 and IPCC Good Practice Guidance (0.2–1%); for operating systems (EF_{op}) of 2.5%, which is in accordance with the IPCC Guidelines 2006 (IPCC 2006, table 7.9, page 7.52) and IPCC Good Practice Guidance (IPCC 2000, table 3.22, page 3.106). The disposal emission factor is 30.0%, which lies in the upper part of the range proposed in IPCC Good Practice Guidance (20–30%).

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country-specific EF_{manu}: 2%
- Country-specific EF_{op}: 2.5%
- Country-specific EF_{disp}: 30%.

The domestic consumption filled in new ground HP is 220 kg R-407C, the manufacturing emissions 4.4 kg R-407C. The 2011 operating stock amounts to 16 234 kg R-407C (ground and other HP) and 51 900 kg R-410A (air HP). The 2011 operating emissions total 405.85 kg R-407C and 1 297.5 kg R-410A. The amount of fluid remained in HP at decommissioning was 60 kg R-407C and 55 kg R-410A. The 2011 disposal emissions in total 18 kg R-407C and 16.5 kg R-410A.

All global warming emissions together amount to 2 919.945 t CO_2 equivalent (2.92 Gg).

Uncertainties and time-series consistency

Öko-Recherche experts assessed the emissions uncertainty (UN) pursuant to approach 1 of the 2006 IPCC Guidelines. The data on heat pumps are deemed precise because the relevant associations, companies and experts for heat pumps and refrigeration systems in Estonia, provided them.

The UN of the three activity data 'Filled in new manufactured products', 'HFC stock in operating systems' and 'Remained in products at decommissioning' is estimated at ± 9%. The emission factors are estimated ± 5%. The combination of the UN of the three activity data with the UN of the emission factors results in the UN of the HFC emissions of ± 10.3%.

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

No source-specific recalculations have been done.

Source-specific planned improvements

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

4.5.1.5.2. Stationary and Room Air-Conditioning

Source category description

Stationary and room air-conditioning systems including chillers, ventilation and split systems are generally imported. Split systems are imported with HFC charge, newly installed chillers and ventilation systems are first-filled inside the country. In these cases emissions from filling (manufacturing) have to be considered. Refrigerants in use for chillers are HFC-134a and the blend R-407C, for ventilation systems and split systems the blends R-407C and R-410A.

Methodological issues

The 2011 newly installed systems, the total 2011 equipment stock, the refrigerant charges by weight and HFC types, and the EF for domestic manufacturing and operating stock were determined in cooperation with the experts from the Estonian Refrigeration Association and companies (manufacturers, traders, service companies) belonging to this association. As mentioned in the heat pump section, the heat pumps on the one hand, and stationary and room air conditioning systems on the other hand were discussed together with the Estonian Heat Pump Association to avoid double counting. The interviews revealed for 2011 the following numbers of operating systems: 686 chillers, 4 590 ventilation systems and 32 000 split systems ('mini-splits'). The EF_{manu} (first filling loss) was established at 20g/system for chillers (0.019%) and 40g/system (factor: 0.24%) for ventilation systems, the EF_{op} (Product Life Factor) at 1% (chillers), 10.5% (ventilation systems) and 2% (split systems). Chillers and split systems are industrially manufactured and tighter than ventilation systems that are assembled on site. Although the emission factor of chillers estimated by the national experts is deemed too low compared with values discussed in other countries, there is currently no more reliable data available. Emissions factors of ventilation systems and split systems are in the range of the IPCC 2006 Guidelines (IPCC 2006, table 7.9, page 7.52). The country-specific emission factor used for disposal (EF_{disp}=30%), is higher than the range proposed in IPCC Good Practice Guidance (5–20%).

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country-specific EF_{manu}: 0.019% (chillers) and 0.24% (ventilation);
- Country-specific EF_{op}: 1% (chillers), 10.5% (ventilation) and 2% (split)
- Country-specific EF_{disp}: 30%.

The operating stock amounts to 93.772 t R-134a, 44.319 t R-32 and 46.245 t R-125. Operating emissions: 4.302 t R-134a, 2.599 t R-32, 2.748 t R-125. As 1995 was the starting point of using HFCs in stationary air-conditioning equipment, first decommissioning emissions occurred in 2010. The amount of fluid remained at products at decomissioning amounts to 2.077 t R-134a in 2011. Disposal emissions: 0.623 t R-134a.

All global warming emissions together amount to 15.804 Gg CO_2 equivalent (15 804 t CO_2 equivalent).

Uncertainties and time-series consistency

Öko-Recherche experts assessed the emissions uncertainty (UN) pursuant to approach 1 of the 2006 IPCC Guidelines. The relevant associations, companies and experts in Estonia very roughly estimated the data on stationary AC systems, especially on emission factors of split systems and chillers.

The UN of the activity data HFC consumption and stock is estimated at ± 15%. The UN of the ventilation emission factors is ± 10%. The UN of the EF for chillers and split systems are more uncertain (± 26%); they are supposed to be too low. The combination of the UN of stock/consumption with the UN of the (given) emission factors results in the UN of the HFC emissions of ± 30% (chillers, splits), and ± 18% (ventilation systems).

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

Activity data on split systems was corrected for years 1998–2010. Recalculation was made due to corrections in split systems data provided by Estonian Refrigeration Association.

Source-specific planned improvements

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

4.5.1.6. Mobile Air-Conditioning

4.5.1.6.1. Passenger Cars

Source category description

In 2011, there were about 574 015 passenger cars in traffic register of Estonia. In Western Europe systematic air-conditioning of passenger cars with the refrigerant HFC-134a had started in 1994. As 360 900 vehicles of the Estonian passenger cars have been manufactured from 1994 onwards approx. 66% the vehicles are potentially air-conditioned. Equipment of these younger vehicles with air-conditioners is high – reaching over 90% in most recent years. The relevant MAC properties (equipment quota, refrigerant charge, leakage rate) depend on car makes and models. The refrigerant charge of passenger car MAC systems ranges from 0.39 kg to 1.24 kg, the emission rate is estimated 10%.

Methodological issues

The Estonian Motor Vehicle Registration Centre provided a list of all passenger cars registered at the end of 2011, subdivided in production years (dating back to 1994 and beyond). No official data about air-conditioning were obtainable.

MAC data depends on specific car models. While making the 2006 investigation the experts were facing the problem that the essential information for the estimation of the HFC stock in the cars of Estonia was available only for the most recent registration year. Thus a model for estimating the MAC data for the registration years 1994–2005 was elaborated and applied. This model was based on the fact that the predominant origin of the Estonian cars is Western Europe (Germany is the biggest source of second hand cars in Estonia), suggesting the conjecture that the average MAC data of the Estonian car park does not significantly differ from the analogous West European figures. In order to validate this hypothesis the quantitative model composition of the Estonian registration year 2006 was compared with the quantitative 2006 model composition of the German car park. As a result it emerged that the Estonian average figures indeed only marginally deviate from the German ones.

This substantial congruence in the 2006 MAC figures made the assumption plausible that such congruence also exists for the previous and the next registration years. Consequently, the German average figures were applied to respective registration years in the Estonian car park. This approach allows that the individual Estonian registration years do not need to be divided into the numerous models they consist of. The Estonian MAC quotas are considered equal to the German MAC quotas, the Estonian MAC charges are considered 2% smaller than the analogous German charges.

The emissions from the refrigerant stock in the car park are estimated applying the leakage rate established in the 2003 EU study (Schwarz & Harnisch, 2003), which the authors of this study claim to be representative of EU countries.

Different types of vehicles have different product life factor (PLF). PLF for different types of vehicles (passenger cars, trucks, buses, ships, railcars, wheel tractors and mobile machinery) that have mobile air-conditioning is calculated as follows: actual emissions from stocks / amount of fluid in operating systems (average annual stocks) • 100. Total PLF for mobile air-conditioning category is calculated as follows: total actual emissions from stocks / total amount of fluid in operating systems (average annual stocks) • 100.[9]

Method according to IPCC Guidelines 2006: Tier 2a with Europe specific determination of EF.

- Country-specific average refrigerant charge: 619 grams.
- Emission factor: 10%, which is in accordance with the IPCC Guidelines 2006 (IPCC 2006, table 7.9, page 7.52) and IPCC Good Practice Guidance (IPCC 2000, table 3.23, page 3.110).
- MAC quotas: In the total fleet, the MAC quotas vary by the production years.

The total HFC-134a stock in passenger car MACs in Estonia amounts to 133 tons in the year 2011. The HFC-134a emissions from the Estonian passenger car fleet in 2011 total 13 334 kg (10%), the CO_2 equivalent of which is 17 334 tons.

The amount of HFC-134a in the passenger cars MACs disposed in 2011 was estimated 10 257 kg. Disposal emissions from the Estonian passenger car fleet in 2011 total 5 128 kg (EF=50%), the CO_2 equivalent of which is 6 667 tons.

The CO_2 equivalent of all 2011 HFC emissions is 24 001 tons (24 Gg).

Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. For the combination of individual uncertainties approach 1 of the 2006 IPCC Guidelines was applied.

The UN of the basic activity data 'HFC stock' is estimated ± 8.5%, which is the combination of the individual UN of a) total registrations in 2006 (± 1%), b) MAC quotas (± 6%), c) refrigerant charges (± 6%) – with most quotas and charges being taken from Germany.

The combination of the UN of the stock (± 8.5%) with the UN of the operating emission factors (± 5%) result in the UN of the HFC emissions of ± 10%.

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

No source-specific recalculations have been done.

Source-specific planned improvements

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

[9] Information about the development of the PLF for different types of vehicles that have mobile air conditioning was included as the recommendation of the UNFCCC review team.

4.5.1.6.2. Trucks

Source category description

In 2011, there were about 84 337 trucks of the weight classes (according to 2002/16/EC) N1, N2, and N3 in traffic register of Estonia, 60% of which are younger than 13 years. In Western Europe systematic air-conditioning of trucks with the refrigerant HFC-134a had started in 1994/95. As a consequence, more than of half Estonian trucks are potentially air-conditioned. Equipment of these younger vehicles with air-conditioners is relatively high – reaching 69% in case of N3 trucks. The relevant MAC properties (equipment quota, refrigerant charge, leakage rate) depend on truck makes and models. The refrigerant charge of truck MAC systems ranges from 0.82 kg to 1.2 kg, the emission rate is 10–15% depending on the weight class.

Methodological issues

The Estonian Motor Vehicle Registration Centre provided a list of all trucks registered at the end of 2011, subdivided in weight classes (N1, N2, and N3), makes, models and production years dating back to 1995 and beyond. No official data about air conditioning were available.

As the 2006 investigation results had showed congruence between Estonian and German passenger car fleets and their MAC data (based on the high share of imported used vehicles from Germany) the following approach was applied to establish necessary truck MAC data. The German F-gas inventory treats the MAC quotas and charges of certain vehicles (12 truck models altogether) as representatives of their respective weight classes and extrapolates their specific figures to the total N1, N2, and N3 trucks in the country. The same truck models as in Germany were identified in the Estonian truck park for each weight category (N1, N2, N3). The German MAC quotas and refrigerant charges of these representative models were applied to the same models in the Estonian truck fleet. The total values of N1, N2 and N3 trucks in Estonia result from extrapolation of the particular model values pursuant to the share that these models have in the total Estonian fleet, by the three different weight classes N1, N2 and N3.

Method according to IPCC Guidelines 2006: Tier 2a with Europe specific determination of EF.

- Country-specific average refrigerant charges: weight class N1: 0.82 kg; weight class N2: 1.0 kg; and weight class N3: 1.2 kg.
- Emission factors (Schwarz, 2007): weight class N1: 10%; weight classes N2 and N3: 15%, which are likewise in accordance with the IPCC Guidelines 2006 (IPCC 2006, table 7.9, page 7.52) and IPCC Good Practice Guidance (IPCC 2000, table 3.23, page 3.110).
- MAC quotas: In the total fleet, the MAC quotas vary by the production years.

The total HFC-134a stock in truck MACs in Estonia amounts to 22 544 kg in the year 2011. The HFC-134a emissions from the Estonian truck fleet in 2011 total 2 866 kg (12.71%), the CO_2 equivalent of which is 3 726 tons.

The amount of HFC-134a in the truck MACs disposed in 2011 was estimated 1 734 kg. Disposal emissions from the Estonian truck fleet in 2011 total 867.1 kg (EF=50%), the CO_2 equivalent of which is 1 127 tons.

The CO_2 equivalent of all 2011 HFC emissions is 4 853 tons (4.85 Gg).

Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. For the combination of individual uncertainties approach 1 of the 2006 IPCC Guidelines was applied.

The UN of the basic activity data 'HFC stock' is estimated ± 8.5%, which is the combination of the individual UN of a) total registrations by weight categories in 2006 (± 1%), b) MAC quotas (± 6%), c) refrigerant charges (± 6%) – with quotas and charges being taken from Germany.

The combination of the UN of the stock (± 8.5%) with the UN of the operating emission factors (± 5%) results in the UN of the HFC emissions of ± 10%.

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

No source-specific recalculations have been done.

Source-specific planned improvements

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

4.5.1.6.3. Buses

Source category description

In 2011, about 4 156 buses were operated in Estonia, 1 701 of which were less than 16 years old (built as of 1995). Equipment of these younger vehicles with air-conditioners is relatively high (approx. 67%). This is because most of them are second-hand vehicles from Western Europe where also most of the few new buses were manufactured. In Western Europe large-scale air-conditioning of buses with the refrigerant HFC-134a had started in 1995 and has reached a high level, now. The relevant MAC properties (equipment quota, refrigerant charge, leakage rate) depend on whether a bus is a city, intercity or a tourist bus. City buses can be subdivided into single and articulated buses; intercity and tourist buses are usually single vehicles, with a small part of tourist buses being double-deckers. The refrigerant charge of bus MAC systems is large, ranging from 7 kg to 20 kg, the emission rate is high mainly because of the up to 50 metres long refrigerant piping.

Methodological issues

The Estonian Motor Vehicle Registration Centre provided a list of all buses registered at the end of 2011 (M3 category), subdivided in makes, models and production years dating back to 1992 and beyond. Data on the city-intercity-tourist bus split were not included, nor are there official data available about air conditioning.

Several big national and local bus operators (TAK, Taisto, SEBE, Hansabuss, GoBus) were interviewed about the MAC data of their own fleet and of the countrywide bus fleet – resulting in two conclusions. Firstly, the shares of the three main bus types are even thirds of the total registrations. Secondly, the average Estonian data on quota, charge, and leakage (refills) largely match the data of Western Europe (Schwarz, 2007) in consequence of the extensive importation of second-hand vehicles from there. In addition, an essential quantity of air-conditioned buses turned out to be manufactured before 1995 so that the decision was made to shift the starting point for the reporting to the years 1992/1993.[10]

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country-specific average refrigerant charges: Single buses (city, intercity, tourist): 10 kg; articulated buses and double deckers: 18 kg.
- Country-specific emission factors: Single buses (city, intercity, tourist): 1.5 kg/a; Articulated buses and double deckers: 3 kg/a, which are likewise in accordance with the IPCC Guidelines 2006 (IPCC 2006, table 7.9, page 7.52) and IPCC Good Practice Guidance.
- MAC quotas: In the total fleet, the MAC quotas vary by the production years.

The total HFC-134a stock in bus MACs in Estonia amounts to 8 316 kg in the year 2011. The HFC-134a emissions from the Estonian bus fleet in 2011 total 1 257 kg (15.11%), the CO_2 equivalent of which is about 1 634 tons.

The amount of HFC-134a in the bus MACs disposed in 2011 was estimated 640 kg. Disposal emissions from the Estonian bus fleet in 2011 total 320 kg (EF=50%), the CO_2 equivalent of which is 416 tons.

The CO_2 equivalent of all 2011 HFC emissions is 2 050 tons (2.05 Gg).

Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. For the combination of individual uncertainties approach 1 of the 2006 IPCC Guidelines was applied.

The UN of the basic activity data 'HFC stock' is estimated ± 8.7%, which is the combination of the individual UN of a) total registrations in 2011 (± 1%), b) bus split (± 5%), c) MAC quota (± 5%), d) refrigerant charge (± 5%).

The combination of the UN of the stock (± 8.7%) with the UN of the operating emission factor (± 5%) results in the UN of the HFC emissions of ± 10%.

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

[10] It was believed that at least the newer of the 120 trolleybuses in Estonia are air-conditioned. This assumption turned out to be wrong. According to the only Estonian operator (TTTK) none of the vehicles is equipped with a MAC.

No source-specific recalculations have been done.

Source-specific planned improvements

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

4.5.1.6.4. Ships

Source category description

Usually, merchant ships >100 Gross Tonnage (GT) are equipped with air-conditioning systems and provision refrigeration, tugs with air-conditioning only, and fishing vessels >18 m with refrigeration. Ship air-conditioning with HFC started from 1996 onwards substituting HCFC-22. Refrigerants in use are HCFC-22, HFC-407C (mixture), HFC-404A (mixture), HFC-427A (mixture), HFC-407A (mixture) and HFC-134a as the new standard refrigerant (Schwarz & Rhiemeier, 2007). Other HFC refrigerants (HFC-507A, HFC-410A, HFC-422A, HFC-422D) are of minor importance. By far most HFC-refrigerants are used for air-conditioning (R-134a); only a small part is used for provision cooling (R-134a, R-404A, R-407C). The cooling and freezing systems of the Estonian deep-sea freezer trawlers operate without HFC (refrigerants: R-22 and ammonia).

Methodological issues

Ships under Estonian flag built in 2000 or later with GT 100 or more and fishing vessels >18 m are listed in the Estonian Ship Register (Estonian Maritime Authority). Data on AC and provision cooling systems of these ships were collected from the operating companies, additionally data on all ferries of the two relevant Estonian ferryboat companies – altogether 36 vessels. (The oldest ship with HFC air-conditioning and provision cooling was built in 1968.) The data on type of refrigerant, charge and refilling in 2011 were provided directly by the ship owners. The estimation of the stock emissions is based on direct measurement (refilling data 2011).

According to Estonian Maritime Administration tugboats >100 GT have no air-conditioning devices.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country-specific HFC refrigerant stock: 5 974 kg R-134a; 1 559 kg R-404A; 388 kg R-407C, 180 kg R-427A, 428 kg R-407A and 34 kg R-422A.
- Country-specific stock emissions (refills), EF = 30%, which is in accordance with the IPCC Good Practice Guidance: 1 792 kg R-134a; 468 kg R-404A; 116 kg R-407C, 54 kg R-427A, 128 kg R-407A and 10 kg R-422A.

The CO_2 equivalent of the stock emissions (all HFC together) is 4 395 tons (4.40 Gg).

Uncertainties and time-series consistency

The data on refills are reliable and complete. As a consequence, the uncertainty of the HFC emissions is nevertheless estimated ± 5%, considering that tugboats are not yet investigated.

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

Activity data in years 2008–2010 were recalculated due to more data about ship air-conditioning was available from Estonian ferryboat companies.

Source-specific planned improvements

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

4.5.1.6.5. Railcars

Source category description

In 2011, there were 24 railcars (restaurant cars, sleeping cars, passenger coaches) of the Estonian fleet equipped with a working air conditioner. All systems had been retrofitted from CFC-12, and the refrigerant in use until 2009 was R-401A. It is a blend containing 13% of HFC-152a by weight, in addition to R-22 (53%) and R-124 (34%); the latter are HCFCs and out of the scope of this report. Beginning from 2010 the refrigerant in use was R-134a.

The relevant MAC properties (refrigerant charge, leakage rate) do not depend on the type of the railcars. The refrigerant charge of railcar MAC systems ranges from 28 kg to 30 kg. The emission rate is high and the losses demand refilling after each arrival at the station in case of the long trips (10 to 17 hrs) between Estonia and Russia.

Methodological issues

Estonian Technical Surveillance Authority was contacted to establish the size of the countrywide fleet. For obtaining MAC data all three local rail operators involved in passenger transport (GoRail, Edelaraudtee, AS EVR Cargo) and one service company (Ühinenud Depood) were interviewed. The results revealed that there are 24 air-conditioned and regularly maintained railcars. Although usually MAC charges depend on the type of a railcar (dining cars and sleeping cars having much higher charges than coaches) it became evident that this rule does not apply in case of Estonia, the refrigerant charges of MAC systems being around 30 kg in all types of railcars. The refrigerant quantity refilled annually into the railcar stock amounts to 200 kg. This corresponds to the experience of local experts that the MAC systems release 20 grams of refrigerant per operating hour.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country-specific average refrigerant charges: 30 kg/a of R-134a.
- Country-specific emission factors: calculation based on annual losses of R-134a and the amount of refrigerant stock leads to the implied emission factor of 0.2778 for all types of railcars in 2011, which is in accordance with the IPCC Good Practice Guidance (IPCC 2000, table 3.23, page 3.110).

The total HFC-134a stock in railcar MACs in Estonia amounts to 720 kg in the year 2011. The HFC-134a emissions from the Estonian railcars in 2011 total 200 kg (27.78%), the CO_2 equivalent of which is 260 tons based on the GWP 1300 of HFC-134a (0.26 Gg).

Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. For the combination of individual uncertainties approach 1 of the 2006 IPCC Guidelines was applied.

The UN of the basic activity data 'HFC stock' is estimated ± 3%, which is the combination of the individual UN of a) number of operating vehicles with air conditioning in 2006 (± 0%), and b) refrigerant charges (± 3%).

The combination of the UN of the stock (± 3%) with the UN of the operating emission factors (± 5%) results in the UN of the HFC emissions of ± 5.8%.

Activity data uncertainty was corrected in uncertainty calculation table (Annex 7) due to entry mistake.

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

No source-specific recalculations have been done.

Source-specific planned improvements

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

4.5.1.6.6. Wheel Tractors and Mobile Machinery

Source category description

First agricultural machines (wheel tractors, combine harvesters) equipped with mobile air-conditioners on Estonian market were manufactured in 1997/1998. With regard to construction machines (excavators, loaders) and other mobile machinery (forestry vehicles, roadwork machines) this equipment appeared later, in 2000. In 2011, there were about 6 365 wheel tractors and mobile machinery in traffic register of Estonia. Thus only 15% of the operating agricultural machines, 32% of the construction machines, and 20% of the other mobile machines in use in Estonia are potentially air conditioned. Air-conditioning of these machines is rapidly growing. The equipment quota of the new agricultural machines has reached 75% in recent years. Among new construction and other mobile machines this quota is still lower (40%) but also increasing. The refrigerant in use is HFC-134a. The relevant MAC properties (equipment quota, refrigerant charge, leakage rate) depend on the type and purpose of a specific machine. The refrigerant charge of tractors and mobile machinery MAC systems ranges from 1.0 kg to 2.0 kg. The emission rate is high due to powerful vibration of these machines causing amongst others the connections in the MAC system to become loose.

Methodological issues

The Estonian Motor Vehicle Registration Centre provided a list of all wheel tractors and mobile machinery registered at the end of 2011. Official data about air-conditioning of the vehicles were not available.

The average charges and quotas of Estonian agricultural machines match the respective values of Western Europe. The authors of this report taking into account the particularities of the Estonian vehicle fleet estimated the amount of leakages and refills.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country-specific average refrigerant charges: wheel tractors, construction machines, forestry and roadwork machines 1.0 kg/a; combine harvesters: 1.6 kg/a.
- Country-specific emission factors: wheel tractors 20% (EF is in the range of the IPCC 2006 Guidelines and IPCC Good Practice Guidance); combine harvesters, construction machines, forestry and roadwork machines 25%, which is likewise in accordance with the IPCC Good Practice Guidance.
- MAC quotas: In the total fleet, the MAC quotas vary by the production years.

In 2011, the total HFC-134a stock in tractor and mobile machinery MACs in Estonia amounts to 11 269 kg. The HFC-134a emissions from the entire Estonian fleet total 2 389 kg (21.2%) the CO_2 equivalent of which is about 3 105 tons (3.105 Gg).

The amount of HFC-134a in the tractor/mobile machinery MACs disposed in 2011 was estimated 867 kg. Disposal emissions from the Estonian fleet in 2011 total 173 kg (EF=20%), the CO_2 equivalent of which is 225 tons.

The CO_2 equivalent of all 2011 HFC emissions is 3 331 tons (3.33 Gg).

Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. For the combination of individual uncertainties approach 1 of the 2006 IPCC Guidelines was applied.

The UN of the basic activity data ‘HFC stock’ is estimated ± 14.5% for every vehicle type, which is the combination of the individual UN of a) total registrations by vehicle types in 2006 (± 3%), b) MAC quotas (± 10%), c) refrigerant charges (± 10%).

The combination of the UN of the stock (± 14.5%) with the UN of the operating emission factors (± 10%) results in the UN of the HFC emissions of ± 17.6%.

Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

Source-specific recalculations

No source-specific recalculations have been done.

Source-specific planned improvements

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

4.5.2. Foam Blowing

4.5.2.1. PU Insulation Panels

4.5.2.1.1. Source category description

In 2011 HFC blown and containing insulation panels made of polyurethane rigid foam were neither manufactured nor used in Estonia; however, imported products had been applied for several years. In 2001, one Estonian company manufacturing PU sandwich panels (consisting of facings and a rigid polyurethane foam core) had substituted the blowing agent CFC directly by the water/CO_2 reaction. The only manufacturer of industrially prefabricated insulation panels for buildings (some type of sandwich element) combining PU spray foam with polystyrene changed in 2004 from the blowing agent HCFC-141b to CO_2/water and methyl formate. From 1998 onwards, a certain amount of PU sandwich elements manufactured with HFC-134a as blowing agent had been imported from abroad. Although the use of these products in Estonia stopped in 2006, the HFCs enclosed in the foam cells of these panels form a small bank that is a source of emissions in the long run.

4.5.2.1.2. Methodological issues

The present bank of HFC-134a as insulating gas in imported sandwich elements was assessed by a model (because the import/export data from the Estonian customs only indicate origin and total weight of sandwich elements without information on the insulating gases). The model is based on information from the Statistics Estonia (annual import of sandwich elements minus export), Estonian experts/importers (average quota of imported sandwich elements with PU-core 1998–2001: 15%, 2002–2006: 40%), and foreign manufacturers of sandwich elements (average quota of PU-foam with HFC-134a: 1998/99: 100%, 2000: 50%, 2001: 10%, 2002ff: 5%; PU core: 30% of the sandwich elements weight). As a result, the bank of HFC containing PU panels (about 760 t) in 2006 was estimated to contain approx. 230 tons PU with HFC-134a with the HFC-134a content in the foam-stock of 6.75%.[11]

The annual use-phase HFC-134a emissions from the bank (EF_{op}) are estimated according to experts from manufacturing companies at 0.5% (cf. UBA 2005: 142), which is likewise in accordance with the IPCC Guidelines 2006 (IPCC 2006, table 7.6, page 7.37) and IPCC Good Practice Guidance.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.
- Country specific EF_{op}: 0.5%.

[11] The panels are manufactured according to experts with 7,5% HFC-134a; after a first year loss (FYL) of 10% during and after manufacturing 6,75% of the blowing agent remain within the foam.

The 2011 Estonian HFC-134a bank in PU insulation panels amounts to 15 tons, the annual use-phase emissions are 0.075 tons (97.5 tons or 0.097 Gg CO_2 equivalent).

4.5.2.1.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. For the combination of individual uncertainties approach 1 of the 2006 IPCC Guidelines was applied.

The UN of the basic activity data 'HFC stock' is estimated at ± >10% because it is based on both official statistical data and expert judgment.

The combination of the UN of the stock (± >10%) with the UN of the operating emission factor (± 10%) results in the UN of the HFC emissions of ± 14%.

4.5.2.1.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.2.1.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.2.1.6. Source-specific planned improvements

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

4.5.2.2. Spray and Injection PU Foam

4.5.2.2.1. Source category description

This sector of on-site insulation with spray respectively injection foam blown with the new-developed HFC-365mfc (with HFC-227ea add-on to reduce the flammability) is small. However, there must not only use-phase emissions be considered but also emissions upon manufacturing until year 2008. The manufacturing emissions are relatively high because the foaming process is an open application. It should be mentioned that HFC-free (water based) PU spray foam systems are also in use, namely for in-site insulation of soil-laid heating pipes, up to some tons/year. In 2009–2011, there was no production of spray and injection PU foam in Estonia.

4.5.2.2.2. Methodological issues

In the EU, for on-site applied foam the hardly inflammable blowing agent HCFC-141b was no longer permitted as of 2004 at the latest. Difficulties with alternative blowing agents arose from two sides. On the one hand the application of HFC-365mfc is not trivial from a technical point of view. On the other hand the manufacturer of this fluid could not satisfy the demand for HFC-365mfc in 2004 because of problems in his production plant. As a consequence, in the EU the HCFC-141b was still in use after 2004 - according to PU system suppliers also in Estonia.

Until 2008, one company in Estonia used HFC-365mfc/HFC-227ea (in addition to a small amount of HFC-134a) as blowing agent for on-site applied PU foam. HFC quota in this mixture: HFC-365mfc = 93%, HFC-227ea = 7%.

According to chemical suppliers, the HFC content in the spray foam system before application is 7.5%. On application (manufacturing), a blowing agent loss (EF_{manu}) must be considered which includes two HFC fractions: one released directly upon application and another being released within one year after application. Both fractions together are called first year loss (FYL). The FYL amounts to 20%; 80% of the original blowing agent remain in the foam cells during the use-phase.[12] The product life factor (EF_{op}) is according to chemical suppliers 1%.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country specific EF_{manu}: 20%.
- Country specific EF_{op}: 1%.

In 2011 the stock constituted of 268.12 kg HFC-365mfc, 33.9 kg HFC-227ea and 30.82 kg HFC-134a. Stock emissions: 2.68 kg HFC-365mfc, 0.34 kg HFC-227ea and 0.3 kg HFC-134a, altogether 3.77 t CO_2 equivalent.

Total global warming emissions: 3.77 t CO_2 equivalent (0.0038 Gg).

4.5.2.2.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. The UN of the basic activity data 'HFC consumption' is estimated at ± >10% because it is based on sales data and expert judgment. The combination of the UN of the consumption (± >10%) with the UN of the manufacturing emission factor (FYL) of ± 10% results in the UN of the HFC emissions of ± 14%.

4.5.2.2.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.2.2.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.2.2.6. Source-specific planned improvements

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

4.5.2.3. PU Integral Skin Foam

4.5.2.3.1. Source category description

In Estonia the PU Integral Skin Foam production started in 2004 with HFC-365mfc which was introduced to the market in 2003. Beforehand, ozone-depleting HCFC-

[12] In contrast to the IPCC guidelines (2006, p. 7.35: FYL 10%), in this report an FYL of 20% is used (Krähling/Solvay 2002: 15% loss on manufacturing, 5% additional loss within the first year).

141b was used; it is no longer allowed from 2004 onwards. All blowing agent applied on manufacturing is supposed to emit to the atmosphere the same year. Until 2009, one company in Estonia used HFC-365mfc and HFC-227ea for manufacturing of a very small amount of PU integral skin products. In 2010–2011, PU Integral Skin Foam was neither manufactured nor used in Estonia.

4.5.2.3.2. Methodological issues

For manufacturing of PU integral skin foam small quantities (1–2%) of HFC are added as auxiliary blowing agent in order to improve product quality. As integral skin is open-cell foam, upon foaming the blowing agent is released almost completely within one year (according to the industrial foam system supplier, and UBA 2005, p. 144). The EF manu (First Year Loss) is 100%. This means methodologically that there is no need for estimating an HFC bank and operating emissions from this bank. Information on the consumption of HFC-365mfc was provided by the manufacturer of integral skin products in Estonia. The EF_{manu} is likewise in accordance with the IPCC Guidelines 2006 (IPCC 2006, page 7.33). IPCC Good Practice Guidance default emission factor is 95%, which is lower than country-specific emission factor.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country specific EF_{manu}: 100%.

4.5.2.3.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. The UN of the activity and emissions data 'HFC consumption' is estimated at only ± 3% because it is based on information of the only user.

4.5.2.3.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.2.3.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.2.3.6. Source-specific planned improvements

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

4.5.2.4. XPS Insulation Foam

4.5.2.4.1. Source category description

The 2006 basic research showed that XPS foam was not manufactured in Estonia whereas imported XPS board for thermal insulation was of some importance in the country. The European manufacturers have stepwise shifted from HCFC blowing agents to HFC-134a/152a and to CO_2. The main XPS suppliers to the Estonian market are using CO_2. One international manufacturer currently using both CO_2 and HFC-

134a blowing agents supplies the Estonian market from a Scandinavian factory with CO_2 blown foam. From 2001 to 2006, this company sold a considerable amount of HFC-134a containing XPS panels to Estonia where these panels were used. It is generally accepted that in case of HFC-134a some 27% of the blowing agent release to the atmosphere on manufacturing (EF_{manu} = 27%). As a consequence, 73% of the blowing agent remains in the panels as insulating cell gas, in the long term. Thus, in Estonia an HFC bank in the XPS board stock was considered as a source of domestic emissions.

4.5.2.4.2. Methodological issues

Seven international chemical companies gave data on the XPS foam market in Estonia. Based on this information, both the year-on-year growth in the domestic XPS-foam bank and the HFC content in the annual sales quantities were assessed for the 2001–2005 periods. From 12.5% (2001) a gradual decrease in the HFC-134a content to 0% (2006) was established, resulting in 5% HFC content of the final 2006 XPS stock (72 000 m^3 XPS, thereof 3,600 m^3 HFC-containing XPS). As the HFC quantity used for the production of one m^3 XPS foam is known (3.3 kg), the HFC bank was calculated from the volume of XPS sold to Estonia. A use-phase emission factor (EF_{op}) of 0.66% was applied to this long-term bank of enclosed HFC-134a. Country specific EF_{op} is lower than the value given in IPCC Good Practice Guidance, 0.75 %.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country specific EF_{op}: 0.66%.
- 2011 HFC-134a bank: 8.39 tons.
- 2011 use-phase emissions: 55.36 kg (0.66%) which is 71.97 t (0.072 Gg) CO_2 equivalent.

4.5.2.4.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts.

No official statistical data on the XPS board consumption in Estonia is available. Thus the annual sales and the current stock of XPS foam with HFC-134a had to be calculated with sector experts. The UN of the activity data ‘HFC stock’ is estimated at ± 20%. The uncertainty of the emission factor is estimated 10% so that the UN of the annual use-phase emissions is ± 22.36%.

4.5.2.4.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.2.4.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.2.4.6. Source-specific planned improvements

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

4.5.2.5. One Component PU Foam

4.5.2.5.1. Source category description

Estonia is amongst the four biggest EU countries manufacturing polyurethane one-component foam (OCF). To a considerable part, the propellant gases in the foam cans are HFCs (HFC-152a) that are added to halogen-free flammable gases. By far most of the domestically used fluorinated greenhouse gases (HFCs) are imported for filling million of OCF cans that are, on their part, predominantly exported, especially to Eastern Europe. There is, however, also a considerable domestic market for OCF, which is supplied by both domestic manufacturers and – to lesser degree – foreign companies. Due to the restrictions of the EU F-gas Regulation on the use of HFCs in OCF both Estonian producers, in 2008, have stopped producing OCF with HFC-134a as propellant, using HFC-152a instead. This has led to major decrease of the emissions (both manufacturing and stock emissions) in the Foam Blowing sector. In 2010–2011, one Estonian producer manufactured OCF with HFC-134a as propellant, but all products were located outside the EU markets.

4.5.2.5.2. Methodological issues

The following data was collected for emission estimation from manufacturing and use of OCF:

- Number of cans (in terms of 750 ml volume) with HFC as blowing agent manufactured in Estonia, average amount of HFC per can, emissions on filling;
- Number of OCF cans (in terms of 750 ml content) with HFC as blowing agent sold to the Estonian market, average amount of HFC propellant per can.

Information sources: The two Estonian companies manufacturing OCF within the country and selling OCF to the Estonian market. The share of foreign OCF companies selling to the Estonian market was also estimated. The EF_{manu} (0.55%) is based on information from the two domestic manufacturers and was compared to international data. As to the application of OCF, it is assumed that all HFC is emitted from the cans in the year of the OCF use. In contrast to the method of the IPCC Guidelines 2000 and 2006 but in accordance with other submissions under the UNFCCC it is assumed that all use-phase emissions occur in the year of sale (use and disposal occurring promptly after sale). The category ‘stock 2011’ is equated to the HFC content of OFC cans sold to the Estonian market and used in 2011. Hence only emissions from manufacturing and use (= stock) are entered in the CRF table, no emissions from disposal. Country specific EF_{manu} is 0.23% (HFC-134a), which is likewise in accordance with the IPCC Guidelines 2006 and IPCC Good Practice Guidance. EF_{op} is 100%, which is higher than the value given in IPCC Good Practice Guidance and IPCC Guidelines 2006 (95 %). The 2011 HFC-152a consumption was in total 1 115 t and HFC-134a consumption was 38.5 t.

Method according to IPCC Guidelines 2006: Tier 2a with country specific determination of EF.

- Country specific EF_{manu}: 0.55% (HFC-152a).

- Country specific EF_{manu}: 0.23% (HFC-134a).
- Country specific EF_{op}: 100%.
- Manufacturing emissions: 6.102 tons HFC-152a or 854.3 t CO_2 equivalent and 0.089 tons HFC-134a or 115 t CO_2 equivalent.
- Stock = use-phase emissions: 29.9 tons HFC-152a or 4 182 t CO_2 equivalent.

The HFC emissions from manufacturing and from stock total to 5 151.7 t or 5.15 Gg CO_2 equivalent.

4.5.2.5.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts. As the domestic and foreign manufacturers themselves provided all the relevant data, the data uncertainty is estimated low. The uncertainty of the annual HFC consumption and – consequently – use-phase emissions by quantity and HFC type is ± 15%. The same value applies to the manufacturing emissions.

4.5.2.5.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.2.5.5. Source-specific recalculations

In the 2013 Submission, HFC-152a emissions from one component PU foam were corrected for year 2010. Recalculation was made due to mistake in manufacturing loss data of one company. The differences between 2012 Submission emissions and 2013 Submission emissions from one component PU foam in 2010 are shown in Table 4.9.

Table 4.9. HFC-152a emissions from one component PU foam in 2012 Submission and in 2013 Submission

Year	Manufacturing loss in 2010, g (the 2012 submission)	Reported manufacturing emissions of HFC-152a, t (the 2012 submission)	Manufacturing loss in 2010, g (the 2013 submission)	Recalculated manufacturing emissions of HFC-152a, t (the 2013 submission)
2010	0.96	17.59	0.24	5.7596

In the 2013 Submission, HFC-134a emissions from one component PU foam were corrected for year 2010. Recalculation was made due to entry mistake in manufacturing emissions. The differences between 2012 Submission emissions and 2013 Submission emissions from one component PU foam in 2010 are shown in Table 4.9.

Table 4.9. HFC-134a emissions from one component PU foam in 2012 Submission and in 2013 Submission

Year	Reported manufacturing emissions of HFC-134a, t (the 2012 submission)	Recalculated manufacturing emissions of HFC-134a, t (the 2013 submission)
2010	0.75	0.075

4.5.2.5.6. Source-specific planned improvements

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

4.5.3. Fire Extinguishers

In Estonia different types of HFC are used for substituting halons in fire protection (flooding equipment): mostly HFC 227ea (FM-200), the mixture R-866 consisting of HFC-134a, HFC-125 and CO_2, and furthermore HFC-23. This group is responsible for about 1.16% of the Estonian F-gas emissions (1.87 Gg CO_2 equivalent).

4.5.3.1. Source category description

F-gases are more expensive than environmentally friendlier substances for fire fighting in indoor flooding systems (e.g. nitrogen, argon). The latter are characterized as overpressure gases. Compared to them, the advantage of F-gases is their lower pressure: The pressure of FM 200 (HFC 227ea) in the piping is about one fifth of the pressure of argon. This makes the F-gases suitable for flooding systems of smaller rooms where the higher pressure of e.g. argon could cause damages. F-gas consumption for fire fighting includes also its usage in military objects.

F-gases for fire fighting are imported to Estonia in closed cylinders. Installation is carried out by connecting the cylinder with the piping system. The cylinder has, according to the supplying companies, no valve outside but only inside so that a mistake upon installation (e.g. opening of the wrong valve) is hardly possible. In case of false alarm or fire the whole charge of the cylinder is blown out. Refilling in site does normally not take place. Emptied cylinders are replaced by full cylinders.

4.5.3.2. Methodological issues

Data on the amount of the three mentioned HFC-based fluids for fire protection in the 2011 stock was provided directly by seven companies dealing with fire protecting systems incl. maintenance and by one supplier of fire fighting agents who submitted the basic data (stock) of eight additional clients. According to experts from these companies no other players were active in this field. The first HFC installation dates back to 2000.

According to IPCC Guidelines 2006 the annual emissions from installed flooding systems are in the range of 2 ± 1 percent of the installed base. As there are no detailed indications on operating emissions from flooding systems in Estonia for a longer period, an EF_{op} of 2% is applied to the bank. Emissions upon filling/refilling (EF_{manu})

are not calculated. According to the long lifetime of flooding systems (15–20 years) and the possibilities of recovery we do not assume end-of-life emissions.

Method Tier 2a according to IPCC guidelines 2006, using IPCC default EF_{op}.

- Operating emission factor EF_{op}: 2%.

In Estonia, the total 2011 quantity of F-gases in installed fire fighting systems amounted to 28.85 t (22.29 t HFC-227ea, 1.88 t HFC-23 and 5.08 t R866, the latter containing 8% CO_2 in mixture with HFC-134a and HFC-125). The emissions from this stock are calculated 2 percent: 37.53 kg HFC-23, 10.17 kg HFC-125, 83.36 kg HFC-134a and 445.87 kg HFC-227ea. The CO_2 equivalent of all 2011 HFC emissions is about 1.87 Gg (1 869 tons).

4.5.3.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts according to approach 1 of the 2006 IPCC Guidelines.

The data are based on direct information from industry, so that the UN of the data on the different HFC stocks can be estimated comparably low (± 10%). The UN of the emission factor is assessed ± ~10%, so that the combined UN of the emissions is estimated ± 14%.

4.5.3.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.3.5. Source-specific recalculations

Activity data in years 2007–2010 were recalculated due to more data from companies dealing with fire protecting systems was available.

4.5.3.6. Source-specific planned improvements

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

4.5.4. Aerosols

4.5.4.1. Metered Dose Inhalers

4.5.4.1.1. Source category description

Under the category of Metered Dose Inhalers (MDI) with HFCs of pharmaceutical grade two aerosol applications are discussed: aerosols for natural medicine and aerosols for the treatment of asthma/COPD (chronic obstructive pulmonary diseases).

4.5.4.1.2. Methodological issues

The domestic manufacturer provided the data on manufacturing, domestic consumption and export of MDIs for natural drug products including the emissions rate from manufacturing (EF_{manu} = 3%). Use-phase emissions: The number of MDIs for both natural and anti-asthma drugs sold to the domestic market in 2011 (production + import - export) is the stock of the same year 2011. (A surcharge factor for hospitals and doctors' samples of 5% is applied.) As the consumption of the products follows the purchase immediately, annual stock and the annual emissions are the same size. HFC-134a is completely exhaled after inhalation so that 100% is the appropriate value for the use-phase emission factor, which is likewise in accordance with the IPCC Guidelines 2006 and IPCC Good Practice Guidance.

In 2011 MDIs (asthma/COPD) with HFC-134a as propellant were sold to Estonian market by eight companies. Sales figures on the various pharmaceutical products were provided by the Estonian Medical Board and information on HFC content per device was provided by respective companies.

Method according to IPCC guidelines 2006: Tier 2a with country specific EF.

- Country specific EF_{manu}: 3%.
- Country specific EF_{op}: 100%.
- Natural MDIs: The 2011 domestic consumption of HFC-134a was 0.96 tons (manufacturing emissions: 28.8 kg), of which 0.84 tons were sold to the domestic market, resulting in use-phase emissions of the same amount.
- Anti-Asthma MDIs: The 2011 domestic market was 1 397 kg, with the same quantity of emissions.
- Overall emissions: 2.261 tons HFC-134a or 2 939 tons CO_2 equivalent (2.94 Gg).

4.5.4.1.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts according to approach 1 of the 2006 IPCC Guidelines.

The data are based on direct information from manufacturers and from trade departments in industry, so that the activity data domestic production and domestic market are deemed highly reliable. As a consequence, the UN of the emissions (manufacturing and use-phase) is estimated ± 10%.

4.5.4.1.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.4.1.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.4.1.6. Source-specific planned improvements

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

4.5.4.2. General and Novelty Aerosols

4.5.4.2.1. Source category description

HFC-134a is used as propellant in some technical aerosols like solvent and cleaning sprays and in novelty aerosols such as signal horns for sport events or hunting. The signal horns were manufactured in Estonia, solvent and cleaning sprays with HFC-134a were imported.

4.5.4.2.2. Methodological issues

The Estonian manufacturer stopped producing signal horns in 2009. In 2010, the use of HFC-134a in solvent and cleaning sprays has stopped in Estonia due to the supplier exchange and changes in product prescription.

As in MDIs, the HFC-consumption for general aerosols in 2009 is equated to emission in the same year 2009 (EF_{op} 100%), which is in accordance with the IPCC Guidelines 2006 and IPCC Good Practice Guidance.

Method according to IPCC guidelines 2006: Tier 2a with country specific EF.

- Country specific EF_{op}: 100%.
- Country specific charge of aerosol cans: 12.9 g

4.5.4.2.3. Uncertainties and time-series consistency

The emissions uncertainty (UN) was assessed by the Öko-Recherche experts according to approach 1 of the 2006 IPCC Guidelines.

The data are based on direct information from industry, so that the UN of the activity data on the number of units and on charges can be estimated low (± 10%). The same UN value applies to the emissions because the emission factor is 100%.

4.5.4.2.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.4.2.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.4.2.6. Source-specific planned improvements

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

4.5.5. Electrical Equipment

4.5.5.1. Source category description

SF_6 is used as an arc quenching and insulating gas in high-voltage (110–380 kV) and medium-voltage (6–35 kV) switchgear (GIS) and control gear. In Estonia the use of SF_6 in this sector started in 1991 (high-voltage) and 1999 (medium-voltage), respectively. The equipment is not manufactured within the country. Medium-voltage GIS (distribution equipment) operate with low over-pressure and little gas quantities of only some kg/system. They are already SF_6 charged when imported and are hermetically closed ('sealed for life'). High-voltage GIS (transmission equipment) with a higher operating pressure (up to 7 bar) and bigger gas quantities ('closed for life') have to be replenished in their lifetime. They are imported with a transport filling and are filled up in site (on site erection).

4.5.5.2. Methodological issues

Estonian companies of electrical power distribution provided data on their equipment, on their SF_6 consumption in total and on refilling during the last year. The refilling data of the HV equipment reported from different power suppliers ranged from 0.1% to 0.7%/year. In case of MV-GIS no losses occurred according to the companies. The main operator of HV-GIS estimated the EF_{manu} (topping up of imported HV-GIS within the country) 0.1%. The EF_{op} of HV- and MV-GIS used in this report is based on the default emission factors of the IPCC Guidelines 2006 with 0.7% (high voltage) and 0.1% (medium voltage) per year, respectively.

Method according to IPCC guidelines 2006: Tier 3.

- Country specific EF_{manu} (manufacturing emission factor, on site erection): 0.1%.
- EF_{op} (according to IPCC GL): 0.7% (HV), 0.1% (MV).

Manufacturing emissions amount to 681 kg. The respective stock amounts to 9 765 kg (HV) and 4 138 kg (MV). Stock emissions: 68.36 kg (HV), 4.14 kg (MV). Total: 72.5 kg.

Total global warming emissions: 1 749 t CO_2 equivalent (1.75 Gg).

4.5.5.3. Uncertainties and time-series consistency

Öko-Recherche experts assessed the emissions uncertainty (UN) pursuant to approach 1 of the 2006 IPCC Guidelines. As the activity data are based on direct information from industry, their UN is estimated low: ± 3%. The UN of the default emission factors is ± 10% (IPCC GL 2006, Tier 3). The combined UN of the emissions is ± ~10.4%.

4.5.5.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.5.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.5.6. Source-specific planned improvements

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

4.5.6. Other

Under this category SF_6 emissions from radiotherapy devices are reported. This is very small category, which is responsible of about 0.04% Estonian F-gas emissions (0.067 Gg CO_2-equivalent).

PFC emissions from sport shoes with gas cushion occurred in Estonia from 2006 to 2008 and SF_6 emissions from 1994 to 2006. For more information, please read 2010 Submission inventory report.

Under this category SF_6 emissions from car tyres are reported. As a considerable part of the Estonian passenger cars are imported second hand vehicles from Germany, SF_6 in tyres came also to Estonia. In Estonia, SF_6 has never been filled into car tyres. The gas is assumed to be released completely to the atmosphere on disposal three years after the filling or one year after importation. SF_6 emissions from car tyres occurred in Estonia from 1993 to 2003.

Source-specific recalculations

The investigation over time series was made and amount of SF_6 in sport shoes (stock) was estimated for years 1991–1994. According to product lifetime of 3 years, first decommissioning emissions occurred in 1994.

The investigation over time series was made and amount of SF_6 in car tyres (stock) was estimated for years 1992–1994. Decommissioning emissions were recalculated for years 1993–2003. According to product lifetime of one year after importation, first decommissioning emissions occurred in 1993. Actual emissions from stocks were corrected for years 1995–2003. Recalculation was made due to only decommissioning emissions occurred in Estonia from car tyres and operating emissions during the use of car tyres are not considered.

4.5.6.1. Other Electrical Equipment

4.5.6.1.1. Source category description

Under 'Other Electrical Equipment' Estonia reports emissions of SF_6 from radiotherapy devices. Two hospitals in Estonia use SF_6 insulated radiotherapy equipment (oncology), in one hospital there are three devices. The three devices in one hospital are in same size, device in another hospital is in different size. Other applications – e.g. SF_6 insulated particle accelerators or gas impregnation of power capacitors – do not occur in Estonia.

4.5.6.1.2. Methodological issues

Data on charge and use-phase losses were directly submitted from the medical operator. The operator calculated the emission rate of the two operating systems at 10% a year (one in 2006 other in 2008 installed modern systems). In case of the smaller system the EF_{op} was calculated at 30% a year, bases on the operator's experience from the last similar devices. In 2011, new equipment in Tallinn with year loss 10%. The country specific EF_{op} deduced from this information is 10.4%.

Method according to IPCC guidelines 2006: Tier 2a with country specific EF.

- Country specific EF_{op}: 10.4%.

The 2011 stock of SF_6 totals 27.2 kg, the 2011 operating emissions 2.82 kg.

Global warming emissions: 67.398 t CO_2 equivalent (0.067 Gg).

4.5.6.1.3. Uncertainties and time-series consistency

The data are based on estimation of the operators. The emissions uncertainty is estimated ± 30%.

4.5.6.1.4. Source-specific QA/QC and verification

The data for this report was collected by the expert of Estonian Environmental Research Centre. A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Industrial Processes sector according to IPCC Tier 1 method.

4.5.6.1.5. Source-specific recalculations

No source-specific recalculations have been done.

4.5.6.1.6. Source-specific planned improvements

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

5. SOLVENT AND OTHER PRODUCT USE (CRF 3)

5.1. Overview of the sector

5.1.1. Description and quantitative overview

Emissions from Solvent and Other Product Use sector in Estonia are divided into following categories: Paint application (CRF 3.A), Degreasing and dry cleaning (CRF 3.B), Chemical products, manufacture and processing (CRF 3.C) and Other (CRF 3.D).

Under categories Paint application (CRF 3.A), Degreasing and dry cleaning (CRF 3.B), Chemical products, manufacture and processing (CRF 3.C) and Other (CRF 3.D.5) Estonia reports indirect greenhouse gas emissions (NMVOCs) and also indirect CO_2 emissions from NMVOC emissions (see Table 5.1). The compiling of NMVOC emission data from the solvent and other product use sector is performed at the Estonian Environment Information Centre. The NMVOC inventory is carried out to meet the obligations of the United Nations Economic Commission for Europe's Convention on Long-Range Transboundary Air Pollution (UNECE CLRTAP). Activity data used in the estimates are obtained from SE and from web-interface air emissions data system for the point sources (OSIS), that contains data reported by the facilities having pollution permit. In some sectors, also expert judgements have been used.

Under category Use of N_2O for Anaesthesia (CRF 3.D.1) Estonia reports N_2O emissions from the use of N_2O in medical and other applications. N_2O is also used as a propellant in aerosol products, emissions from this are reported under category N_2O from Aerosol Cans (CRF 3.D.3). N_2O is not used in fire extinguishers in Estonia.

Table 5.1. Reported emissions from Solvent and Other Product Use in Estonia in 2011

CRF	Source	Emissions	Method	Emission factor
3.A	Paint application	NMVOC, CO_2	Tier 1	D
3.B	Degreasing and dry cleaning	NMVOC, CO_2	Tier 1	D
3.C	Chemical products, manufacture and processing	NMVOC, CO_2	Tier 1	D
3.D	Other			
3.D.1	Use of N_2O for Anaesthesia	N_2O	Tier 2	CS
3.D.3	N_2O from Aerosol Cans	N_2O	Tier 2	CS
3.D.4	Other Use of N_2O	IE (3.D.1)		
3.D.5	Other			
	Printing industry	NMVOC, CO_2	Tier 1	D
	Domestic solvent use	NMVOC, CO_2	Tier 1	D
	Other product use	NMVOC, CO_2	Tier 1	D

Emissions from Solvent and Other Product Use contribute to 0.09% of the total anthropogenic greenhouse gas emissions in Estonia. The most important greenhouse gas emissions from solvent and other product use in Estonia are indirect CO_2 emissions from Paint application (CRF 3.A) and Other (CRF 3.D.5) with 29.86% and 28.19% of the total greenhouse gas emissions in solvent and other product use sector (see Table 5.2 and Figure 5.1).

Emissions from the solvent and other product use sector have decreased by 28.69% compared to the base year 1990. Two major categories where decrease of NMVOC emissions have occurred in later years are paint application (CRF 3.A) and other product use (CRF 3.D.5). The fluctuation of NMVOC emissions in the period 1990–2011 has occurred mostly due to the welfare of the economic state of the country. The decrease in the emissions between 1991 and 1993 was due to the economic crisis what was conditioned by the fall of the Soviet Union and the independence of the Estonian Republic. Between 1993 and 1998 the economic growth induced the growing usage of NMVOC containing paints in decorative and industrial coating application. At the end of 1998 the world was struck by the economic crisis, which affected the construction sector and as a consequence the usage of decorative coatings also. From 2001 the economy turned again into growth until in 2008 the world suffered the economic depression. Because of that, compared with the year 2007, the NMVOC emissions decreased 29.41% by the year 2011 (see Table 5.2).

Table 5.2. Emissions from solvent and other product use in 1990–2011 (Gg)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Indirect CO_2																						
Paint application	5.13	6.04	3.68	3.39	5.11	6.96	7.9	8.81	9.49	8.88	5.32	4.98	5.83	6.11	6.93	7.97	8.51	8.73	5.69	4.52	4.92	5.63
Degreasing and dry cleaning	2.64	2.6	2.55	2.5	2.54	2.6	2.83	2.7	2.64	2.69	2.62	2.52	2.58	2.55	2.55	2.54	2.61	2.53	2.5	2.27	2.29	2.32
Chemical products, manufacture and processing	1.09	1.35	0.44	0.3	0.3	0.55	0.43	0.42	0.68	0.48	0.24	0.25	0.33	0.28	0.4	0.28	0.35	0.58	0.69	1.09	0.36	0.69
Other	11.92	12.09	10.37	9.86	9.82	10.33	10.5	10.21	10.94	10.85	10.84	9.95	10.04	9.68	9.01	9.21	9.54	7.93	8.19	6.16	5.02	5.32
NMVOC																						
Paint application	2.33	2.75	1.67	1.54	2.32	3.16	3.59	4.01	4.31	4.04	2.42	2.26	2.65	2.78	3.15	3.62	3.87	3.97	2.59	2.06	2.23	2.56
Degreasing and dry cleaning	1.2	1.18	1.16	1.14	1.15	1.18	1.29	1.23	1.2	1.22	1.19	1.14	1.17	1.16	1.16	1.16	1.19	1.15	1.14	1.03	1.04	1.05
Chemical products, manufacture and processing	0.5	0.62	0.2	0.13	0.14	0.25	0.2	0.19	0.31	0.22	0.11	0.11	0.15	0.13	0.18	0.13	0.16	0.26	0.31	0.50	0.16	0.31
Other	5.42	5.5	4.71	4.48	4.46	4.7	4.77	4.64	4.97	4.93	4.93	4.52	4.56	4.4	4.09	4.19	4.33	3.61	3.72	2.80	2.28	2.42
N_2O																						
Use of N_2O for Anaesthesia and Other Use of N_2O	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02
N_2O from Aerosol Cans[13]	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.01	0.01	0.01	0.01	0.03

[13] N_2O emissions from aerosol cans are presented in tons.

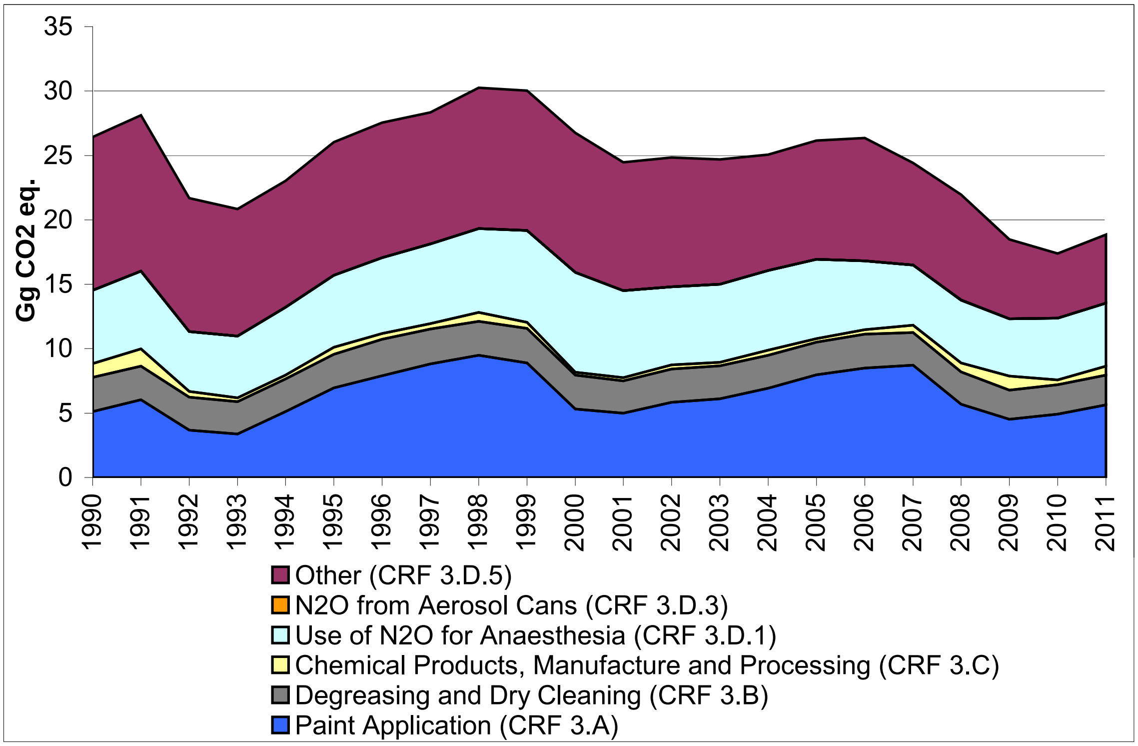


Figure 5.1. Emissions from Solvent and Other Product Use in Estonia in 1990–2011 (Gg CO_2 eq.)

5.2. Paint application (CRF 3.A), Degreasing and dry cleaning (CRF 3.B), Chemical products, manufacture and processing (CRF 3.C) and Other (CRF 3.D.5)

5.2.1. Source category description

Under categories Paint application (CRF 3.A), Degreasing and dry cleaning (CRF 3.B), Chemical products, manufacture and processing (CRF 3.C) and Other (CRF 3.D.5) Estonia reports indirect greenhouse gas emissions (NMVOCs) and also indirect CO_2 emissions from NMVOC emissions.

5.2.2. Methodological issues

Indirect CO_2 emissions from solvent and other product use were calculated using methodology from the IPCC 2006 Guidelines (Box 7.2, page 7.6). According to the method:

$$Emissions_{CO2} = Emissions_{NMVOC} \cdot \text{Percent carbon in NMVOCs by mass} \cdot 44/12$$

It was assumed that the average carbon content is 60% by mass for all categories under the sector of solvent and other products used according to the 2006 IPCC Guidelines.

5.2.3. Uncertainty and times-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The uncertainty of activity data is estimated at ±25% and the uncertainty of emission factor is estimated at ±10%. The uncertainty of emission factor took into account the fact that the default fossil carbon content fraction of NMVOC is 60 percent by mass, is based on limited published national analyses of the speciation profile, as described in the IPCC 2006 Guidelines.

5.2.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Solvent and Other Product Use sector according to IPCC Tier 1 method.

5.2.5. Source-specific recalculations

NMVOC and indirect CO_2 emissions from paint application, chemical products, manufacture and processing, printing industry and other product use were corrected for the years 2006–2010 and from degreasing and dry cleaning for the years 2006–2008, 2010. Recalculations were due to updates in activity data in databases of Statistics Estonia and corrections in SNAP (Selected Nomenclature of sources of Air Pollution) codes in OSIS. The difference in indirect CO_2 emissions between 2012 Submission and 2013 Submission is shown in Table 5.3.

Table 5.3. Indirect CO_2 emissions from solvent and other product use in 2012 Submission and in 2013 Submission (Gg)

CRF	Source	Year	the 2012 Submission	the 2013 Submission
3.A	Paint Application	2006	8.1509	8.5075
		2007	7.9423	8.7258
		2008	5.8116	5.6946
		2009	4.6766	4.5244
		2010	5.2298	4.9158
3.B	Degreasing and Dry Cleaning	2006	2.6104	2.6140
		2007	2.5169	2.5263
		2008	2.4972	2.4971
		2010	2.2879	2.2899
3.C	Chemical Products, Manufacture and Processing	2006	0.4983	0.3472
		2007	0.8455	0.5821
		2008	1.0302	0.6917
		2009	0.6392	1.0937
		2010	0.2959	0.3599
3.D.5	Other/Printing Industry	2006	1.4728	1.4659
		2007	0.8814	1.08
		2008	1.4820	1.6998

		2009	0.5046	0.5023
		2010	0.7781	0.7786
3.D.5	Other/Other Product Use	2006	6.1994	5.111
		2007	6.654	3.8995
		2008	3.5442	3.5362
		2009	2.7189	2.7117
		2010	1.3024	1.2904

5.2.6. Source-specific planned improvements

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

5.3. Use of N_2O for Anaesthesia (CRF 3.D.1), Other Use of N_2O (CRF 3.D.4) and N_2O from Aerosol Cans (CRF 3.D.3)

5.3.1. Source category description

Under category Use of N_2O for Anaesthesia (CRF 3.D.1) Estonia reports N_2O emissions from the use of N_2O in medical and other applications. N_2O emissions from aerosol cans are reported under category N_2O from Aerosol Cans (CRF 3.D.3).

5.3.2. Methodological issues

N_2O emissions from the categories Use of N_2O for Anaesthesia and N_2O from Aerosol Cans are calculated by Estonian Environmental Research Centre. N_2O emissions from N_2O used in medical and other applications are estimated taking into account the amount of N_2O sold to Estonian market. Activity data was collected directly from the companies importing N_2O for medical use and other applications to Estonia from 1992 to 2011. Activity data for 1991–1992 was estimated based on the surrogate data method. It was assumed that all N_2O sold to Estonian market in a year was used in the same year. According to the 2006 IPCC Guidelines (IPCC 2006, page 8.36), it is assumed that none of the administered N_2O is chemically changed by the body and therefore emission factor of 1.0 was applied.

N_2O containing aerosol cans are not produced in Estonia but imported and sold to Estonian market. Total quantity of N_2O supplied to Estonian market was obtained from distributors of N_2O products. From 2007–2011 aerosols with N_2O as propellant were sold to Estonian market by one company. Number of cans sold and N_2O content in each can was obtained from this company. According to the 2006 IPCC Guidelines (IPCC 2006, page 8.36), none of the N_2O is reacted during the process and all of the N_2O is emitted to the atmosphere resulting in the emissions factor of 1.0 for this source.

5.3.3. Uncertainty and times-series consistency

IPCC Tier 1 method was used in estimating the uncertainties of this category.

The data are based on direct information from companies importing N_2O to Estonia and selling it to Estonian market so that the uncertainty of activity data is estimated low: ± 5%. The uncertainty of emission factor is assumed to be extremely small and is estimated at ± 2%.

5.3.4. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Solvent and Other Product Use sector according to IPCC Tier 1 method.

5.3.5. Source-specific recalculations

N_2O emissions from N_2O used for Anaesthesia (CRF 3.D.1) were recalculated for years 1990–1991. Activity data on N_2O sold to Estonian market was available from companies importing N_2O for medical use and other applications to Estonia since 1992. N_2O emissions in 1990–1991 were reported as not occurring (NO). As there have been most probably import and usage of N_2O also in 1990 and 1991, emissions were estimated based on the surrogate data method.

N_2O emissions from Aerosol Cans (CRF 3.D.3) were recalculated for year 2010. Recalculation was made due to corrections in data received from company selling N_2O containing aerosols to Estonian market. The difference between 2012 Submission emissions and 2013 Submission emissions in 2010 is less than 0.001 Gg CO_2 eq.

5.3.6. Source-specific planned improvements

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

6. AGRICULTURE (CRF 4)

6.1. Description and quantitative overview

6.1.1. Overview of the sector

The total GHG emissions reported in the agricultural sector of Estonia were 1 270.52 Gg CO_2 eq in 2011. The sector contributed about 6.1%[14] to the total CO_2eq emissions in Estonia (Figure 6.1).

Estonia's agricultural GHG emissions consist of

- CH_4 emissions from enteric fermentation of domestic livestock (for 14 sub-categories of livestock),
- CH_4 end N_2O emissions from manure management systems,
- direct and indirect N_2O emissions from agricultural soils. Direct N_2O emissions include emissions from synthetic fertilizers, emissions from animal waste and sludge applied to agricultural soil, emissions from cropping of N-fixing crops and emissions from crop residues and cultivation of organic soils. Indirect N_2O emissions include emissions due to atmospheric deposition and leaching and run-off.

Enteric fermentation of livestock and direct emissions from agricultural soils were the highest contributors to the total emissions from the agricultural sector (Figure 6.1).

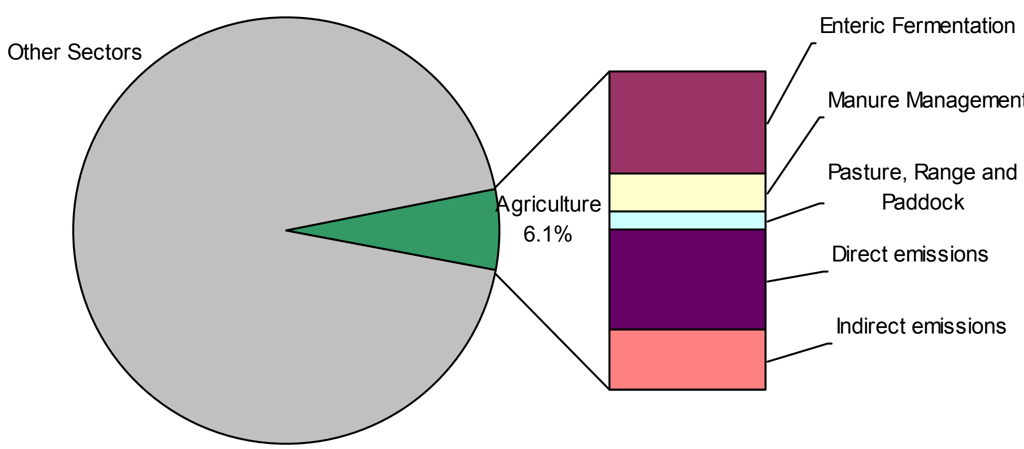


Figure 6.1. Emissions from agriculture compared to total CO_2 eq emissions in 2011, %

[14] GHG emissions related to LULUCF sector are not included.

CO_2 eq emissions from the agricultural sector declined 59.88% by 2011 compared with the base year (i.e., 1990), mostly due to decrease in livestock population and quantities of synthetic fertilizers and manure applied on agricultural fields (Figure 6.2, Table 6.1).

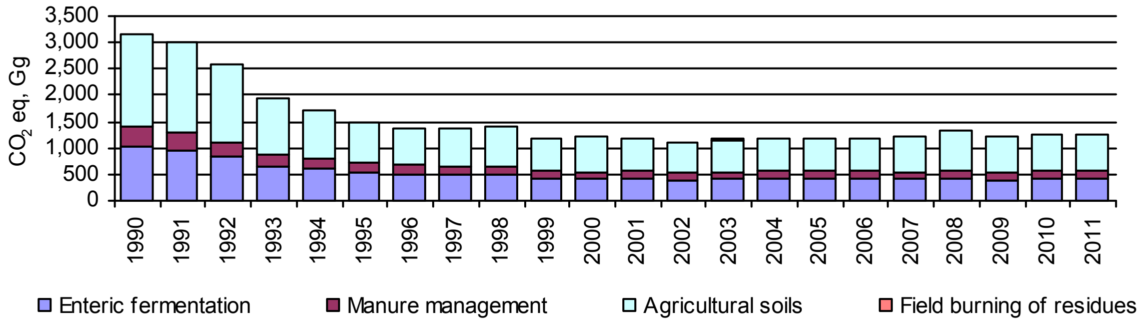


Figure 6.2. Trends in emissions by source categories in Estonia in 1990–2011, Gg CO_2eq

Table 6.1. Estonia's agricultural GHG emissions by sources in 1990–2011, Gg

Year	Enteric fermentation	Manure management		Agricultural soils		Field burning of agricultural residues		Total GHG emissions		Total CO_2 eq emissions
				Direct	Indirect					
	CH_4	CH_4	N_2O[15]	N_2O	N_2O	CH_4	N_2O	CH_4	N_2O	CO_2eq
1990	48.43	3.60	1.64	3.18	1.84	0.261	0.004	52.29	6.67	3 166.8
1991	45.38	3.25	1.54	3.09	1.76	0.250	0.004	48.89	6.39	3 007.9
1992	39.46	2.35	1.32	2.70	1.47	0.174	0.003	41.98	5.49	2 584.5
1993	31.18	1.88	1.05	2.04	0.95	0.213	0.003	33.27	4.05	1 954.1
1994	28.15	1.88	0.96	1.63	0.85	0.138	0.002	30.17	3.45	1 702.4
1995	24.88	1.76	0.85	1.41	0.71	0.144	0.002	26.78	2.97	1 483.7
1996	23.64	1.36	0.79	1.31	0.63	0.173	0.003	25.18	2.73	1 375.3
1997	23.39	1.40	0.78	1.28	0.68	0.179	0.003	24.97	2.74	1 372.8
1998	22.65	1.43	0.75	1.47	0.73	0.154	0.002	24.23	2.95	1 422.7
1999	19.53	1.24	0.64	1.18	0.61	0.112	0.002	20.88	2.43	1 190.9
2000	19.21	1.25	0.64	1.20	0.64	0.185	0.003	20.64	2.48	1 203.7
2001	19.90	1.38	0.66	1.11	0.62	0.149	0.002	21.43	2.38	1 188.8
2002	18.77	1.37	0.62	1.03	0.56	0.135	0.002	20.27	2.22	1 112.7
2003	19.12	1.70	0.60	1.09	0.65	0.130	0.002	20.96	2.33	1 163.6
2004	19.35	1.70	0.60	1.15	0.67	0.152	0.002	21.20	2.42	1 196.4
2005	19.49	1.76	0.59	1.13	0.61	0.193	0.003	21.44	2.32	1 170.8
2006	19.55	1.81	0.58	1.09	0.64	0.154	0.002	21.51	2.31	1 166.4
2007	19.23	1.95	0.56	1.23	0.67	-	-	21.18	2.47	1 209.3
2008	19.27	1.97	0.58	1.44	0.83	-	-	21.24	2.85	1 329.9
2009	18.99	2.03	0.57	1.26	0.71	-	-	21.02	2.55	1 230.6
2010	19.31	2.24	0.57	1.28	0.74	-	-	21.55	2.59	1 256.6
2011	19.56	2.16	0.58	1.29	0.76	-	-	21.72	2.63	1 270.5
%, 2011[16]	32.3	3.6	14.1	31.5	18.5	-	-	35.9	64.1	100.0

[15] N_2O emissions include N_2O emissions from Pasture, Range and Paddock category.
[16] % from the total CO_2 eq emissions, in CO_2 eq.

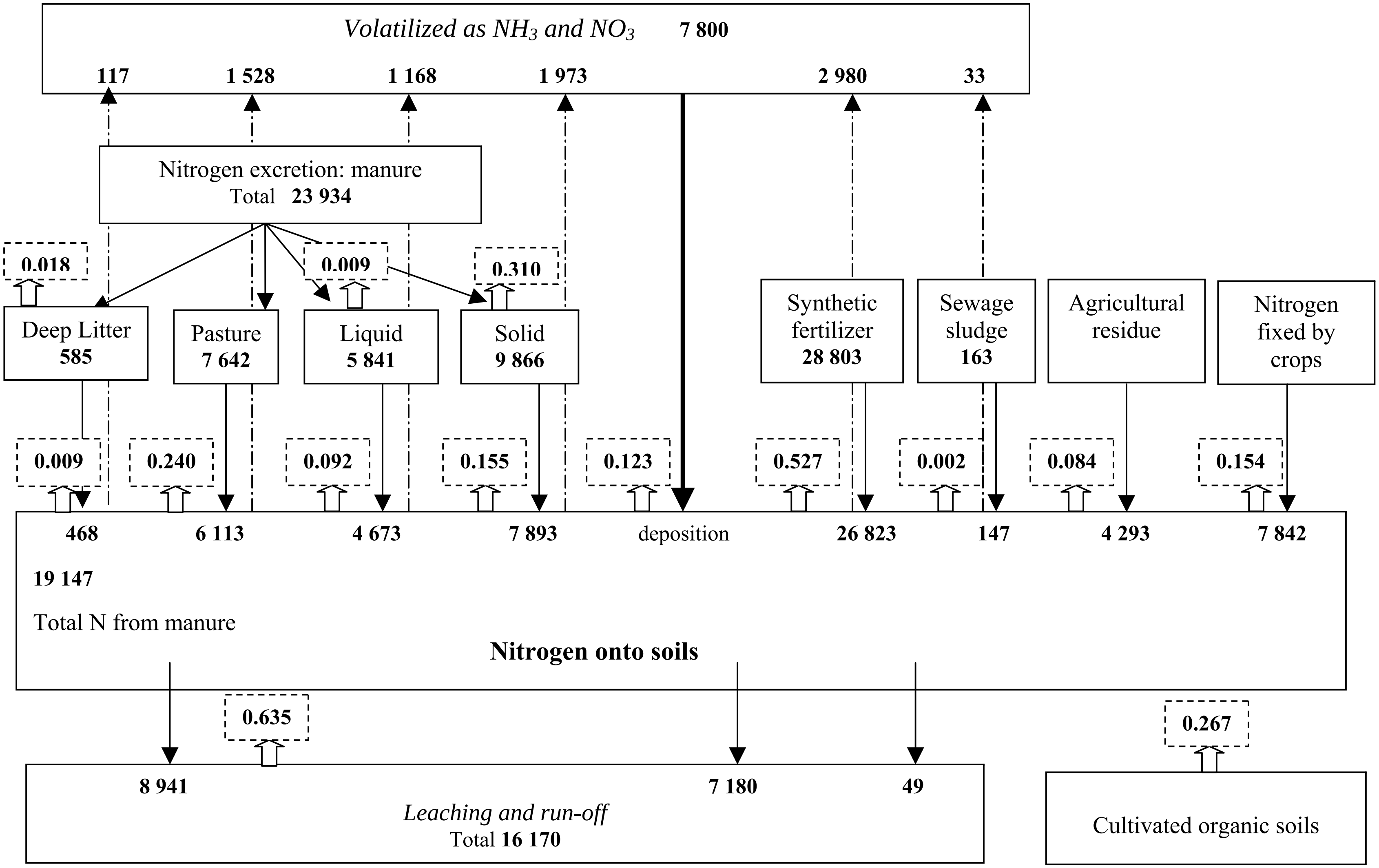


Figure 6.3. Nitrogen flow balance of Estonia's agriculture in 2011 (the scheme was adopted from Finland's NIR (2009))
(Bulk arrows stand for emissions, thin arrows for N flow. Nitrogen amounts are in Mg/year and emissions (fragmental line) in Gg/year)

Results of nitrogen balance of Estonia completed in the 2013 submission are presented in Figure 6.3. The total amount of nitrogen excreted with manure was 23 934 Mg in 2011; 20% of the total nitrogen volatilized as NH_3 and NO_3, the rest of the amount (19 147 Mg) entered into soils in 2011. Solid storage manure management system (MMS) was the main source of N_2O emissions from manure management of Estonia. Nitrogen contained in synthetic fertilizers applied on agricultural soils made up 28 803 MgN. Amounts of nitrogen contained in other sources, which were accounted under the agricultural sector, were noticeably lower than amounts of nitrogen excreted with manure and contained in fertilizers. The total amount of nitrogen that volatized as NH_3 and NO_3 was 7 800 Mg, N_2O emissions due to atmospheric deposition were 0.123 Gg; N2O emissions from nitrogen leaching and run-off were 0.635 Gg in Estonia.

6.2. Source category description and methodology

The *tier 1* and *tier 2* approaches were implemented to estimate GHG emissions from the agriculture sector in Estonia. A list of methods and emission factors employed in the estimates for each sub-category of the agriculture sector is presented in Table 6.2. Rice is not cultivated in Estonia. Savanna areas do not exist in Estonia.

Several recalculations were carried out to improve quality of the inventory in the following sub-sectors of the agriculture sector:

- Enteric fermentation (CRF 4.A);
- Manure management (CRF 4.B);
- Direct soil emissions (CRF 4.D.1);
- Pasture, range and paddock manure (CRF 4.D.2);
- Indirect soil emissions (4.D.3).

Table 6.2. Methods and emission factors used to estimate GHG emissions of the agriculture sector

	CH_4		N_2O		Key category	
	Method applied	Emission factor	Method applied	Emission factor	LULUCF sector is not included	LULUCF sector is included
4.A. Enteric Fermentation						
1. Cattle						
a. Cows, bulls and heifers (2 years and over)						
Dairy cattle	T2	D, CS			L	L, T
Non-dairy cattle					L, T(17)	L, T
…Mature females	T2	D, CS				
…Mature males	T2	D, CS				
b. Bovine animals (ages between 1 and 2 years)	T2	D, CS			L, T	L, T
c. Calves (6-12 months old)	T2	D, CS			L, T	L, T
d. Calves (0-6 months old)	T2	D, CS			L, T	L, T
2. Swine						

[17] Mature non-dairy cattle and young cattle were grouped and considered in the context 'Non-Dairy Cattle' category.

	CH_4		N_2O		Key category	
	Method applied	Emission factor	Method applied	Emission factor	LULUCF sector is not included	LULUCF sector is included
a. Piglets, live weight less than 20 kg	T2	D, CS				
b. Young pigs, live weight 20 - <50 kg	T2	D, CS				
c. Fattening pigs, live weight						
50 - <80 kg	T2	D, CS				
80 - <110 kg	T2	D, CS				
110 kg or more	T2	D, CS				
d. Breeding pigs, live weight 50 kg and more	T2	D, CS				
3. Sheep	T1	D				
4. Goats	T1	D				
5. Horses	T1	D				
6. Poultry	NA	NA				
7. Fur farming	T1	D				
4.B. Manure Management						
1. Cattle						
a. Cows, bulls and heifers (2 years and over)						
Dairy cattle	T2	D, CS				
Non-dairy Cattle						
Mature females	T2	D, CS				
Mature males	T2	D, CS				
b. Bovine animals (ages between 1 and 2 years)	T2	D, CS				
c. Calves (6-12 months old)	T2	D, CS				
d. Calves (0-6 months old)	T2	D, CS				
2. Swine						
a. Piglets, live weight less than 20 kg	T2	D, CS				
b. Young pigs, live weight 20 - <50 kg	T2	D, CS				
c. Fattening pigs, live weight						
50 - <80 kg	T2	D, CS				
80 - <110 kg	T2	D, CS				
110 kg or more	T2	D, CS				
d. Breeding pigs, live weight 50 kg and more	T2	D, CS				
3. Sheep	T1	D				
4. Goats	T1	D				
5. Horses	T1	D				
6. Poultry	T1	D				
7. Fur farming	T1	D				
1. Anaerobic lagoon			NA	NA		
2. Liquid system			T2	D		
3. Daily spread			NA	NA		
4. Solid storage and dry lot			T2	D	L, T	L, T
5. Other AWMS			NA	NA		
4.C. Rice Cultivation	NA	NA				
4.D. Agricultural soil						
1. Direct Soil Emissions						
a. Synthetic Fertilizers			T1	D	L, T	L, T
b. Animal Waste Applied to Soils			T1	D	L	L, T
c. N-fixing crops			T1b	D	L, T	L, T

	CH_4		N_2O		Key category	
	Method applied	Emission factor	Method applied	Emission factor	LULUCF sector is not included	LULUCF sector is included
d. Crop Residues			T1b	D		
e. Cultivation of Histosols			T1	D	T	L, T
f. Other direct emissions / Sewage sludge use			T1	D		
2. Pasture, range and paddock			T2	D	L, T	L, T
3. Indirect Emissions						
a. Atmospheric Deposition			T1b	D		
b. Leaching and Run-off			T1b	D	L, T	L, T
4.E. Prescribed Burning of Savannas	NA	NA	NA	NA		
4.F. Field Burning of Agricultural Residues	NA	NA	NA	NA		

T1 – Tier 1; T – Tier 2; D – IPCC default; CS – Country-specific; NO – Not occurring; NA – Not applicable.

6.2.1. References – sources of information

The estimations were carried out based on approaches presented in the 1996 Revised IPCC Guidelines (IPCC, 1997) and in the IPCC Good Practice Guidance (IPCC, 2000).

Activity data were obtained from Estonian national statistics, default emission factors (EFs) were taken from the IPCC Guidelines (IPCC, 1997, 2000) and country-specific EFs were calculated based on country-specific data. The list of institutions directly and indirectly involved in the inventory process is presented in Table 6.3.

Table 6.3. List of institutions (datasets) involved in the emission inventory for the agricultural sector

References	Link	Abbreviation	Data, activity
Tallinn University of Technology	www.ttu.ee	TUT	- activity data handling; - estimation of emissions; - reporting (the CRF tables, the NIR).
Statistics Estonia – Agricultural Statistics	www.stat.ee	SE	- collection and reporting of data on livestock population, quantities of crop produced and amounts of fertilizers applied on fields.
Estonian Animal Recording Centre	www.jkkeskus.ee	EARC	- collection and reporting of data on milk production, fat content in milk; - collection data on dairy cattle population by dairy-cattle breed.
Estonian Environment Information Centre	www.keskkonnainfo.ee	EEIC	- providing with data on areas of organic soils under cultivation. - collection and reporting of data on amounts of sludge used for improvement of environment (on agricultural fields).

6.2.2. Livestock characterization

Estonia's livestock population decreased by 2011 in comparison with the base year: the number of dairy cattle decreased by 66 per cent: from 280.7 thousand heads to 96.2 thousand heads (Figure 6.4, Figure 6.5, Figure 6.6), the number of non-dairy cattle decreased from 475.1 thousand heads in 1990 to 142.1 thousand heads in 2011 (Figure 6.4, Figure 6.6). The total number of swine decreased by 57 per cent, i.e. from 859.9 thousand heads in 1990 to 365.7 thousand heads in 2011 (Figure 6.4, Figure 6.7). The population of horses decreased from 8.6 thousand heads in 1990 to 6.5 thousand heads in 2011 – by 24 per cent (Figure 6.4). The number of sheep decreased by 39 per cent – from 138 thousand heads in 1990 to 83.9 thousand heads in 2011. However, the population number of goats increased from 1.8 thousand heads to 4.3 thousand heads from 1990 to 2011 (Figure 6.4). The poultry population decreased by 69 per cent by 2011 compare to the base year – from 6 536.5 thousand heads in 1990 to 2 032.9 thousand heads in 2011 (Figure 6.8).

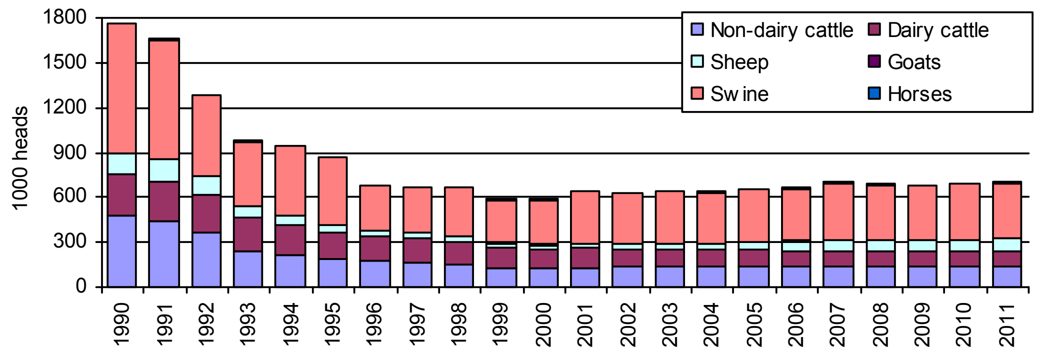


Figure 6.4. Population of livestock in Estonia in 1990–2011, 1000 heads

The data on mature non-dairy cattle population were collected and reported by SE according to two methodologies employed: for 1990–1998 – livestock population data have been reported for two sub-categories (bovine animals and mature males) and for 1999–2011 – the population of three sub-categories of non-dairy mature was reported by SE (bovine animals, mature males and females). In order to guarantee consistency in activity data used, data of 1990–1998 were updated based on the assumptions applied in the 2010 submission, results are illustrated in (Figure 6.6, Appendix A.3.3_I).

In the 2013 submission, in order to take into account a recommendation of the ERT (see ARR2011, para 70) and to calculate emissions from enteric fermentation and manure management of calves aged between 0–6 months, further development and changes were applied to activity data on cattle population – to calves (less than 1 year). Currently, Estonian statistics do not collect separately data on calve population (0–6 months), data are collected and reported on the population of calves less than 1 year old. Hence, population of calves (0–6 months) was separated from the total population of calves based on the data on number of calves born in each quarter (it was applied that about 50% of the total population of calves (0–12 months) are calves less than 6 months old, for the entire time-period). GHG emissions from enteric fermentation and manure management were estimated for calves (0–6 months) and calves (6–12 months).

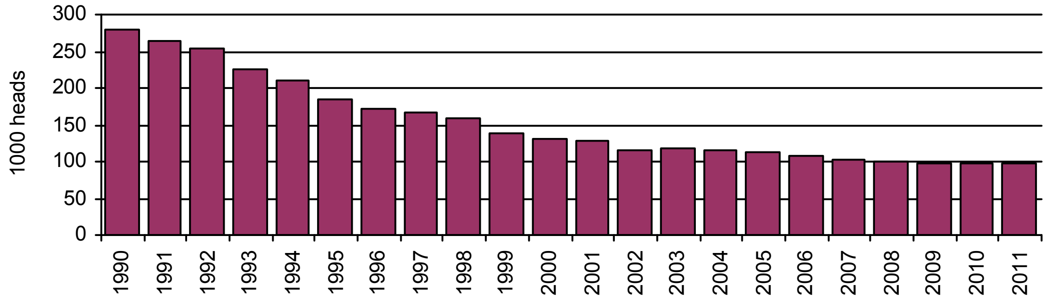


Figure 6.5. Population of dairy cattle in Estonia in 1990–2011, 1000 heads

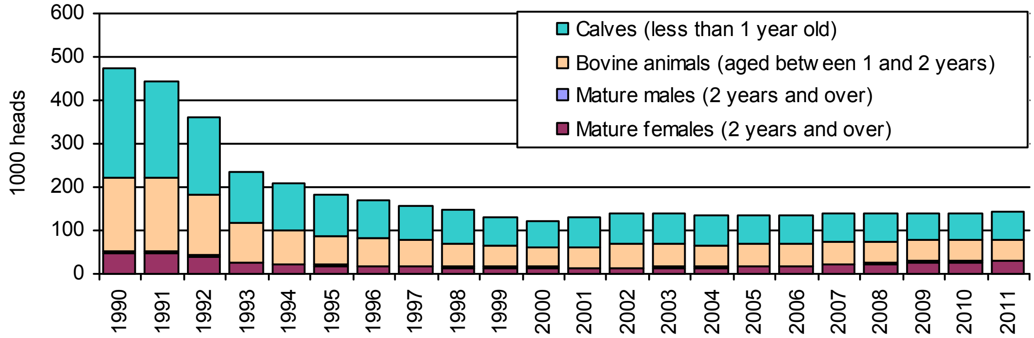


Figure 6.6. Population of non-dairy cattle in Estonia in 1990–2011, 1000 heads

Activity data on swine population in 1990–1998 were updated in the 2009 submission. Since, the number of swine population for 1990–1998 has been reported for three sub-categories of swine (breeding sows, fattening pigs and young swine); however, the number of swine population for 1999–2008 has been reported for six sub-categories of swine (piglets, with live weight less than 20 kg; young pigs, with live weight 20–<50kg; pigs, with live weight 50–<80kg, 80–<110kg and 110 kg and more; and breeding sows). Hence, based on the average structure of swine population (by categories) of 1999–2008, activity data on swine population in 1990–1998 were recalculated for six sub-categories instead of three reported earlier (Figure 6.7, Appendix A.3.3_I).

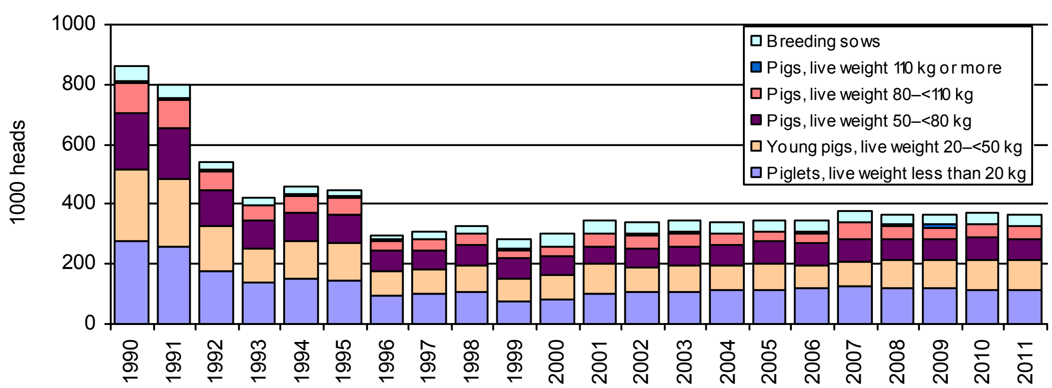


Figure 6.7. Population of swine in Estonia in 1990–2011, 1000 heads

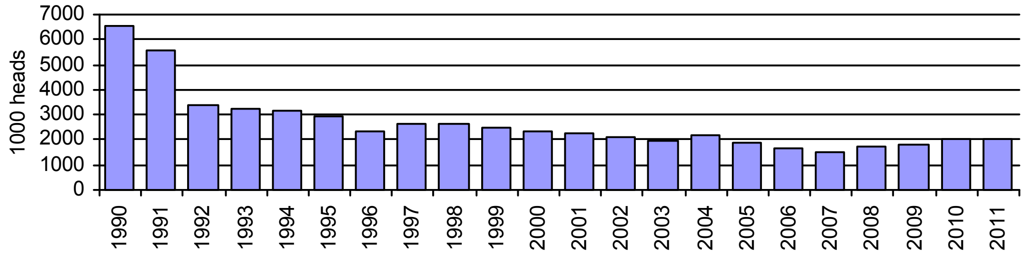


Figure 6.8. Population of poultry in Estonia in 1990–2011, 1000 heads

Population of fur animals remarkably decreased by 1999 compared to 1990 due to absence of markets (Figure 6.9). In 1998, Estonian fur farmers established a relationship with colleagues from Nordic countries. The new partners provided Estonian farmers with valuable assistance regarding breeding programmers, improving basic herds, etc. (Saveli, 2004). Since 2000, the number of fur animals has started slightly to increase. Nowadays, a major share of the production of Estonian fur farming is exported (Estonica, 2010).

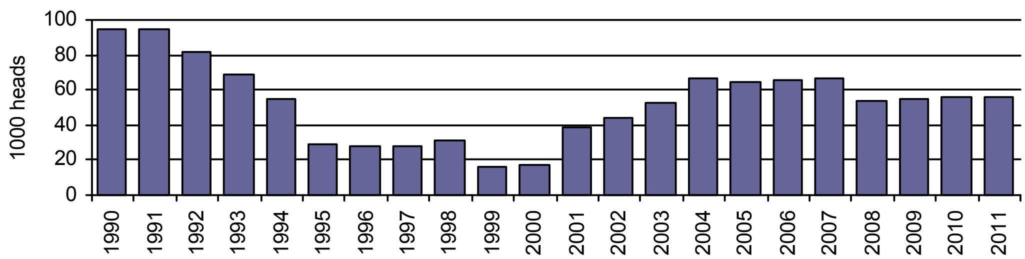


Figure 6.9. Population of fur animals in Estonia in 1990–2011, 1000 heads[18]

The activity data used in the estimations in the 2013 submission differ from those reported in the FAO statistic dataset due to different methods of data reporting (Table 6.4). In the framework of the FAO datasets, the data on livestock population is reported according the following methodology – the total number of live animal is given for the year ending 30 September (e.g. number of live animals enumerated in a given country any time between 1 October and 30 September of the following year should be considered for the later year). According to the methodology established in SE, total number of live animal is presented for the year ending 31 December.

The data of SE were used in the estimates of the 2013 submission.

[18] Data on fur animal population in 1994–2011 were obtained from SE datasets; the data of 1991 – from (Saveli, 2004) and data of 1990, 1992–1993 were interpolated/extrapolated.

Table 6.4. The number of livestock population in Estonia in 1992–2011, in accordance with SE and the FAO datasets, 1000 heads (SE, 2011; FAOSTAT, 2011)

Year	Cattle		Pigs		Sheep		Goats		Horses		Poultry	
	SE	FAO	SE	FAO	SE	FAO	SE	FAO	SE	FAO	SE	FAO
1992	613.0	708.3	541	798.6	121.5	141.9	1.2	NR	6.6	7.8	3 418.1	5 538
1993	462.6	614.6	424	541.1	82.2	124.2	1.1	NR	5.2	6.6	3 226.1	3 418
1994	418.3	463.2	460	424.3	60	83.3	1.5	NR	5.0	5.2	3 129.7	3 226
1995	369.7	419.5	449	459.8	48.2	61.5	1.6	NR	4.6	5.0	2 911.3	3 130
1996	342.4	370.4	298	448.8	37.6	49.8	1.6	NR	4.2	4.6	2 324.9	2 911
1997	325.0	343.0	306	298.4	33.9	39.2	1.7	NR	4.2	4.2	2 602	2 325
1998	306.7	325.6	326	306.3	28.7	33.9	2.1	1.7	3.9	4.2	2 635.7	2 602
1999	267.3	307.5	286	326.4	28.2	28.7	2.7	2.1	3.9	3.9	2 461.8	2 636
2000	252.8	267.3	300	285.7	29	28.2	3.2	2.7	4.2	3.9	2 366.4	2 414
2001	260.5	252.8	345	300.2	28.8	29	3.6	3.2	5.5	4.2	2 294.9	2 318
2002	253.9	260.5	341	345.0	29.9	28.8	3.9	3.6	5.3	5.5	2 096.3	2 249
2003	257.2	253.9	345	340.8	30.8	29.9	3.5	3.9	5,8	5.3	1 945.2	2 070
2004	249.8	257.2	340	344.6	38.8	30.8	2.9	3.5	5.1	5.8	2 183	1 929
2005	249.5	249.8	346.5	340.1	49.6	38.1	2.8	2.9	4.8	5.1	1 878.7	2 161
2006	244.8	249.5	345.8	346.5	62.7	49.6	3.3	2.8	4.9	4.8	1 638.7	1 854
2007	240.9	244.8	379.0	345.8	72.4	62.7	4.0	3.3	5.3	4.9	1 477.6	1 638
2008	237.9	240.5	364.9	379.0	78.2	72.4	3.6	4.0	5.2	5.3	1 757.3	1 478
2009	234.7	237.9	365.1	364.9	76.5	78.2	3.9	3.6	5.4	NR	1 792.2	1 757
2010	236.3	234.7	371.7	365.1	78.6	76.5	4.1	3.9	6.8	5.4	2 046.4	1 792
2011	238.3	236.3	365.7	371.7	83.9	78.6	4.3	4.1	6.5	6.8	2 032.9	2 046

NR – the data are not reported by the FAO

6.3. Enteric fermentation (CRF 4.A)

6.3.1. Source category description

Methane is emitted as a by-product of 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 methane is then eructated or exhaled by the animal. Within livestock, ruminant livestock (cattle, buffalo, sheep, and goats) are the primary source of emissions (IPCC, 2000). Pigs are non-ruminant animals and convert a smaller proportion of feed intake into methane than ruminants.

The total CO_2eq emissions from enteric fermentation of Estonian livestock made up 32% from the total CO_2eq emissions of the agricultural sector in Estonia in 2011. CH_4 emissions of 2011 were 60 per cent lower than the emissions of the base year due to decrease in number of livestock population (Table 6.5, Figure 6.10).

Table 6.5. CH_4 emissions from enteric fermentation by animal type in 1990–2011 in Estonia, Gg

Year	Cattle	Swine	Sheep	Goats	Horses	Poultry	Fur animals	Total CH_4, Gg
1990	46.32	0.83	1.10	0.009	0.15	NE	0.010	48.43
1991	43.32	0.77	1.13	0.010	0.14	NE	0.010	45.38
1992	37.83	0.52	0.97	0.006	0.12	NE	0.008	39.46
1993	30.00	0.41	0.66	0.006	0.09	NE	0.007	31.18
1994	27.12	0.45	0.48	0.008	0.09	NE	0.006	28.15
1995	23.96	0.43	0.39	0.008	0.08	NE	0.003	24.88
1996	22.97	0.29	0.30	0.008	0.08	NE	0.003	23.64
1997	22.73	0.30	0.27	0.009	0.08	NE	0.003	23.39
1998	22.02	0.32	0.23	0.011	0.07	NE	0.003	22.65
1999	18.92	0.30	0.23	0.014	0.07	NE	0.002	19.53
2000	18.57	0.31	0.23	0.016	0.08	NE	0.002	19.21
2001	19.21	0.34	0.23	0.018	0.10	NE	0.004	19.90
2002	18.06	0.35	0.24	0.020	0.10	NE	0.004	18.77
2003	18.40	0.35	0.25	0.018	0.10	NE	0.005	19.12
2004	18.59	0.33	0.31	0.015	0.09	NE	0.007	19.35
2005	18.65	0.34	0.40	0.014	0.09	NE	0.006	19.49
2006	18.60	0.34	0.50	0.017	0.09	NE	0.007	19.55
2007	18.15	0.38	0.58	0.020	0.10	NE	0.007	19.23
2008	18.17	0.36	0.63	0.018	0.09	NE	0.005	19.27
2009	17.90	0.36	0.61	0.020	0.10	NE	0.005	18.99
2010	18.17	0.37	0.63	0.021	0.12	NE	0.006	19.31
2011	18.38	0.36	0.67	0.022	0.12	NE	0.006	19.56
%, 2011	94.0	1.8	3.4	0.1	0.6	-	0.0	100

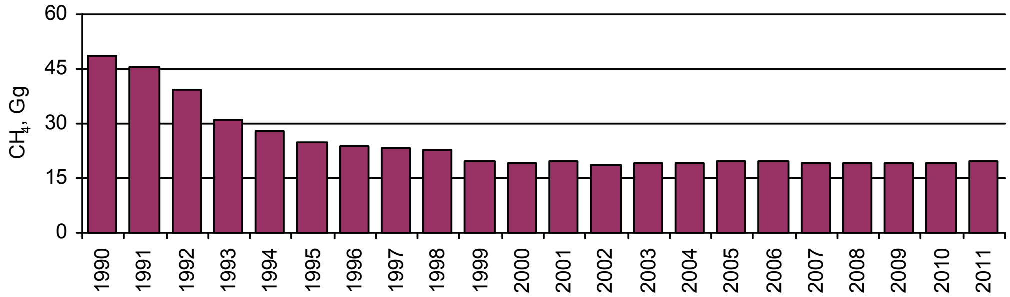


Figure 6.10. CH_4 emissions enteric fermentation from Estonia's livestock in 1990–2011, Gg

6.3.2. Enteric fermentation of cattle

6.3.2.1. Methodology, data availability, data sources and emission factors

The *Tier 2* method (IPCC, 2000) was used to estimate CH_4 emissions from enteric fermentation of dairy cattle and mature non-dairy and young cattle (bovine cattle, calves 0–6 months and 6–12 months). In the 2013 submission, two key recalculations were performed: namely, population of calves (less than 1 year old) was split into two groups: calves 0–6 months old and calves 6–12 months old. Methane emissions from enteric fermentation were estimated separately for these two groups of calves (a recommendation of ERT, see ARR2011, para 70). In addition, reporting way of emissions in the CRF reporter was changed: CH_4 emissions from enteric fermentation of bovine animals were excluded from 'Mature cattle' category and included and reported under 'Young cattle' category.

A disaggregation on county level of Estonia was applied (Table 6.6). Estonia's counties are visualized in Figure 6.11.

Table 6.6. Symbols used in the algorithm for cattle

County of Estonia	Cattle category
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 (aged between 1 and 2 years)
i5- Järva county	j5- Calves (0-6 months old)
i6- Lääne county	j6- Calves (aged between 6 months and 1 year)
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	
i15- Võru county	

Figure 6.11. Administrative boundaries of Estonia's counties

Net energy for maintenance – Net energy required to keep the animals in energy equilibrium (6.1)

$$NE_{mji} = C_{f\,ji} \bullet (weight_{ij})^{0.75} \tag{6.1}$$[19]

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;

C_f – Coefficient for calculating NE_m (Table 6.7);

Table 6.7. C_f coefficient[20]

Animal category	C_{fi}
Cattle (non-lactating)	0.322
Cattle (lactating)	0.335

Net energy for activity for animals (6.2)

$$NE_{aji} = C_a \bullet NE_{mji} \tag{6.2}$$[21]

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 (Table 6.8);

[19] IPCC 2000, Agriculture, Equation 4.1, pp. 4.13.
[20] IPCC 2000, Agriculture, Table 4-4, pp. 4.15.
[21] IPCC 2000, Agriculture, Equation 4.2a, pp. 4.14.

NE_m – Net energy required for maintenance by *j* category of cattle in *i* county (6.1);

Table 6.8. Activity coefficients corresponding to animal's feeding situation[22]

Feeding situation	Definition	C_a
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 (6.3)

$$NE_{gji} = 4.18 \times \left\{ (0.035 W_{ji}^{0.75} \times WG_{ji}^{1.119}) + WG_{ji} \right\} \qquad (6.3)^{23}$$

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 (6.4)

$$NE_{l_i} = kg\_of\_milk/day_i \times (1.47 + 0.40 \times Fat_i) \qquad (6.4)^{24}$$

NE_{li} – Net energy for lactation by dairy cattle in *i* county, MJ/head/day;

Fat – Fat content of milk in *i* county, %;

Net energy for pregnancy (6.5)

$$NE_{pregnancy} = C_{pregnancy} \bullet NE_m \qquad (6.5)^{25}$$

$NE_{pregnancy}$ – net energy required for pregnancy, MJ/head/day;

$C_{pregnancy}$ – pregnancy coefficient = 0.1[(26)];

NE_m – net energy required by the animal for maintenance, MJ/head/day;

Ratio of net energy available in a diet for maintenance to digestible energy consumed (6.6)

$$NE_{ma}/DE_{ji} = 1.123 - (4.092 \times 10^{-3} \times DE_{ji}\%) + (1.126 \times 10^{-5} \times (DE_{ji}\%)^2) - 25.4/DE_{ji}\% \qquad (6.6)^{27}$$

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;

[22] IPCC 2000, Agriculture, Table 4.5, pp. 4.15.
[23] IPCC 1997, Agriculture, Reference Manual, Equation 3, pp. 4.18.
[24] IPCC 2000, Agriculture, Equation 4.5a, pp. 4.17.
[25] IPCC 2000, Agriculture, Equation 4.8, pp. 4.18.
[26] IPCC 2000, Agriculture, Table 4.7, pp. 4.19.
[27] IPCC 2000, Agriculture, Equation 4.9, pp. 4.19.

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 (6.7)

$$NE_g/DE_{ji} = 1.164 - (5.160 \times 10^{-3} \times DE_{ji}\%) + (1.308 \times 10^{-5} \times (DE_{ji}\%)^2) - 37.4/DE_{ji}\% \qquad (6.7)^{28}$$

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 (6.8)

$$GE = \frac{(NE_{m\,ji} + NE_{feedji} + NE_{lji} + NE_{workji} + NE_{pregnancyji}) \times \left(\frac{100}{DE_{ji}\%}\right)}{(NE/DE)_{ji} + (NE_{gji}/\{NE_g/DE\}_{ji})} \qquad (6.8)^{29}$$

GE – Gross energy intake 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[30], 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, %;

Methane emission factor from livestock category (6.9)

$$E = [GE \times Y_m \times (365 days/yr)] / [55.65 MJ / CH_4\ kg] \qquad (6.9)^{31}$$

E – Methane emissions 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.

[28] IPCC 2000, Agriculture, Equation 4.10, pp. 4.19.
[29] IPCC 2000, Agriculture, Equation 4.11, pp. 4.20 (the equation was slightly modified); IPCC 1997, Agriculture, Reference Manual, Equation 13, pp. 4.21.
[30] Net energy for work was not calculated.
[31] IPCC 2000, Agriculture, Equation 4.14, pp. 4.26.

Main data sources used in the estimations of CH_4 EF for enteric fermentation by sub-categories of cattle:

Weight, kg – data on weight of dairy-cattle were calculated based on data of EARC, an expert judgment on weight of main categories of dairy-cattle and from scientific literature (Table 6.12, Appendix A.3.3_III);

Milk production per day, kg/day – a source of data is SE (Table 6.10, Appendix A.3.3_II);

Fat content of milk, % - data were obtained from EARC;

Percentage of cows that give birth in a year, % – data were employed from EARC (Appendix A.3.3_II);

Feed digestibility, % – data were used from (Kaasik et al., 2002);

Methane conversion rate, Y_m % (Table 6.9) – the values of Ym of mature dairy and non-dairy cattle and bovine animals were used from the 1996 IPCC Guidelines (1997).

Table 6.9. Methane conversion rate, %

Cattle category	Ym, %
Mature dairy cattle[32]	6
Mature non-dairy cattle[33]	
…Mature males (2 years and over)	6.5
…Mature females (2 years and over)	6.5
Young cattle	
…Bovine animals (aged between 1 and 2 years)[34]	6
…Calves (6-12 months)[19]	6
…Calves (0-6 months)	3

Value of *Ym* for calves (0–6 months) was estimated taking into account feed intake diet of animals and development conditions of rumen: namely, the development of rumen of calves is complete between the 7th and 9th week of life, but may take several additional weeks (German NIR, 2012), which stipulate markedly lower methane emissions. Additionally, consumption of milk (only) assumes zero methane emissions from the rumen (IPCC GPG, p.4.26). In Estonia, it was investigated that calves get milk and milk substitute until the age of 3 months, which assume zero emissions from enteric fermentation; at the age of 3–6 months, calves feed on mineral fodder (Lehtsalu et al., 2010). Hence, it was assumed that methane conversion rate of calves (0–6 months) is 3%, the rate was estimated as arithmetic mean based on the rate of calves between 0 and 3 months (which is zero) and from 3 to 6 months (Ym is 6%).

Values of CH_4 EFs estimated for enteric fermentation of dairy cattle are presented in Table 6.10. The highest values of CH_4 EFs for dairy cattle among counties of Estonia were observed in Põlva and Tartu in 2011; these counties were characterized by high milk production per head of dairy cow.

[32] IPCC 1997, Agriculture, Reference Manual, Table A-1, pp. 4.31.
[33] IPCC 1997, Agriculture, Reference Manual, Table A-2 (Mature Females and Males of Eastern Europe), pp. 4.32.
[34] IPCC 1997, Agriculture, Reference Manual, Table A-2 (Young Cattle of Eastern Europe), pp. 4.32.

Table 6.10. Milk yield per cow, fat content and CH_4 EF for dairy cattle by counties of Estonia in 2011

County	Milk yield per cow, kg/head/year	Fat content[35], %	Emission factor, kg CH_4/head/year
Harju	6 600	4.07	122.32
Hiiu	4 667	4.37	105.63
Ida-Viru	6 298	4.11	120.21
Jõgeva	7 465	4.14	131.55
Järva	7 473	4.03	130.58
Lääne	6 388	4.13	120.73
Lääne-Viru	7 524	4.05	131.08
Põlva	7 737	4.12	133.87
Pärnu	7 294	4.08	129.32
Rapla	7 267	4.21	130.00
Saare	6 179	4.13	118.79
Tartu	8 237	4.03	137.17
Valga	6 470	4.14	121.67
Viljandi	6 711	4.10	123.72
Võru	6 345	4.22	121.02

The values of CH_4 EFs for enteric fermentation of non-dairy cattle (mature and young) are presented in Table 6.11.

Table 6.11. CH_4 EF of enteric fermentation of non-dairy cattle in 2011, kg CH_4/head/year

Livestock category of non-dairy cattle	Emission factor, kg CH_4/head/year
Mature males (2 years and over)	60.93
Mature females (2 years and over)	60.99
Bovine animals (aged between 1 and 2 years)	54.50
Calves (6-12 months)	38.50
Calves (0-6 months)	9.38

The values of CH_4 EF have increased in the period of 1990–2011, mainly, due to the increase in milk production by cow (Table 6.12). Figure 6.12 illustrates the trend of annual changes in CH_4 EFs for dairy cattle, milk yield per cow and number of dairy cattle population in relation to the base year (1990 = 1).

Table 6.12. Weight, milk yield per cow and fat content of milk, gross energy intake and CH_4 EFs for dairy cattle in 1990–2011 (Appendix A.3.3_II)

Year	Weight of dairy-cattle, kg/head	Fat content of milk, %	Milk yield per cow, kg/head/yr	Gross energy intake, MJ/head/day	Emission factor, kg CH_4/head/yr
1990	544.9	4.14	4 164	253.9	99.02
1991	545.1	4.14	3 968	248.6	96.99
1992	545.3	4.07	3 530	237.1	92.45
1993	545.6	4.10	3 322	232.5	90.62
1994	545.7	4.12	3 455	229.7	89.53
1995	545.8	4.20	3 588	231.8	90.36
1996	545.9	4.34	3 809	241.2	94.75
1997	546.1	4.32	4 484	250.6	98.40

[35] Results of animal recording in Estonia in 1997–2011. Annual Reports. Available at: www.jkkeskus.ee/page.php?page=0147.

Year	Weight of dairy-cattle, kg/head	Fat content of milk, %	Milk yield per cow, kg/head/yr	Gross energy intake, MJ/head/day	Emission factor, kg CH_4/head/yr
1998	546.3	4.26	4 456	260.3	102.14
1999	546.5	4.23	4 171	250.3	99.43
2000	546.7	4.29	4 660	265.6	104.56
2001	546.8	4.31	5 313	283.8	109.40
2002	546.9	4.29	5 138	280.7	108.81
2003	547.0	4.31	5 231	281.9	110.13
2004	546.9	4.27	5 596	291.0	113.72
2005	546.9	4.21	5 886	297.7	116.47
2006	546.9	4.17	6 285	307.0	120.47
2007	547.0	4.15	6 484	311.6	120.97
2008	547.1	4.12	6 781	318.1	124.74
2009	547.2	4.14	6 838	320.0	125.64
2010	547.3	4.11	7 021	324.0	127.18
2011	547.4	4.10	7 168	327.2	128.28
IPCC default					
EE[36]	550[(37)]		2 550		81[(38)]
WE	550		4 200		100

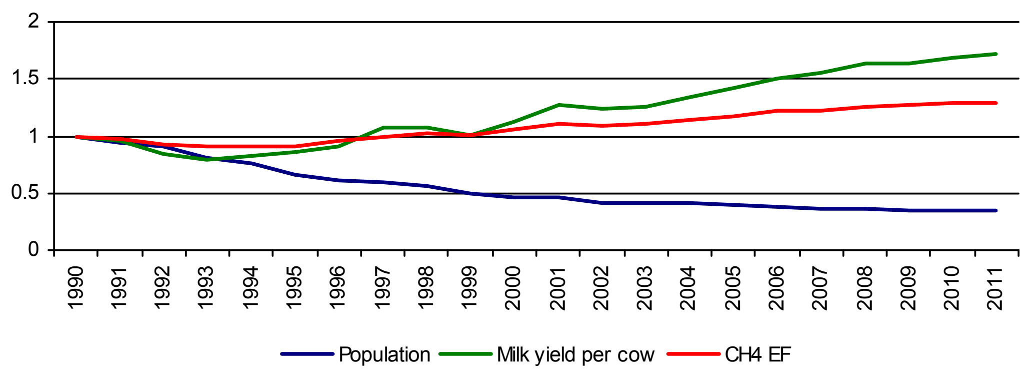


Figure 6.12. The changes in dairy cattle population, milk yield per cow and CH_4 EF in the period of 1990–2011 in relation to the base year (1990 = 1)

6.3.2.2. Quantitative overview – CH_4 emissions from enteric fermentation of cattle in 2011

The total CH_4 emissions from enteric fermentation of cattle were 18.38 Gg in 2011. Dairy cattle livestock was a main contributor to CH_4 emissions from cattle enteric fermentation in Estonia in 2011 (Table 6.13). The emissions decreased by 60 per cent by 2011 in comparison with the base year.

[36] EE – Eastern Europe, WE – Western Europe.
[37] IPCC 1997. Agriculture. Reference Manual. Table A-1, pp.4.31.
[38] IPCC 1997. Agriculture, Reference Manual. Table 4-4, pp. 4.11.

Table 6.13. CH_4 emissions from enteric fermentation of cattle in 1990–2011 in Estonia, Gg

Year	Cattle[39]			Total, CH_4 Gg
	Dairy cattle	Mature non-dairy cattle	Young cattle	
1990	27.79	3.12	15.41	46.32
1991	25.64	3.10	14.59	43.32
1992	23.43	2.52	11.88	37.83
1993	20.54	1.66	7.80	30.00
1994	18.93	1.41	6.78	27.12
1995	16.75	1.22	5.99	23.96
1996	16.26	1.14	5.57	22.97
1997	16.50	1.07	5.16	22.73
1998	16.20	0.99	4.83	22.02
1999	13.76	0.98	4.18	18.92
2000	13.70	0.97	3.90	18.57
2001	14.07	0.80	4.33	19.21
2002	12.58	0.80	4.68	18.06
2003	12.86	0.93	4.61	18.40
2004	13.25	0.98	4.37	18.59
2005	13.14	1.07	4.44	18.65
2006	13.06	1.15	4.39	18.60
2007	12.46	1.33	4.35	18.15
2008	12.52	1.52	4.13	18.17
2009	12.15	1.62	4.13	17.90
2010	12.27	1.79	4.10	18.17
2011	12.34	1.96	4.08	18.38
%, 2011	67.1	10.7	22.2	100

6.3.3. Enteric fermentation of swine

6.3.3.1. Methodology, data availability, data sources and emission factors

The *Tier 2* was used to estimate CH_4 emissions from enteric fermentation of swine. The estimation was carried out for the main sub-categories of pigs broken down by weight of animals (Table 6.14), methane conversion factors were taken from the revised 1996 IPCC Guidelines (IPCC, 1997), ratios of feed digestibility were obtained from (Kaasik et al., 2002).

Gross energy intake by swine (6.10, 6.11)

$$GE_{ji} = ME_{ji}/DE_{ji} \qquad (6.10)^{40}$$

GE – Gross energy intake by *j* swine category in *i* county, MJ/head/day;

DE – Digestible energy as percentage of gross energy of *j* category of swine in *i* county, %;

$$ME_{ji} = 2.0 \times w_{ji}^{0.63} \qquad (6.11)^{41}$$

[39] CH_4 emissions are reported according to the classification of the CRF reporter, since Option B was implemented to report emissions from enteric fermentation of cattle.

[40] Oll *et al.*, 1991; Turnpenny *et al.*, 2001.

[41] Oll *et al.*, 1991; Turnpenny *et al.*, 2001.

ME_{ji} – Energy intake for maintenance and growth of *j* swine category in *i* county, MJ/head/day;
w_{ji} – Live weight of *j* category in *i* county, kg.

Table 6.14. Symbols used in the equations

County of Estonia	Swine categories
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	
i14- Viljandi county	
i15- Võru county	

Methane emission factor from livestock category (6.12)

$$E = [GE \times Y_m \times (365 days/yr)] / [55.65 MJ / CH_4 \, kg] \quad (6.12)^{42}$$

E – Methane emissions 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.

Table 6.15 demonstrates CH_4 emission factors for each category of swine and the IPCC default EF for swine recommended for developed countries (IPCC, 1997). Implied emission factors for swine enteric fermentation for the entire time-series are presented in Figure 6.13.

Table 6.15. Methane emission factors for swine enteric fermentation, kg CH_4/head/year

Swine category	Emission factor, kg CH_4/head/year	
	calculated	IPCC default[43]
Total		1.5
Piglets, live weight less than 20 kg	0.39	
Young pigs, live weight 20–<50 kg	0.87	
Fattening pigs		
…live weight 50–<80 kg	1.36	
…live weight 80–<110 kg	1.73	
…live weight 110 kg or more	1.90	
Breeding pigs, live weight 50 kg or more	1.49	

[42] IPCC 2000. Agriculture. Equation 4.14, pp. 4.26.
[43] IPCC 1997. Agriculture. Reference Manual. Table 4-3. pp. 4.10.

Figure 6.13. Implied emission factor (IEF) of swine enteric fermentation in 1990–2011, CH_4 kg/head/year

6.3.3.2. Quantitative overview – CH_4 emissions from enteric fermentation of swine in 2011

The total CH_4 emissions from swine enteric fermentation were 0.36 Gg in 2011. The emissions decreased by 57 per cent since the base year due to decreasing population of swine (Figure 6.14).

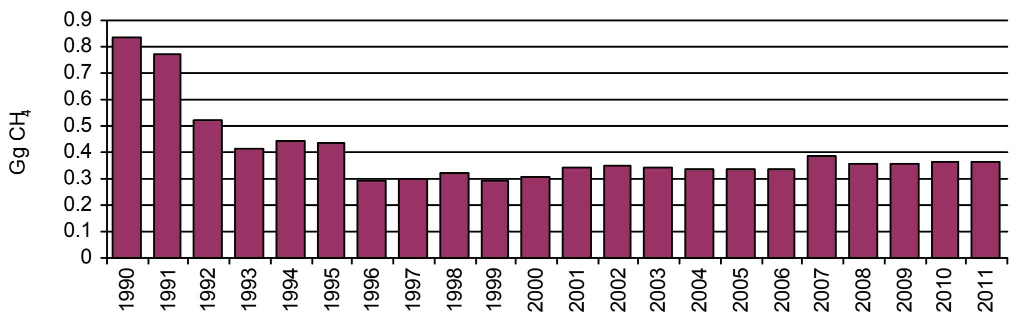


Figure 6.14. CH_4 emissions from enteric fermentation of swine in 1990–2011 in Estonia, Gg

6.3.4. Enteric fermentation of other livestock

6.3.4.1. Methodology, data availability, data sources and emission factors

The *Tier 1* (IPCC, 1997) was used to estimate CH4 emissions from enteric fermentation of other livestock (6.13).

$$CH_4\ Emission = EF_{ji} \times population_{ji} / (10^6\ kg/Gg) \qquad (6.13)^{44}$$

CH_4 $Emission_{ji}$ – Methane emissions 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;

[44] IPCC 2000. Agriculture. Equation 4.12, pp. 4.25.

Population$_{ji}$ – Number of *j* category of animals in *i* county, head.

CH_4 emission factors, recommended by the 1996 Revised IPCC Guidelines for developed countries (IPCC, 1997), were used to estimate CH_4 emissions from enteric fermentation of sheep, goats and horses (Table 6.16). The emission factors for fur animals were provided by a Finnish expert in the Agriculture sector (Sanna Pitkänen, personal communication).

Table 6.16. Enteric fermentation methane emission factors, kg CH_4/head/year[45]

Livestock category	Emission factor, kg CH_4/head/year
Sheep	8
Goats	5
Horses	18
Poultry	Not estimated
Fur animals	0.1[46]

6.3.4.2. Quantitative overview – CH_4 emissions from enteric fermentation of other livestock categories in 2011

The total CH_4 emissions from enteric fermentation of other livestock were 0.82 Gg in 2011. CH_4 emissions declined by 36 per cent by 2011 in comparison with the base year due to decrease in number of other livestock population (Figure 6.15).

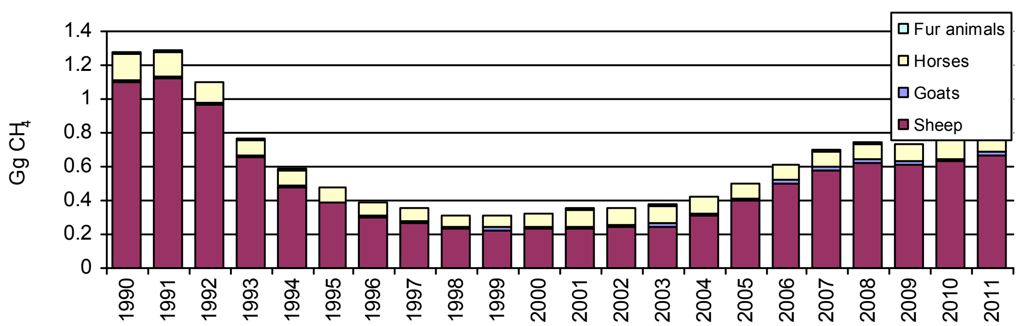


Figure 6.15. CH_4 emissions from enteric fermentation of other livestock categories in 1990–2011, Gg

6.3.5. Uncertainties and time-series consistency

The estimation of CH_4 emissions from enteric fermentation of cattle and swine were carried out based on the *Tier 2* approach with Estonian activity data and default factors obtained from the IPCC Guidelines (1997, 2000). The *Tier 1* method was used to estimate CH_4 emissions from other livestock: goats, horses, sheep and fur animals.

[45] IPCC 1997. Agriculture. Reference Manual. Table 4-3 (developed countries), pp. 4.10.

[46] For fur animals, Norwegian emission factor was used (0.1 kg/animal/year). The emission factor was derived by scaling the emission factor of swine based on comparison between the average weights of swine and fur animals. Swine was assumed to be similar to fur animals with regard to digestive system and feeding.

Uncertainty rates of activity data are not calculated in Estonia. The data were obtained from (Rypdal and Winiwarter, 2001), where uncertainties of activity data (livestock population) are presented for a few countries: Austria (±10%), Norway (±5–10%), the Netherlands (<±5%), USA (±2%). The experiences of Austria were used to calculate uncertainties in emissions from enteric fermentation of livestock (Table 6.17). The uncertainty in CH_4 emission factors for livestock categories (sheep, goats, horses) is reported to be ±20% (IPCC, 1997).

Table 6.17. Estimated values of uncertainties used in the agriculture sector

Input	Uncertainty	References
Activity data		
Estonia's livestock population (cattle, swine, sheep, goats, horses, poultry and fur animals)	± 10%	Rypdal and Winiwarter, 2001
Emission factors		
Enteric fermentation (CH_4) (cattle, swine, fur farming)	± 50%	IPCC, 2000. Agriculture. pp. 4.27
Enteric fermentation (CH_4) (sheep, goats, horses)	± 20%	Table 4-3 of the 1996 IPCC Guidelines, pp. 4.10

In spite of the fact that the *Tier 2* method is used in the calculation of emissions from cattle and swine, the default uncertainty rate was taken as ±50% due to lack of uncertainty analysis performed to estimate uncertainty rates of each parameter (Table 6.17) (IPCC, 2000).

6.3.6. Source-specific QA/QC and verification

The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.1.

The QC/QA plan for the agricultural sector includes the QC activities described in the IPCC GPG (IPCC 2000, Table 8.1). The activities are carried out every year during the inventory. The QC check list is used during the inventory.

6.3.7. Source-specific recalculations

There are several recalculations carried out in the 2013 submission in framework of the estimation of CH_4 emissions from enteric fermentation of cattle and swine:

Cattle enteric fermentation:

(1) data on weight of dairy cattle were updated;

(2) emissions from enteric fermentation were estimated separately for calves (0–6 months) and calves (6–12 months) (a recommendation of the ERT, see ARR2011, para 70). For this purpose, the total population of calves (less than 1 year old) was split into two groups;

(3) data on weight of bovine cattle (aged between 1 and 2 years) was updated, country-specific values were used;

(4) reporting way of emissions in the CRF reporter was changed: emissions from enteric fermentation of bovine animals (aged between 1 and 2 years) were

excluded from 'Manure non-dairy cattle' category (Option B) and reported under 'Young Cattle' category in the 2013 submission.

The changes in the values of CH_4 EFs received due to the update of dairy-cattle weight and in CH_4 emissions from enteric fermentation are presented in Table 6.18.

Table 6.18. CH_4 EFs and emissions from dairy cattle enteric fermentation in 1990–2010

Year / Parameter	CH_4 EF, kg CH_4/head/year		Emissions, CH_4 Gg	
	Reported in the 2012 submission	Reported in the 2013 submission	Reported in the 2012 submission	Reported in the 2013 submission
Estonian Red	550	540		
Estonian Holstein	600	550		
Estonian Native	410	460		
1990	99.34	99.02	27.89	27.79
1991	99.42	96.99	26.28	25.64
1992	94.94	92.45	24.06	23.43
1993	93.23	90.62	21.13	20.54
1994	92.18	89.53	19.49	18.93
1995	93.06	90.36	17.25	16.75
1996	97.51	94.75	16.73	16.26
1997	101.21	98.40	16.97	16.50
1998	105.01	102.14	16.65	16.20
1999	102.15	99.43	14.14	13.76
2000	107.51	104.56	14.08	13.70
2001	112.35	109.40	14.45	14.07
2002	111.83	108.81	12.93	12.58
2003	113.19	110.13	13.22	12.86
2004	116.76	113.72	13.60	13.25
2005	119.52	116.47	13.48	13.14
2006	123.56	120.47	13.39	13.06
2007	124.05	120.97	12.78	12.46
2008	127.87	124.74	12.84	12.52
2009	128.82	125.64	12.46	12.15
2010	130.38	127.18	12.58	12.27

The results of the recalculation performed to estimate emissions from enteric fermentation of young cattle are presented in Table 6.19.

Table 6.19. CH_4 emissions from enteric fermentation of young cattle (bovine and calves aged between 0 and 6 months, and between 6 and 12 months) in 1990–2010, Gg

	Reported CH_4 emissions in the 2012 submission	Recalculated CH_4 emissions in the 2013 submission
1990	21.83	15.41
1991	20.48	14.59
1992	16.67	11.88
1993	10.94	7.80
1994	9.56	6.78
1995	8.48	5.99
1996	7.87	5.57
1997	7.27	5.16
1998	6.82	4.83
1999	5.88	4.18
2000	5.50	3.90
2001	6.13	4.33

	Reported CH_4 emissions in the 2012 submission	Recalculated CH_4 emissions in the 2013 submission
2002	6.56	4.68
2003	6.50	4.61
2004	6.14	4.37
2005	6.23	4.44
2006	6.16	4.39
2007	6.10	4.35
2008	5.83	4.13
2009	5.81	4.13
2010	5.77	4.10

Sheep and goat enteric fermentation

There is one recalculation performed to estimate CH_4 emissions from enteric fermentation of sheep and goats: data on livestock population were updated for 1990–1992 and for 1995 due to omission made in the previous submissions. The results of recalculation are presented in Table 6.20.

Table 6.20. CH_4 emissions from enteric fermentation of sheep and goats in 1990–1992, 1995, Gg

	Sheep		Goats	
	Reported in the 2012 submission	Reported in the 2013 submission	Reported in the 2012 submission	Reported in the 2013 submission
1990	1.12	1.10	0.005	0.009
1991	1.14	1.13	0.005	0.010
1992	0.98	0.97	0.006	0.006
1995	-	-	0.009	0.008

6.3.8. Source-specific planned improvements

Activity data and EFs are kept under consideration and will be updated necessarily.

6.4. Manure management (CRF 4.B)

6.4.1. CH_4 emissions from manure management

Methane is produced from the decomposition of the organic matter remaining in the manure under anaerobic conditions (IPCC, 2000). CH_4 emission rates from manure management directly depend on the manure management system and temperature.

CH_4 emissions (recalculated to CO_2 eq) from manure management comprised 3.6% in the total agricultural emissions in Estonia in 2011.

The total CH_4 emissions from livestock manure management were 2.163 Gg in Estonia in 2011, the emissions declined by 40 per cent by 2011 in comparison with the base year (Table 6.21, Figure 6.16).

Table 6.21. CH_4 emissions from manure management in 1990–2011 in Estonia, Gg

Year	Cattle	Swine	Sheep	Goats	Horses	Poultry	Fur animals	Total
1990	1.06	1.98	0.026	0.0002	0.012	0.51	0.013	3.60
1991	0.99	1.78	0.027	0.0002	0.011	0.43	0.013	3.25

Year	Cattle	Swine	Sheep	Goats	Horses	Poultry	Fur animals	Total
1992	0.87	1.17	0.023	0.0001	0.009	0.27	0.011	2.35
1993	0.70	0.89	0.016	0.0001	0.007	0.25	0.009	1.88
1994	0.63	0.98	0.011	0.0002	0.007	0.24	0.007	1.88
1995	0.56	0.95	0.009	0.0002	0.006	0.23	0.004	1.76
1996	0.54	0.63	0.007	0.0002	0.006	0.18	0.004	1.36
1997	0.53	0.65	0.006	0.0002	0.006	0.20	0.004	1.40
1998	0.52	0.69	0.005	0.0003	0.005	0.21	0.004	1.43
1999	0.39	0.64	0.005	0.0003	0.005	0.19	0.002	1.24
2000	0.37	0.68	0.006	0.0004	0.006	0.18	0.002	1.25
2001	0.45	0.73	0.005	0.0004	0.008	0.18	0.005	1.38
2002	0.43	0.75	0.006	0.0005	0.007	0.16	0.006	1.37
2003	0.79	0.74	0.006	0.0004	0.008	0.15	0.007	1.70
2004	0.81	0.70	0.007	0.0003	0.007	0.17	0.009	1.70
2005	0.89	0.70	0.009	0.0003	0.007	0.15	0.009	1.76
2006	0.97	0.69	0.012	0.0004	0.007	0.13	0.009	1.81
2007	1.01	0.79	0.014	0.0005	0.007	0.12	0.009	1.95
2008	1.09	0.71	0.015	0.0004	0.007	0.14	0.007	1.97
2009	1.14	0.72	0.015	0.0005	0.008	0.14	0.007	2.03
2010	1.24	0.81	0.015	0.0005	0.010	0.16	0.007	2.24
2011	1.25	0.72	0.016	0.0005	0.009	0.16	0.007	2.16
%, 2011	57.7	33.4	0.7	0.0	0.4	7.3	0.3	

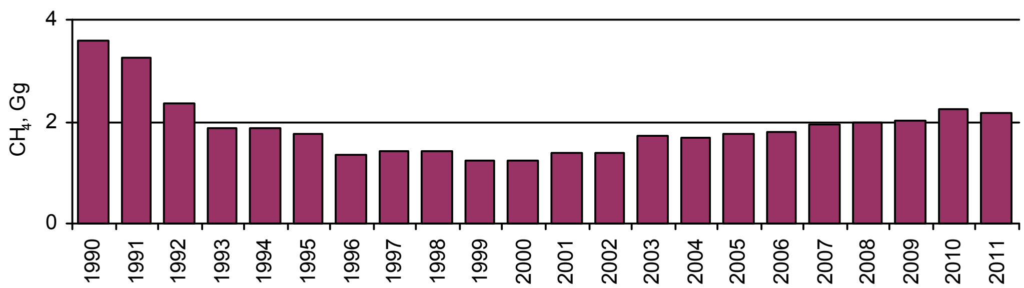


Figure 6.16. CH_4 emissions from Estonia's livestock manure management in 1990–2011, Gg

6.4.1.1. Cattle manure management

6.4.1.1.1. Methodology, data availability, data sources and emission factors

CH_4 production from manure of dairy cattle and non-dairy cattle was estimated based on the algorithm presented in the IPCC (2000) using country-specific data and IPCC default factors (6.14–6.16).

$$CH_4\_Emissions_{ji} = EF_{ji} \times Population_{ji} / (10^6 \, kg/Gg) \quad (6.14)^{47}$$

CH_4 Emissions$_{ji}$ – Methane emissions from manure management of *j* category of cattle in *i* county, Gg CH_4/year;
EF_{ji} – Methane emission factor for *j* category of cattle in *i* county, kgCH_4/head/year;
Population$_{ji}$ – The number of head in *j* category of cattle in *i* county, heads.

[47] IPCC 2000. Agriculture. Equation 4.15, pp. 4.30.

$$EF_{ji} = VS_{ji} \times 365\_days/yr \times B_{oji} \times 0.67kg/m^3 \times \sum_{nK} MCF_{nk} \times MS\%_{jiK} \qquad (6.15)^{48}$$

EF_{ji} – Annual methane emission factor for *j* category of cattle in *i* county, kg;

VS_{ji} – Volatile solid excreted 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 (Table 6.22);

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*.

$$VS_{ji}\ (kg\ \ dm/day) = \frac{GE_{ii}}{18.45} \times (1 - \frac{DE_{ji}\%}{100\%}) \times (1 - \frac{ASH\%}{100\%}) \qquad (6.16)^{49}$$

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, % (Table 6.22);

ASH – Ash content of the manure as a percentage, % (8%).

Table 6.22. Parameters used in the estimates

Cattle category	Feeding situation	Digestibility of feed, %[50]	CH_4 Conversion, %	Bo, m^3 CH_4/kg VS
Mature cattle[51]				
...Dairy	Pasture/Range	67	6	0.24
...Non-dairy cattle:				
…...Mature females	Pasture/Range	62	6.5	0.17
…...Mature males	Pasture/Range	63	6.5	0.17
Bovine animals (aged between 1 and 2 years)[52]	Pasture/Range	63	6	0.17
Calves (6-12 months old)[53]	Pasture/Range	63	6	0.17
Calves (0-6 months old)	Stall feed	63	3	0.17

The country-specific module on MMS (Appendix A.3.3_IV) and CH_4 EFs employed in the estimations are presented in Table 6.23. The country-specific CH_4 EFs are

[48] IPCC 2000. Agriculture. Equation 4.17, pp. 4.34.
[49] IPCC 2000. Agriculture. Equation 4.16, pp. 4.31.
[50] Kaasik et al., 2002.
[51] IPCC 1997. Agriculture. Reference Manual. Dairy Cattle – Table A-1, Non-dairy cattle – Table A-2. pp. 4.341-4.343 (for Eastern European countries).
[52] IPCC 1997. Agriculture. Reference Manual. Bovine animals – Table A-2. pp. 4.342-4.343 (replacement/ growing cattle of Western European countries).
[53] IPCC 1997. Agriculture. Reference Manual. Calves – Table A-2, pp. 4.342-4.343 (young cattle of Eastern European countries).

higher than IPCC default CH_4 EFs, because the amount of manure stored in the liquid/slurry system, is higher than IPCC default share (for Eastern Europe).

Table 6.23. Manure management system usage, methane conversion factors (MCFs) and manure management emission factors for dairy cattle in 2011 by county of Estonia

County	Manure management system, %			Emission factor, kg CH_4/head/yr
	Liquid/Slurry	Solid Storage	Pasture/Range	
Harju	14.6	45.9	39.6	6.97
Hiiu	0.0	56.2	43.8	2.60
Ida-Viru	17.7	41.7	40.7	7.65
Jõgeva	17.4	42.0	40.7	8.29
Järva	22.7	36.6	40.7	9.78
Lääne	13.3	48.6	38.1	6.55
Lääne-Viru	28.7	33.8	37.5	11.57
Põlva	32.0	28.0	40.0	12.78
Pärnu	34.9	30.1	35.0	13.18
Rapla	29.0	30.8	40.2	11.57
Saare	15.5	43.6	40.9	7.01
Tartu	43.5	15.3	41.2	16.68
Valga	23.5	33.5	43.1	9.33
Viljandi	23.1	37.5	39.4	9.38
Võru	12.1	45.4	42.5	6.23
Estonian average	25.2	35.2	39.6	10.32
EE[54]	18	68 +1[(55)]	13	6.0
MCFs[56], %	10	1	1	

Implied CH_4 EFs have increased by 2011 since 1990, due to changes in technology of dairy cattle housing. The transition from tie-stall housing technology to loose-housing technology launched in Estonian farms in the beginning of 2000's, that stipulated a switch from solid storage MMS to liquid/slurry MMS in dairy cattle farms (Figure 6.17; see also Appendix A.3.3_IV).

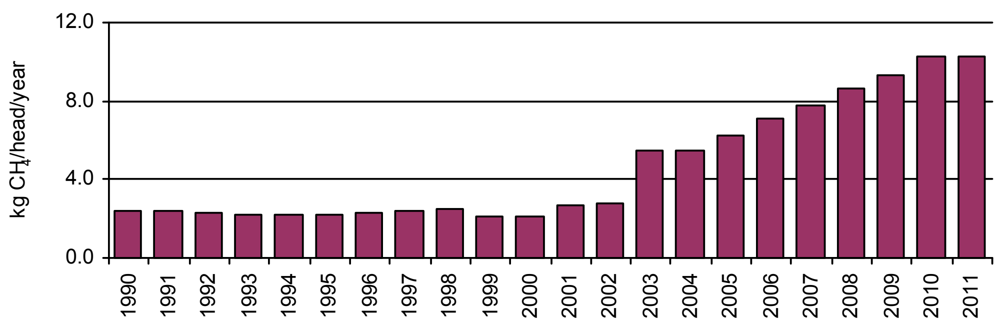


Figure 6.17. Implied CH_4 emission factor for dairy-cattle manure management system in 1990–2011, kg CH_4/head/year

It was assumed that MMS usage for manure storage of mature non-dairy cattle has not changed over the whole period of reporting – tie stall housing technology with solid

[54] IPCC 1997. Agriculture. Reference Manual. Table B-3, pp. 4.43.
[55] Daily spread.
[56] IPCC 1997. Agriculture. Reference Manual, Table 4-8, pp. 4.25.

storage MMS was mostly applied in cattle breeding holdings. Hence, a share of non-dairy cattle manure stored to solid storage MMS made up 56% and about 44% of time, mature non-dairy cattle spent on pasture. CH_4 EFs applied in the estimations were: mature males – 1.10kgCH_4/head/year and mature females – 1.13kgCH_4 per head/year. Values of EFs were used to estimate CH_4 emissions for the entire time-series.

MMSs used to store animal waste generated by bovine cattle (young cattle) and by calves (6–12 months) and CH_4 EFs for each county of Estonia are presented in Table 6.24 (see also Appendix A.3.3_IV).

Table 6.24. Manure management system usage, methane conversion factors and manure management emission factors for young cattle in 2011, by county of Estonia

County	Manure management system, %				EFs, kg CH_4/head/year	
	Liquid/Slurry	Solid Storage	Deep litter	Pasture/Range	Bovine animals	Calves (6-12 months old)
Harju	8.1	49.2	9.6	33.1	2.75	1.95
Hiiu	0.0	56.2	0.0	43.8	1.06	0.75
Ida-Viru	2.2	56.7	5.2	35.9	1.77	1.25
Jõgeva	4.7	35.9	18.9	40.5	3.32	2.35
Järva	9.7	37.1	13.9	39.3	3.32	2.34
Lääne	0.0	50.8	12.2	37.0	2.23	1.58
Lääne-Viru	1.5	45.1	17.6	35.8	2.89	2.04
Põlva	13.1	26.6	21.0	39.4	4.32	3.05
Pärnu	12.6	40.1	12.8	34.5	3.49	2.47
Rapla	0.0	38.6	21.6	39.7	3.13	2.21
Saare	1.8	53.2	7.5	37.5	1.95	1.38
Tartu	13.0	20.4	29.8	36.8	5.15	3.64
Valga	0.0	41.2	16.3	42.5	2.62	1.85
Viljandi	0.4	52.3	11.1	36.2	2.16	1.53
Võru	0.0	57.7	0.9	41.4	1.14	0.81

CH_4 IEFs for young cattle have slightly changed over 1990–2011 (Figure 6.18), because of the shifts in the housing technology – from tie stall housing to loose-housing, from solid storage MMS to liquid/slurry MMS and deep litter MMS.

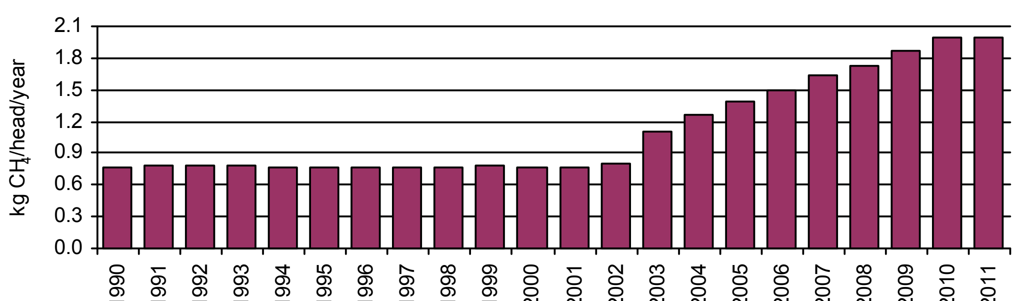


Figure 6.18. Implied CH_4 emission factor for young cattle MMS in 1990–2011, kgCH_4/head/year

Calves (0–6 months) are kept in individual or group boxes, which corresponds to solid storage MMS. Hence, the ratio of manure stored to solid MMS is 56%; in summer period, calves are kept on pasture or at outside yard, which can be defined as pasture, range (44%). EF for manure management of calves (0–6 months old) was estimated at 0.37 kg CH_4/head/year for the entire time period.

6.4.1.1.2. Quantitative overview – CH_4 emissions from cattle manure management in 2011

The total CH_4 emissions from cattle manure management were 1.25 Gg in Estonia in 2011, the emissions increased by 17% by 2011 in comparison with the base year (Table 6.25).

Table 6.25. CH_4 emissions from cattle manure management activities in 1990–2011 in Estonia, Gg

Year	Dairy cattle	Mature non-dairy cattle	Young cattle	Total emissions
1990	0.682	0.06	0.323	1.063
1991	0.629	0.06	0.304	0.991
1992	0.575	0.05	0.248	0.869
1993	0.504	0.03	0.163	0.698
1994	0.464	0.03	0.142	0.632
1995	0.411	0.02	0.126	0.559
1996	0.399	0.02	0.117	0.537
1997	0.405	0.02	0.108	0.533
1998	0.398	0.02	0.101	0.517
1999	0.287	0.02	0.087	0.393
2000	0.271	0.02	0.082	0.371
2001	0.345	0.01	0.091	0.451
2002	0.319	0.01	0.101	0.435
2003	0.636	0.02	0.138	0.791
2004	0.642	0.02	0.149	0.809
2005	0.703	0.02	0.165	0.888
2006	0.769	0.02	0.177	0.967
2007	0.800	0.02	0.190	1.014
2008	0.866	0.03	0.194	1.088
2009	0.902	0.03	0.208	1.140
2010	0.991	0.03	0.219	1.243
2011	0.993	0.04	0.219	1.248
%, 2011	79.5	2.9	17.6	100

6.4.1.2. Swine manure management

6.4.1.2.1. Methodology, data availability, data sources and emission factors

Methane production from the manure of swine by sub-categories was estimated based on the algorithm described in Chapter 6.3.3.1.

Methane conversion factors and the use of different systems of manure management for swine manure storage are presented in Table 6.26.

Table 6.26. Parameter used in the estimates

	Feed digestibility, %[57]	VS, kg/h/d	Bo, m^3 CH_4/kg VS[58]	MCF, %[59]
Piglets, live weight less than 20 kg	85	0.08	0.45	0.6
Young pigs, live weight 20–<50 kg	85	0.18	0.45	0.6
Fattening pigs				
…live weight 50–<80 kg	80	0.37	0.45	0.6
…live weight 80–<110 kg	80	0.47	0.45	0.6
…live weight 110 kg or more	80	0.51	0.45	0.6
Breeding pigs, live weight 50 kg or more	80	0.40	0.45	0.6

[57] Kaasik et al., 2002.
[58] IPCC 1997. Agriculture. Reference Manual. Table B-6, pp. 4.46.
[59] IPCC 1997. Agriculture. Reference Manual. Table A-4, pp. 4.35.

Table 6.27. MMS usage, methane conversion factor and manure management emission factors for swine in 2011 by county of Estonia

County	Manure management system, %			Emission factor, kg CH_4/head/year					
				Piglets, live weight less than 20 kg	Young pigs, live weight 20–<50 kg	Fattening pigs…			Breeding pigs, live weight 50 kg or more
	Liquid/ Slurry	Solid storage	Pasture, Range			...live weight 50–<80 kg	...live weight 80–<110 kg	…live weight 110 kg or more	
Harju	98.4	1.3	0.3	0.87	1.91	4.00	5.08	5.57	4.37
Hiiu	0.0	99.7	0.3	0.09	0.19	0.41	0.51	0.56	0.44
Ida-Viru	59.5	40.2	0.3	0.56	1.23	2.58	3.27	3.59	2.82
Jõgeva	36.4	63.3	0.3	0.38	0.83	1.73	2.20	2.42	1.90
Järva	85.0	14.7	0.3	0.76	1.68	3.51	4.45	4.88	3.84
Lääne	0.0	99.7	0.3	0.09	0.19	0.41	0.51	0.56	0.44
Lääne-Viru	66.9	32.8	0.3	0.62	1.36	2.85	3.62	3.97	3.12
Põlva	37.0	62.7	0.3	0.38	0.84	1.76	2.23	2.45	1.92
Pärnu	79.3	20.4	0.3	0.72	1.58	3.30	4.19	4.59	3.61
Rapla	97.0	2.7	0.3	0.86	1.89	3.95	5.01	5.50	4.32
Saare	98.3	1.4	0.3	0.69	1.51	3.16	4.01	4.40	3.46
Tartu	61.8	37.9	0.3	0.58	1.27	2.66	3.38	3.71	2.91
Valga	24.3	75.4	0.3	0.28	0.62	1.29	1.64	1.80	1.41
Viljandi	98.1	1.6	0.3	0.86	1.90	3.98	5.06	5.55	4.36
Võru	0.3	99.4	0.3	0.09	0.20	0.42	0.53	0.58	0.46
EE[60]	8[(61)]	39 +14+38[(62)]							4[(63)]
MCFs[64], %	10	1	1						

[60] IPCC 1997. Agriculture. Reference Manual. Table B-6, pp. 4.46.
[61] Anaerobic lagoons.
[62] 14% - Dry lot and 38% – Pits less than 1 month and more than 1 month.
[63] IPCC 1997. Agriculture. Reference Manual. Table 4-6, pp. 4.13.
[64] IPCC 2000. Agriculture. Table 4-10, pp. 4.36; IPCC 1997. Agriculture. Reference Manual, Table 4-8, pp. 4.25.

The algorithm and dataset used to develop the country-specific module on MMS in Estonia was described in Appendix A.3.3_IV and the results are presented in Table 6.27. MCF related to each type of MMS and CH_4 EFs related to Estonian counties are reported in the same table.

In the 2013 submission, CH_4 emissions from slurry treated in biogas plant were taken into consideration for the first time. Since, the IPCC Guidelines do not provide rules on how to include biogas treated slurry in the inventory, experience of Danish colleagues was implemented (Danish NIR, 2011). Results of the study indicate that CH_4 emissions from biogas treated slurry are lower than non-biogas treated slurry: namely, from pig treated slurry emissions are lower by 40% than from untreated slurry.

Hence, the estimation of CH_4 emissions from biogas treated slurry was performed as follows (Danish NIR, 2011; 6.17):

$$CH_{4,treated\_slurry} = VS \cdot B_0 \cdot MCF \cdot 0.67 \cdot E_{lower} \quad (6.17)$$

Where, VS, B_0, MCF were used as described in Table 6.26, E_{lower} for pig slurry treated for biogas was used at 0.60.

Total amounts of pig slurry treated in biogas plant are presented in Table 6.28, it made up about 50% of the total slurry excreted by swine in Saare County.

Table 6.28. Pig manure slurry treated for biogas production in plant in 2006–2011

	2006	2007	2008	2009	2010	2011
tonnes	27 830	25 362	41 639	39 530	36 808	37 997

Implied CH_4 emission factors for swine manure management system have slightly changed in the period of 1990–2011 due to changes in the structure of swine population, the IEFs are slightly lower in 2006–2011 due to relatively low emissions from treated pig slurry in Saare county. Values of IEFs are reported in Figure 6.19.

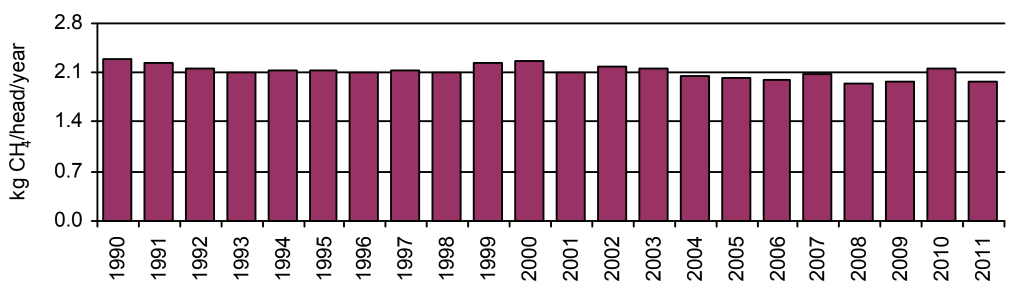


Figure 6.19. Implied CH_4 emission factor for swine manure management system in 1990–2011, kg CH_4/head/year

6.4.1.2.2. Quantitative overview – CH_4 emissions from swine manure management in 2011

The total CH_4 emissions from swine manure management were 0.72 Gg in Estonia in 2011 (Figure 6.20). The emissions decreased by 63 per cent by 2011 in comparison with the base year due to decrease in number of swine population. In total, due to use of swine slurry in biogas production plant, the reduction of CH_4 emissions from MMSs were about 1.3–2.3% out of the total emission of swine MMS in 2006–2011.

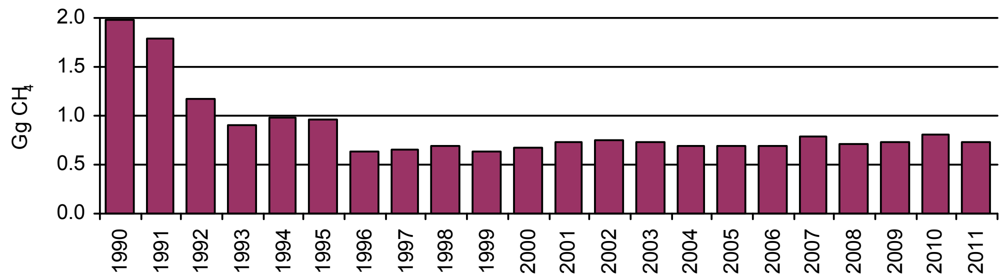


Figure 6.20. CH_4 emissions from swine MMSs in 1990–2011 in Estonia, Gg

6.4.1.3. Other livestock manure management

6.4.1.3.1. Methodology, data availability, data sources and emission factors

CH_4 emissions from manure management for other livestock were calculated in accordance with the equation (6.13) using activity data on the population of livestock and the default IPCC emission factors (IPCC, 1997).

The module on MMS for sheep, goats and horse livestock categories was developed based on grazing-period of animals (Appendix A.3.3_IV). Animal wastes generated by livestock categories are stored in 'solid manure management system' (Table 6.29).

Table 6.29. Manure management system usage and methane emission factors from manure management of other livestock categories[65]

Livestock category	Manure management system, %		Emission factor[66], kg CH_4/head/year
	Solid storage	Pasture/Range	
Sheep	50.68	49.32	0.19
Goats	50.68	49.32	0.12
Horses	58.90	41.10	1.4
Poultry[67]	98.54	1.46	0.078
Fur animals[68]	100	-	
…Foxes and Raccoon			2.34
…Minks			1.305

6.4.1.3.2. Quantitative overview – CH_4 emissions from manure management other livestock categories in 2011

The total CH_4 emission from manure management system of other livestock categories was 0.192 Gg in Estonia in 2011 (Figure 6.21). The emission declined by

[65] The module was applied only in the estimation of N_2O emissions from manure management of other livestock, since CH4 emission from manure management was estimated based on Tier 1 of the IPCC Guidelines.
[66] IPCC 1997. Agriculture. Reference Manual. Table 4-5 (developed countries, cool climate region), pp. 4-12.
[67] The data of 2011.
[68] The values of manure management factor for fur animals were provided by a finish expert of the Agriculture sector.

66 per cent by 2011 in comparison with the base year due to decrease in the number of other livestock population.

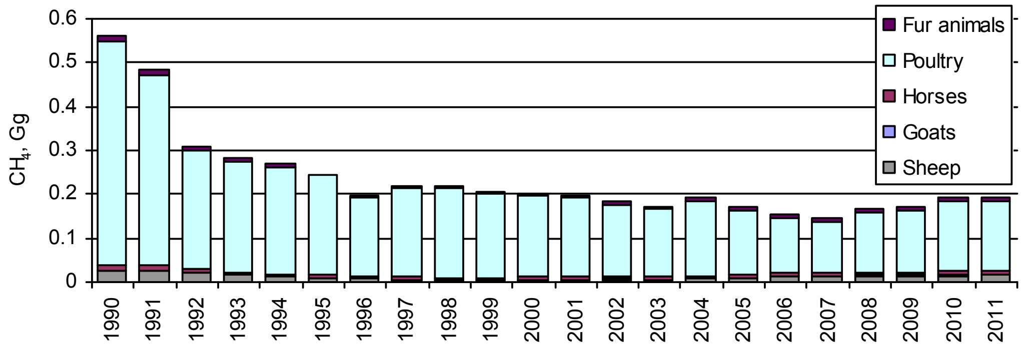


Figure 6.21. CH_4 emission from manure management other livestock categories in 1990–2011, Gg

6.4.1.4. Source-specific recalculations

There are several recalculations carried out in the 2013 submission:

Cattle manure management:

(1) data on weight of dairy cattle were updated;

(2) emissions from enteric fermentation were estimated separately for calves (0–6 months) and calves (6–12 months) (a recommendation of the ERT, see ARR2011, para 70). For this purpose, the total population of calves, which are less than 1 year old (data are collected by the SE and represents the population of calves), was split into two groups;

(3) data on weight of bovine cattle (aged between 1 and 2 years) was updated, country-specific values were used;

(4) reporting way of emissions in the CRF reporter was changed: emissions from enteric fermentation of bovine animals (aged between 1 and 2 years) were excluded from 'Manure non-dairy cattle' category (Option B) and reported under 'Young Cattle' category in the 2013 submission;

(5) Estonian country-specific module on manure management system was developed for 1990 and 2010; the interpolation between 1990 and 2001, between 2001 and 2010 was applied.

The results of the recalculations are reported in Table 6.30.

Table 6.30. CH_4 emissions from cattle manure management systems in 1990–2010, Gg

Year	Reported CH_4 emissions in the 2012 submission	Recalculated CH_4 emissions in the 2013 submission
1990	3.476	1.063
1991	3.284	0.991
1992	2.884	0.869
1993	2.315	0.698
1994	2.064	0.632
1995	1.839	0.559
1996	1.774	0.537

Year	Reported CH_4 emissions in the 2012 submission	Recalculated CH_4 emissions in the 2013 submission
1997	1.760	0.533
1998	1.715	0.517
1999	1.466	0.393
2000	1.409	0.371
2001	1.504	0.451
2002	1.417	0.435
2003	1.434	0.791
2004	1.457	0.809
2005	1.457	0.888
2006	1.450	0.967
2007	1.402	1.014
2008	1.400	1.088
2009	1.371	1.140
2010	1.389	1.243

Swine manure management:

Estonian country-specific module on manure management system was developed for 1990 and 2010; the interpolation between 1990 and 2001, between 2001 and 2010 was applied.

The results of the recalculations are reported in Table 6.31.

Table 6.31. CH_4 emissions from swine manure management systems in 1990–2010, Gg

Year	Reported CH_4 emissions in the 2012 submission	Recalculated CH_4 emissions in the 2013 submission
1990	1.660	1.979
1991	1.539	1.781
1992	1.042	1.170
1993	0.822	0.894
1994	0.898	0.978
1995	0.887	0.954
1996	0.589	0.629
1997	0.613	0.651
1998	0.659	0.691
1999	0.608	0.640
2000	0.640	0.677
2001	0.700	0.731
2002	0.708	0.749
2003	0.696	0.740
2004	0.658	0.698
2005	0.668	0.698
2006	0.681	0.687
2007	0.775	0.788
2008	0.714	0.712
2009	0.703	0.722
2010	0.767	0.805

Sheep and goat manure management:

There is one recalculation performed to estimate CH_4 emissions from MMS of sheep and goats: data on livestock population were updated for 1990–1992 and for 1995 due to an omission made in the previous submissions. The results of the recalculations are presented in Table 6.32.

Table 6.32. CH_4 emissions from sheep and goat manure management in 1990–1992 and in 1995, Gg

	Sheep		Goats	
	Reported CH_4 emissions in the 2012 submission	Recalculated CH_4 emissions in the 2013 submission	Reported CH_4 emissions in the 2012 submission	Recalculated CH_4 emissions in the 2013 submission
1990	0.027	0.026	0.0001	0.0002
1991	0.027	0.027	0.0001	0.0002
1992	0.023	0.023	0.0001	0.0001
1995	0.009	0.009	0.0002	0.0002

6.4.1.5. Source-specific planned improvements

Activity data and EFs are kept under consideration and will be updated necessarily.

6.4.2. N_2O emissions from manure management

6.4.2.1. 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).

6.4.2.2. Cattle manure management

6.4.2.2.1. Methodology, data availability, data sources and emission factors

The key methodology used for the estimation of N_2O emissions from manure management was the *Tier 2* method (IPCC, 1997) (6.18).

$$(N_2O-N)_{(mm)} = \sum_{(S)} \{[\sum_{(T)} N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}] \bullet EF_{3(S)}\} \quad (6.18)$$[69]

$(N_2O\text{-}N)_{(mm)}$ – 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* (Table 6.41);

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 (6.19):

[69] IPCC 2000. Agriculture. Equation 4.18. pp. 4.42.

$$N_2O_{(mm)} = (N_2O - N)_{(mm)} \bullet 44/28 \quad (6.19)$$

The data on livestock population by categories were obtained from database of SE (Appendix A.3.3_I). Nitrogen excretion factors for all categories of cattle were calculated based on nitrogen balance described in (PVT, 2007) (6.20):

$$N_{excreta_{ji}} = N_{feed_{ji}} - (N_{milk} + N_{weight\_gain} + N_{embryo})_{ji} \quad (6.20)$$

$N_{excreta\_ji}$ – Nitrogen excreted per *j* category of cattle in *i* country, kg/head/year;

N_{feed_ji} – Nitrogen consumption with feed by *j* category of cattle in *i* country, kg/head/year;

N_{milk_ji} – Nitrogen absorbed in milk, kg/head/year;

$N_{weight\ gain\_ji}$ – Nitrogen retained for growth per *j* category of cattle in *i* country, kg/head/year;

N_{embryo_ji} – Nitrogen required to support embryo development in *i* country, kg/head/year.

Nitrogen contained in feed consumed by different categories of cattle was calculated taken into account the values of gross intake (kg/head/yr, the algorithm is described in Chapter 6.3.2.1. and average rates of nitrogen content in animal feed (Appendix A.3.3_V). N_{milk}, N_{gain} and N_{embryo} were estimated as follows (Standard values…, 1997):

N_{milk} = kg milk protein per cow per year / 6.35

N_{gain} = kg weigh gain per head per year * nitrogen content in body weight

N_{embryo} = kg calf * nitrogen content in embryo

The values of nitrogen content in milk, body weight and embryo are reported in (Appendix A.3.3_V). Values of milk protein content by county of Estonia in 1990–2011 were obtained from EERC[70].

Table 6.33. Weight, milk yield per cow and protein content of milk in 1990–2011 (Appendix A.3.3_II)

Year	Weight of dairy-cattle, kg	Milk yield per cow, kg/head/yr	Protein content of milk, g/kg	Gross energy intake, MJ/head/day	Nitrogen excretion rate, kg N/head/yr
1990	544.9	4 164	3.22	253.9	88.72
1991	545.1	3 968	3.25	248.6	88.12
1992	545.3	3 530	3.14	237.1	85.82
1993	545.6	3 322	3.11	232.5	84.93
1994	545.7	3 455	3.15	229.7	84.09
1995	545.8	3 588	3.17	231.8	84.67
1996	545.9	3 809	3.20	241.2	87.81
1997	546.1	4 484	3.15	250.6	90.35
1998	546.3	4 456	3.18	260.3	92.37
1999	546.5	4 171	3.15	250.3	87.00

[70] Results of animal recording in Estonia in 1997–2011. Annual Reports. Available at: www.jkkeskus.ee/page.php?page=0147.

Year	Weight of dairy-cattle, kg	Milk yield per cow, kg/head/yr	Protein content of milk, g/kg	Gross energy intake, MJ/head/day	Nitrogen excretion rate, kg N/head/yr
2000	546.7	4 660	3.28	265.6	92.96
2001	546.8	5 313	3.31	283.8	96.55
2002	546.9	5 138	3.27	280.7	96.39
2003	547.0	5 231	3.30	281.9	95.70
2004	546.9	5 596	3.31	291.0	98.30
2005	546.9	5 886	3.34	297.7	99.50
2006	546.9	6 285	3.35	307.0	101.47
2007	547.0	6 484	3.36	311.6	101.56
2008	547.1	6 781	3.36	318.1	114.51
2009	547.2	6 838	3.37	320.0	115.25
2010	547.3	7 021	3.36	324.0	116.14
2011	547.4	7 168	3.39	323.9	116.14
IPCC default					
EE[71]	550[(72)]	2 550			70[(73)]
WE	550	4 200			100

The trend in (implied) nitrogen excretion rates reported in the CRF are presented in Table 6.33, nitrogen excretion factors for dairy cattle by county of Estonia in 2011 are presented in Table 6.34.

Table 6.34. Milk yield per cow, gross intake and nitrogen excretion rate in 2011 by counties of Estonia

County	Milk yield per cow, kg/head/year	Gross energy intake, MJ/head/day	Nitrogen excretion rate, kg N/head/year
Harju county	6 600	312.3	113.48
Hiiu county	4 667	269.6	103.16
Ida-Viru county	6 298	305.8	111.31
Jõgeva county	7 465	335.0	118.77
Järva county	7 473	332.6	117.93
Lääne county	6 388	308.4	113.00
Lääne-Viru county	7 524	334.3	118.60
Põlva county	7 737	341.2	120.77
Pärnu county	7 294	329.4	117.59
Rapla county	7 267	331.8	119.09
Saare county	6 179	303.2	110.84
Tartu county	8 237	351.1	122.47
Valga county	6 470	310.6	112.40
Viljandi county	6 711	315.7	113.96
Võru county	6 345	309.1	112.47

The calculation of nitrogen excretion rates for non-dairy cattle categories were performed based on the algorithm presented by equation (6.20). The rates are reported in Table 6.35.

[71] IPCC 1997. Agriculture. Reference Manual. Table 4-4, pp. 4.11 and Table A-1, pp. 4.31.
[72] IPCC 1997. Agriculture. Reference Manual. Table A-1, pp. 4.31.
[73] IPCC 1997. Agriculture, Reference Manual. Table 4-20, pp. 4.99.

Table 6.35. Nitrogen excretion rates of non-dairy cattle in 1990–2011, kg N/head/year

Livestock category of non-dairy cattle	Nitrogen excretion rate, kg N/head/yr
Mature males (2 years and over)	65.15
Mature females (2 years and over)	44.74
Bovine animals (aged between 1 and 2 years)	56.72
Calves (6-12 months)[74]	39.67
Calves (0-6 months)	18.28

6.4.2.2.2. Quantitative overview – Nitrogen excretion by cattle livestock in 2011

The total quantity of nitrogen generated by cattle was 17 185 tonnes in Estonia in 2011. The allocation of nitrogen excreted among different types of MMS is presented in Table 6.36.

Table 6.36. The allocation of the quantity of nitrogen (in manure) excreted by cattle among different types of manure management system, tonnes N/year

Year	Liquid system	Solid storage	Deep litter	Pasture range and paddock	Total nitrogen
1990	-	24 900	-	19 434	44 334
1991	-	23 435	-	18 291	41 726
1992	-	20 642	-	16 111	36 753
1993	-	16 349	-	12 760	29 109
1994	-	14 792	-	11 545	26 338
1995	-	13 060	-	10 193	23 253
1996	-	12 407	-	9 683	22 090
1997	-	12 166	-	9 495	21 661
1998	-	11 650	-	9 092	20 742
1999	-	9 777	-	7 631	17 407
2000	-	9 674	-	7 551	17 225
2001	-	10 011	-	7 813	17 824
2002	74	9 435	25	7 375	16 909
2003	991	8 646	200	7 135	16 970
2004	1 310	8 363	256	7 080	17 009
2005	1 566	8 040	327	6 985	16 919
2006	1 825	7 672	379	6 839	16 715
2007	2 018	7 209	436	6 603	16 267
2008	2 479	7 323	475	6 946	17 222
2009	2 685	6 945	530	6 773	16 932
2010	3 049	6 682	584	6 777	17 092
2011	3 032	6 737	585	6 831	17 185

6.4.2.3. Swine

6.4.2.3.1. Methodology, data availability, data sources and emission factors

Activity data on swine population were obtained from national statistics, a method used in the estimation was employed from the IPCC Guidelines (Chapter 6.3.3.1). Nitrogen excretion rates were used from (Keskkonnaministri määrus nr 48, 5.12.2008) (Table 6.37).

[74] 2-round production cycle was applied for calves (0-6 months and 6-12 months).

Table 6.37. Average N excretion factors used in the estimates, kg N/head/year

Swine category	Nitrogen excretion rate, kg N/head/year	IPCC default, kg N/head/year
Piglets, live weight less than 20 kg	4.57	
Young pigs, live weight 20–<50 kg	9.51	
Fattening pigs		
…live weight 50–<80 kg	10.53	
…live weight 80–<110 kg	10.53	
…live weight 110 kg or more	10.53	
Breeding pigs, live weight 50 kg or more	31.67	
Total swine category		20[75]

Nitrogen (implied) excretion factors reported in the CRF are demonstrated in Figure 6.22. The rate has slightly changed over the entire time-series due to the changes in the structure of swine population.

Figure 6.22. Implied swine nitrogen excretion factor reported in the CRF for 1990–2011, kg N/head/year

6.4.2.3.2. Quantitative overview – Nitrogen excretion by swine livestock in 2011

The total quantity of nitrogen generated by pigs was 3 837 tonnes in Estonia in 2011. The allocation of nitrogen excreted among different types of manure management system is presented in Table 6.38.

Table 6.38. The allocation of amount of nitrogen (contained in manure) excreted by pigs and stored in different types of MMSs, tonnes N/year

Year	Liquid system	Solid storage	Pasture, range and paddock	Total nitrogen
1990	7 116	1 026	-	8 142
1991	6 423	1 086	-	7 509
1992	4 249	829	-	5 078
1993	3 327	739	-	4 066
1994	3 492	895	-	4 387
1995	3 337	884	-	4 222
1996	2 243	612	-	2 855
1997	2 362	644	-	3 006
1998	2 504	697	-	3 201

[75] IPCC 1997. Agriculture, Reference Manual. Table 4-20, pp. 4.99.

Year	Liquid system	Solid storage	Pasture, range and paddock	Total nitrogen
1999	2 479	716	-	3 195
2000	2 650	802	-	3 452
2001	2 950	859	-	3 809
2002	2 886	839	-	3 725
2003	2 882	834	-	3 716
2004	2 736	841	-	3 577
2005	2 756	881	-	3 637
2006	2 732	935	-	3 666
2007	2 909	1 035	1	3 944
2008	2 797	982	2	3 780
2009	2 784	972	3	3 760
2010	2 850	1 013	12	3 875
2011	2 809	1 017	11	3 837

6.4.2.4. Other livestock

6.4.2.4.1. Methodology, data availability, data sources and emission factors

Activity data on other livestock population were obtained from national statistics, the module on MMS was used from Table 6.29 and nitrogen excretion rates (Table 6.39) were obtained from the Revised 1996 IPCC Guidelines (IPCC, 1997).

Table 6.39. Nitrogen excretion factors per head of animal, kg N/head/year

Livestock category[76]	Nitrogen excretion rate, kg N/head/year
Poultry	0.6
Sheep	16
Horses, Goats	25
Fur farming[77]	
…Foxes and Raccoon	2.3
…Minks	1.3

6.4.2.4.2. Quantitative overview – Nitrogen excretion by other livestock in 2011

The total amount of nitrogen generated by other livestock was 2 912 tonnes in 2011. The breakdown of the quantity of nitrogen excreted by other livestock categories is reported in Table 6.40.

Table 6.40. Nitrogen (in manure) excreted by other livestock categories, t N/year

Year	by livestock category					by MMS		
	Sheep	Goats	Horses	Poultry	Fur animals	Solid storage	Pasture/ range	Total
1990	2 208	45	215	3 922	153	5 213	1 330	6 543
1991	2 254	48	195	3 323	153	4 645	1 328	5 973
1992	1 944	30	165	2 051	136	3 217	1 109	4 326
1993	1 315	28	130	1 936	119	2 744	783	3 527
1994	960	38	125	1 878	103	2 494	610	3 104
1995	771	40	115	1 747	61	2 224	510	2 734

[76] IPCC 1997. Agriculture, Reference Manual. Table 4-20, pp. 4.99.
[77] The values of emission excretion rates from manure management of fur animals was provided by an Finish expert in the agriculture sector.

Year	by livestock category					by MMS		
	Sheep	Goats	Horses	Poultry	Fur animals	Solid storage	Pasture/ range	Total
1996	602	40	105	1 395	60	1 792	410	2 202
1997	542	43	105	1 561	59	1 921	389	2 310
1998	459	53	98	1 581	62	1 901	352	2 252
1999	451	68	98	1 477	33	1 775	352	2 127
2000	464	80	105	1 420	36	1 739	366	2 105
2001	461	90	138	1 377	71	1 755	382	2 136
2002	478	98	133	1 258	78	1 664	380	2 044
2003	493	88	145	1 167	92	1 607	378	1 985
2004	621	73	128	1 310	116	1 817	430	2 247
2005	794	70	120	1 127	102	1 708	505	2 213
2006	1 003	83	123	983	105	1 689	607	2 296
2007	1 158	100	133	887	108	1 695	690	2 385
2008	1 251	90	130	1 054	77	1 870	732	2 602
2009	1 224	98	135	1 075	77	1 885	724	2 609
2010	1 258	103	170	1 228	80	2 079	759	2 838
2011	1 342	108	163	1 220	80	2 112	800	2 912

6.4.2.4.3. Quantitative overview – N_2O emissions from manure management systems in Estonia in 2011

The total quantity of nitrogen generated by livestock and stored in solid, liquid and deep litter types of MMSs was 16 293 tonnes in 2011 (Table 6.42). N_2O emissions at 0.338 Gg occurred from the stored manure. The breakdown of N_2O emissions released from different types of manure management systems is reported in Table 6.41.

Table 6.41. Emission factors of manure management practice[78]

Manure management system	EF_3 (kg N_2O-N/kg Nitrogen excreted)
Liquid system	0.001
Solid storage	0.02
Deep Litter	0.02
Pasture range and paddock	0.02

[78] IPCC 2000. Agriculture. Table 4.12, pp 4.43.

Table 6.42. Nitrogen (in manure) excreted by other livestock categories and N_2O emissions from manure management systems in 1990–2011

Year	Nitrogen excreted, tonnes					N_2O emissions, Gg			
	Liquid/ Slurry	Solid storage	Deep Litter	Pasture/ Range	Total	Liquid/ Slurry	Solid storage	Deep Litter	Total [79]
1990	7 116	31 139		20 764	59 019	0.011	0.979	-	0.990
1991	6 423	29 166		19 618	55 208	0.010	0.917	-	0.927
1992	4 249	24 688		17 220	46 157	0.007	0.776	-	0.783
1993	3 327	19 833		13 543	36 702	0.005	0.623	-	0.629
1994	3 492	18 181		12 155	33 828	0.005	0.571	-	0.577
1995	3 337	16 168		10 703	30 209	0.005	0.508	-	0.513
1996	2 243	14 811		10 094	27 147	0.004	0.465	-	0.469
1997	2 362	14 731		9 885	26 978	0.004	0.463	-	0.467
1998	2 504	14 248		9 444	26 196	0.004	0.448	-	0.452
1999	2 479	12 268		7 983	22 730	0.004	0.386	-	0.389
2000	2 650	12 215		7 917	22 782	0.004	0.384	-	0.388
2001	2 950	12 624		8 195	23 769	0.005	0.397	-	0.401
2002	2 960	11 938	25	7 755	22 678	0.005	0.375	0.001	0.381
2003	3 873	11 086	200	7 513	22 671	0.006	0.348	0.006	0.361
2004	4 045	11 021	256	7 510	22 833	0.006	0.346	0.008	0.361
2005	4 323	10 629	327	7 490	22 769	0.007	0.334	0.010	0.351
2006	4 557	10 295	379	7 446	22 677	0.007	0.324	0.012	0.343
2007	4 927	9 939	436	7 294	22 597	0.008	0.312	0.014	0.334
2008	5 275	10 175	475	7 680	23 604	0.008	0.320	0.015	0.343
2009	5 469	9 803	530	7 500	23 302	0.009	0.308	0.017	0.333
2010	5 899	9 774	584	7 547	23 804	0.009	0.307	0.018	0.335
2011	5 841	9 866	585	7 642	23 934	0.009	0.310	0.018	0.338
2011, %	24.4	41.2	2.4	31.9	100	2.7	91.8	5.4	100

[79] N_2O emissions from 'Pasture/range and paddock' were considered under Direct soil emissions.

6.4.2.5. Uncertainties and time-series consistency

CH_4 emissions from manure management were calculated based on activity data and emission factors.

Uncertainties in estimates of CH_4 emissions from sheep, goats, horses and poultry manure management are reported in (IPCC, 1997) (Table 6.43).

Emission factors for cattle and swine were calculated using IPCC default parameters (volatile solids, CH_4 producing capacity, methane conversion factors, manure management system). IPCC default uncertainty was used in the estimates (±25%) (Table 6.43), the factor was developed based on the experience of other countries. Rypdal and Winiwarter documented that an uncertainty in CH_4 emissions from manure management is ±25% in Norway, ±25% in the Netherlands, ±30% in UK and ±36% in USA (Rypdal and Winiwarter, 2001) and ±30% in Finland (Monni and Syri, 2003).

N_2O emissions from livestock manure management were calculated based on activity data (livestock population), nitrogen excretion factors (Nex, kg/head/year) were calculated based on nitrogen balance of animals and N emission factor related to manure management system. However, in spite of the use of nitrogen balance, default uncertainty rates for Nex (by categories of livestock) were used from the IPCC Guidelines (IPCC, 1997).

IPCC reports nitrogen emission factors for all systems of manure management used in Estonia's estimates of N_2O emissions from animal manure (Table 6.43).

Table 6.43. Estimated values of uncertainties used in agriculture sector

Input	Uncertainties	References
Activity data		
Estonia's livestock population (cattle, swine, sheep, goats, horses, poultry and fur animals)	± 10%	Rypdal and Winiwarter, 2001
Emission factors		
Manure management (CH_4) (cattle, swine)	± 25%	Rypdal and Winiwarter, 2001
Manure management (CH_4) (sheep, goats, horses, fur animals)	± 20%	Table 4-5 of the 1996 IPCC Guidelines, pp. 4.12
Manure management (N_2O)		
…Nitrogen excretion factor (Nex)	± 25%	IPCC, 2000. Agriculture. pp. 4.46
…Anaerobic lagoon	-50%...+100%	IPCC, 2000. Agriculture. pp. 4.43
…Liquid system	-50%...+100%	IPCC, 2000. Agriculture. pp. 4.43
…Solid storage	-50%...+100%	IPCC, 2000. Agriculture. pp. 4.43
…Pasture/range and paddock	-50%...+100%	IPCC, 2000. Agriculture. pp. 4.43
…Other systems (cattle and swine deep litter, poultry manure with bedding)	-50%...+100%	IPCC, 2000. Agriculture. pp. 4.43

6.4.2.6. Source-specific QA/QC and verification

The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.1.

The QA/QC plan for the agricultural sector includes the QC activities described in the IPCC GPG (IPCC 2000, Table 8.1). The activities are carried out every year during the inventory. The QC check list is used during the inventory.

6.4.2.7. Source-specific recalculations

There are several recalculations carried out in the 2013 submission, in 'N_2O emissions from manure management system' sub-section:

Activity data on livestock population:

(1) activity data on sheep and goat population in 1990–1992 and in 1995 were updated because of the omission made in the previous submissions;

Initial parameters used to estimate gross energy intake were recalculated (for cattle):

(2) data on weight of dairy cattle were updated;

(3) data on weight of bovine cattle (aged between 1 and 2 years) were updated, country-specific values were used;

(4) emissions from enteric fermentation were separately estimated for calves (0–6 months) and calves (6–12 months). For this purpose, the total population of calves, which is collected by the SE and represents the population of calves, which are less than 1 year old, was split into two groups;

Nitrogen excretion rates were recalculated:

(5) data on protein content in milk were updated: county-specific protein content of milk was applied in the estimation for the entire period;

(6) nitrogen excretion rates of all categories of young cattle were calculated based on the updated data;

The module on MMS usage was changed:

(7) Estonian country-specific MMSs were developed for cattle, swine and poultry based on data of 1990, 2001 and 2010.

The results of the recalculations performed are presented in Table 6.44, Table 6.45.

Table 6.44. Nitrogen excretion by cattle livestock categories in 1990–2010, kg N/ year

Year	Dairy cattle		Young cattle	
	2012[80]	2013	2012	2013
1990	25 280	24 904	19 950	17 058
1991	24 023	23 291	18 919	16 076
1992	22 468	21 746	15 401	13 086
1993	19 928	19 254	10 113	8 590
1994	18 418	17 777	8 787	7 486
1995	16 267	15 698	7 757	6 628
1996	15 609	15 068	7 209	6 154
1997	15 691	15 152	6 681	5 692
1998	15 165	14 649	6 255	5 338
1999	12 485	12 041	5 422	4 614
2000	12 620	12 178	5 059	4 311
2001	12 855	12 416	5 612	4 793
2002	11 539	11 143	6 068	5 153
2003	11 605	11 180	5 972	5 089
2004	11 861	11 453	5 662	4 814
2005	11 617	11 224	5 754	4 891
2006	11 383	11 000	5 696	4 839

[80] 2012 – the 2012 submission; 2013 – the 2013 submission.

Year	Dairy cattle		Young cattle	
	2012[80]	2013	2012	2013
2007	10 818	10 461	5 644	4 790
2008	11 886	11 497	5 353	4 566
2009	11 517	11 145	5 355	4 557
2010	11 590	11 207	5 316	4 522

Table 6.45. N_2O emissions from Estonian livestock MMSs in 1990–2010, Gg

Year	Liquid/Slurry MMS		Solid storage MMS		Deep Litter MMS	
	2012	2013	2012	2013	2012	2013
1990	0.026	0.011	0.823	0.979	-	-
1991	0.024	0.010	0.771	0.917	-	-
1992	0.020	0.007	0.639	0.776	-	-
1993	0.016	0.005	0.510	0.623	-	-
1994	0.015	0.005	0.470	0.571	-	-
1995	0.014	0.005	0.413	0.508	-	-
1996	0.012	0.004	0.371	0.465	-	-
1997	0.012	0.004	0.369	0.463	-	-
1998	0.012	0.004	0.355	0.448	-	-
1999	0.011	0.004	0.307	0.386	-	-
2000	0.011	0.004	0.305	0.384	-	-
2001	0.012	0.005	0.315	0.397	-	-
2002	0.011	0.005	0.299	0.375	-	0.001
2003	0.011	0.006	0.300	0.348	-	0.006
2004	0.011	0.006	0.304	0.346	-	0.008
2005	0.011	0.007	0.300	0.334	-	0.010
2006	0.011	0.007	0.297	0.324	-	0.012
2007	0.011	0.008	0.293	0.312	-	0.014
2008	0.011	0.008	0.309	0.320	-	0.015
2009	0.011	0.009	0.306	0.308	-	0.017
2010	0.012	0.009	0.313	0.307	-	0.018

6.4.2.8. Source-specific planned improvements

Activity data and EFs are kept under consideration and will be updated necessarily.

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

N_2O 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 available for nitrification and the amount of N_2O emitted (IPCC, 2000).

The following agricultural activities influence N flows in agricultural soils:

- Synthetic fertilizers;
- Animal excreta nitrogen used as fertilizer;
- Sewage sludge application on agricultural soils;
- Biological nitrogen fixation;
- Crop residue;
- Cultivation of high organic content soils.

6.5.1. Source category description

The total direct N_2O emissions from agricultural soils were 1.29 Gg in Estonia in 2011 (Figure 6.23). N_2O emissions decreased by 60% by 2011 in comparison with the base year due to decrease in number of livestock population (i.e., amount of animal manure applied on agricultural soils) due to decline in quantity of fertilizers applied on agricultural land and due to N-fixing crops production (Figure 6.24).

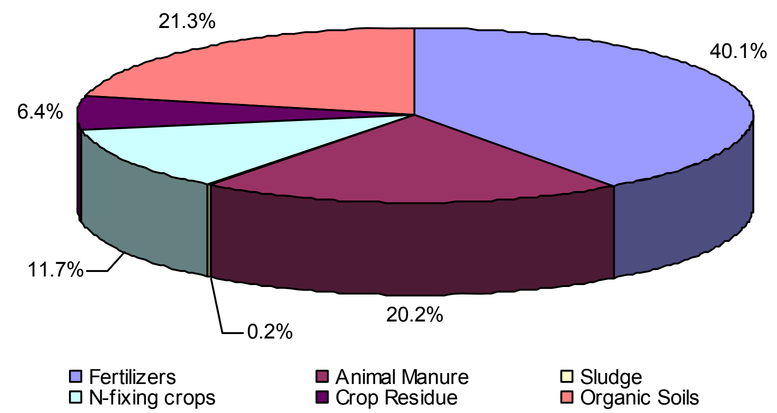


Figure 6.23. Direct N_2O emissions from agricultural soils in Estonia in 2011, %

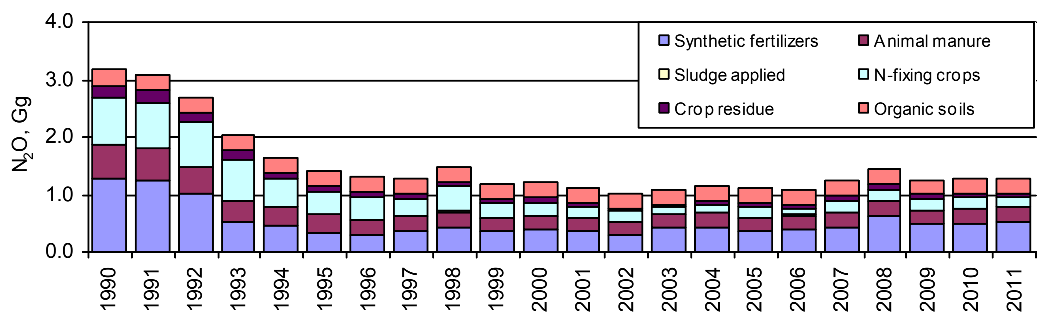


Figure 6.24. Direct N_2O emissions from agricultural soils in Estonia in 1990–2011, Gg

6.5.2. Activity data employed

Activity data on amount of synthetic fertilizers applied on agricultural fields, crop production in Estonia were obtained from the datasets of SE. The data on amounts of sludge used on agricultural lands were used from the EEIC. The data on areas of histosols under cultivation in Estonia were obtained in the framework of National Forest Inventory (Chapter LULUCF).

6.5.3. N_2O emissions from synthetic fertilizer nitrogen applied to soils (CRF 4.D.1.1)

N_2O emissions are estimated from annual synthetic nitrogen applied to soils. The algorithm reported in IPCC (2000) was used to estimate nitrogen input into agricultural soils adjusted for volatilization (6.21, 6.22).

$$F_{SN} = N_{FERT} \times (1 - Frac_{GASF}) \quad (6.21)$$[81]

F_{SN} – Calculation of synthetic fertilizer use, N_2O Gg;

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 (Table 6.46);

N_2O emissions into the atmosphere from using of synthetic nitrogen were calculated based on the formula (6.21).

$$N_2O_{direct} - N = F_{SN} \bullet EF \bullet 44/28_1 \quad (6.22)$$

Table 6.46. IPCC default factors used in the estimation

Factors	Value
EF_1 for F_{SN}	1.25%[82]
$Frac_{GASF}$	0.1 kg NH_3-N + NO_x-N/kg of synthetic fertilizer nitrogen applied[83]

6.5.3.1. Quantitative overview – N_2O emissions from synthetic fertilizers applied to soils in 2011

The total N_2O emissions from synthetic fertilizers applied onto agricultural soils were 0.527 Gg in Estonia in 2011 (Figure 6.26). The emissions declined by 59 per cent by 2011 in comparison with the base year due to the decrease in the amounts of synthetic fertilizers applied to agricultural fields, mostly on fields sown with cereals and forage crops (Figure 6.25, Appendix A.3.3_VI).

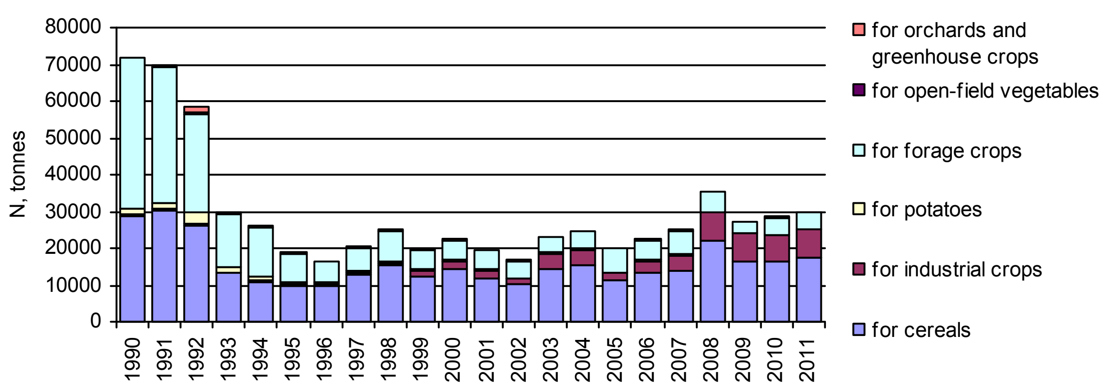


Figure 6.25. Quantity of synthetic fertilizers applied to agricultural soils in 1990–2011 in Estonia, tonnes[84]

[81] IPCC 2000. Agriculture. Equation 4.22, pp. 4.56.
[82] IPCC 2000. Agriculture. Table 4-17, pp. 4.60.
[83] IPCC 1997. Agriculture. Reference Manual. Table 4-19, pp. 4.94.

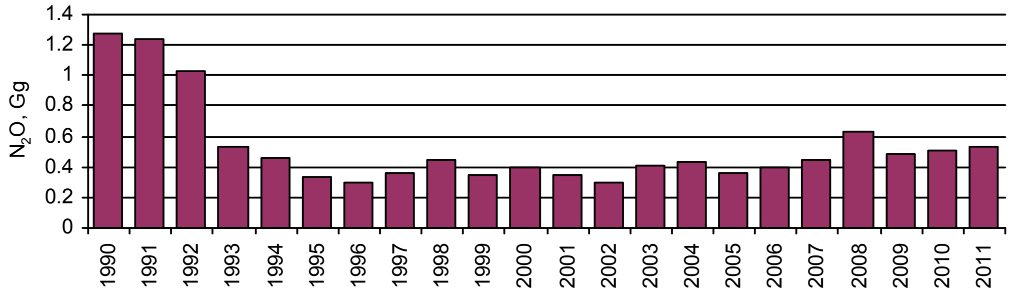


Figure 6.26. N_2O emissions from synthetic fertilizers applied to agricultural soils in 1990–2011 in Estonia, Gg

6.5.4. N_2O emissions from animal manure applied to soils (CRF 4.D.1.2)

N_2O emits from agricultural soil through manure application to fields as organic fertilizer.

6.5.4.1. Methodology, data availability, data sources and emission factors

N_2O emission into the atmosphere from animal waste applied to agricultural fields as organic fertilizer was estimated according to the algorithm proposed by the IPCC (1997) (6.23, 6.24).

$$N_2O_{direct} - N = F_{AW} \bullet EF_1 \qquad (6.23)$$

$$F_{AW} = \sum_T (N_{(T)} \bullet Nex_{(T)} \bullet (1 - Frac_{GASM}))[1 - (Frac_{FUEL\text{-}AM} + Frac_{PRP})] \qquad (6.24)$$ [85]

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/year;

$N_{(T)}$ – Number of animals per type of animal in country;

Nex – Total nitrogen excretion by animals in country, kg N/year;

$Frac_{GASM}$ – Fraction of total nitrogen excretion that is emitted as NOx or NH_3, kg N/kg N;

$Frac_{FUEL\text{-}AM}$ – Fraction of livestock nitrogen excretion contained in excrements burned for fuel, kg N/kg N totally excreted;

$Frac_{PRP}$ – Fraction of livestock nitrogen excreted and deposited onto soil during grazing, kg N/kg N excreted.

Nitrogen excreted per head of different categories of animals and per waste management systems was estimated in 'N_2O emissions from manure management' chapter. IPCC default factors were used to estimate nitrogen input to agricultural soils (Table 6.47).

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[84] The fraction lost as NH_3 and NO_x has not been substracted.
[85] IPCC 2000. Agriculture. Equations 4.23, pp 4.56.

Table 6.47. IPCC default factors used in the estimation of N_2O emissions from animal waste applied to soils[86]

Factor	Value
$Frac_{FUEL}$	0.0 kg N/kg nitrogen excreted
$Frac_{GASM}$	0.2 kg NH_3-N + NO_x-N/kg of nitrogen excreted by livestock

6.5.4.2. Quantitative overview – N_2O emissions from animal manure applied to soils in 2011

The total N_2O emissions from animal manure applied on agricultural soils were 0.256 Gg in Estonia in 2011 (Figure 6.27). The emission decreased by 57 per cent by 2011 compared to the base year, due to the decline in number of livestock population.

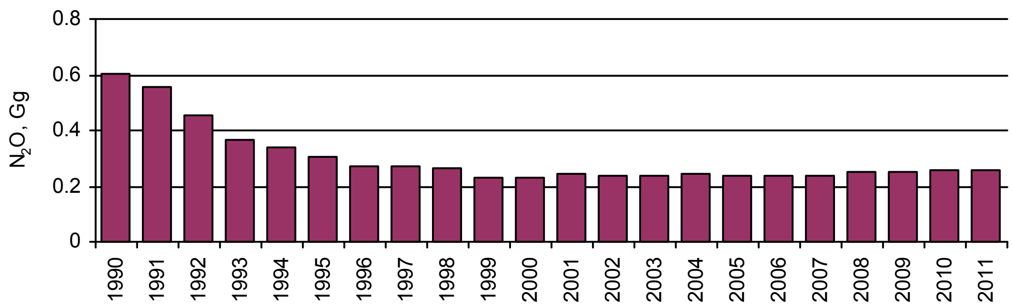

Figure 6.27. N_2O emissions from animal manure applied to agricultural soils in 1990–2011 in Estonia, Gg

6.5.5. Nitrogen input in N-fixing crops (CRF 4.D.1.3)

Amount of nitrogen fixed by N-fixing crops cultivated annually is based on the assumption that the amount of N contained in the aboveground plant material (crop product plus residues) is a reasonable proxy for the total amount of N fixed by the crop (IPCC, 2000).

6.5.5.1. Methodology, data availability, data sources and emission factors

The *Tier 1b* method (IPCC, 1997) was used to estimate emissions from N fixing crops (6.25).

$$F_{BN} = \sum_i [Crop_{BF} \bullet (1 + Res_{BF_i} / Crop_{BF_i}) \bullet Frac_{DM_i} \bullet Frac_{NCRBF_i}] \qquad (6.25)$$ [87]

$Crop_{BF}$ – Production of N-fixing crops in country, kg dry biomass/year;

$Res_{BFi}/Crop_{BFi}$ – residue to crop product mass ratio specific to each crop type i;

FracDMi – the fraction of dry matter in the aboveground biomass of each crop type *i*;

$Frac_{NCRBF}$ – Fraction of nitrogen in N-fixing crop, kg N/kg of dry biomass;

[86] IPCC 1997. Agriculture, Reference Manual. Table 4-19, pp. 4.94.
[87] IPCC 2000. Agriculture. Equation 4.26, pp. 4.57.

Activity data on the production of N-fixing crops in Estonia were obtained from SE (Appendix A.3.3_VII). IPCC default factor was used in the estimation (Table 6.48).

Annual N_2O emissions from N-fixing crops were calculated using the formula (6.26).

$$N_2O_{direct} = F_{BN} \bullet EF_1 \bullet 44/28 \qquad (6.26)$$

EF_1 – IPCC default factor for N-fixing crops (1.25%).

The values of conversion factor from fresh matter to dry matter, crop/residues product ratio and nitrogen fraction in crops are presented in Table 6.48; production data of N-fixing crops in Estonia in 1990–2011 are presented in Figure 6.29, Figure 6.30.

6.5.5.2. Quantitative overview – N_2O emissions from growing of N-fixing crops in 2011

The total production of legumes (i.e., dry bean and peas) was 13,565 tonnes and 490,320 tonnes of clover and alfalfa in Estonia in 2011.

The total N_2O emissions from growing of N-fixing crops were 0.154 Gg in Estonia in 2011 (Figure 6.28).

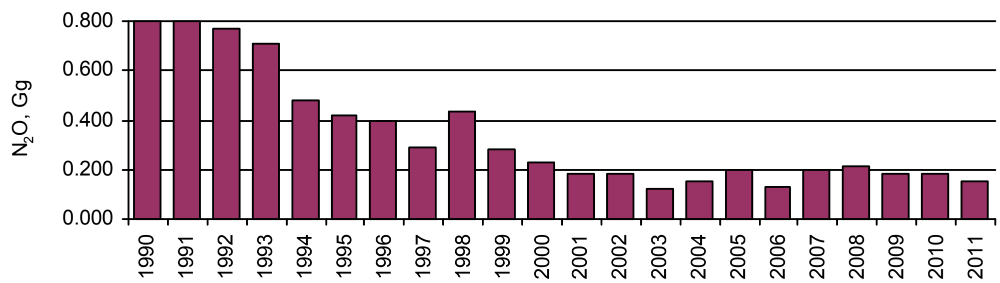

Figure 6.28. N_2O emissions from growing of N-fixing crops in 1990–2011 in Estonia, Gg

6.5.6. N_2O emissions from nitrogen input from crop residues (CRF 4.D.1.4)

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

6.5.6.1. Methodology, data availability, data sources and emission factors

The modified IPCC *Tier 1b* method was used to estimate emissions from crop residues returned to the soil (6.27).

$$F_{CF} = \sum_i (Crop_{O_i} \bullet Res_{O_i}/Crop_{O_i} \bullet Frac_{DM_i} \bullet Frac_{NCRO_i}) \bullet (1 - Frac_{BURN_i} - Frac_R) + \sum_j Crop_{O_j} \bullet Res_{O_j}/Crop_{O_j} \bullet Frac_{DM_j} \bullet Frac_{NCRO_j}) \bullet (1 - Frac_{BURN_j} - Frac_R)$$

(6.27)[88]

$Crop_{BF}$ - Production of pulses in country, kg dry biomass/year;

$Crop_0$ – Production of non-N-fixing crops in country, kg dry biomass/year;

$Res_O/Crop_O$ and $Res_{BF}/Crop_{BF}$ – residue to crop product mass ratio;

$Frac_{NCRBF}$ – 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.

Annual N_2O emissions from crop residues were calculated using the formula (6.28).

$$N_2O_{direct} = F_{CR} \bullet EF_1 \bullet 44/28 \quad (6.28)$$

Selected crop residue statistics and factors used in the algoritm to estimate emissions from crop residues are presented in Table 6.48, Table 6.50.

Table 6.48. Selected crop residue statistics

Crop type	Residue/Crop product ratio	Dry matter fraction	Nitrogen fraction
Wheat	1.3	0.82-0.88	0.0028
Barley	1.2	0.82-0.88	0.0043
Maize	1	0.70-0.86	0.0081
Oats	1.3	0.92	0.007
Rye	1.6	0.9	0.0048
Triticale	1.45	0.85-0.92	0.0038
Millet	1.4	0.85-0.92	0.007
Peas	1.5	0.87	0.0142
Beans	2.1	0.82-0.89	0.0142
Potatoes	0.4	0.30-0.60	0.011
Feed beet and sugar beet	0.3	0.10-0.20	0.0228
Clover[89]	-	0.86	0.018
Alfalfa	-	0.86	0.018

Table 6.49. Factors used in the algorithm to estimate N_2O emissions from crop residues[90]

Factor	Unit
$Frac_R$	0 kg N/kg crop-N[91]
$Frac_{BURN}$	0 (92), kg N/kg crop-N
EF_1 for F_{CF}	1.25%(93)

[88] IPCC 2000. Agriculture. Equation 4.29, pp. 4.59.
[89] Austria's NIR 2011, Table 196. pp. 293.
[90] IPCC 1997. Agriculture. Workbook. Table 4-17, pp 4.35.
[91] $Frac_R$ at value of 0 was apply because of a recommendation of the TERT (conducted in 2012).
[92] Since 2007 the activities to burn crop residues have been prohibited by a law (Põllumajandusministri määrus nr 57, 20.04.2007 and nr 20, 23.02.2011).
[93] IPCC 2000. Agriculture. Table 4-17, pp. 4.60.

6.5.6.2. Quantitative overview – N_2O emissions from crop-residues in 2011

In 2011, production of cereals was 771.6 thousand tonnes, maize – 68.6 thousand tonnes, industrial crops – 0.2 thousand tonnes, potatoes – 164.7 thousand tonnes and legumes and fodder roots – 15.6 and 0.5 thousand tonnes, respectively (Figure 6.29–Figure 6.32) (data of SE, see also Appendix A.3.3_VII). The inter-annual changes in crop production are explained by decline in the total sown area and by weather conditions (Appendix A.3.3_VII).

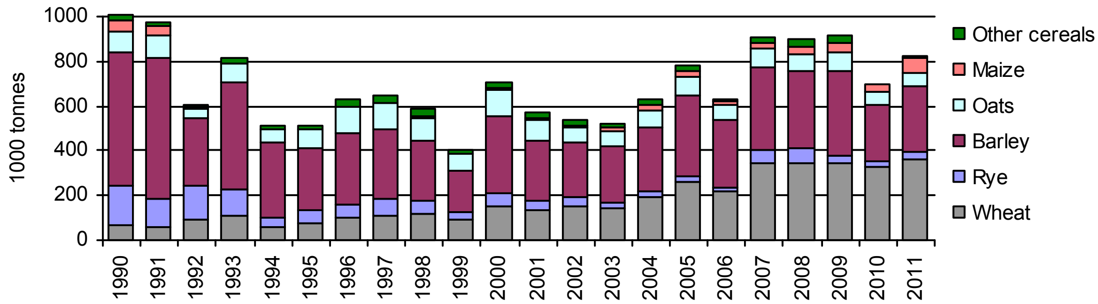

Figure 6.29. Cereals and maize production in 1990–2011 in Estonia, 1000 tonnes

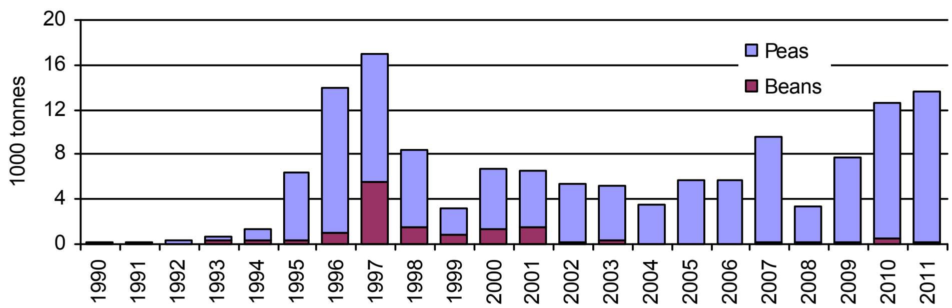

Figure 6.30. Production of legumes in 1990–2011 in Estonia, 1000 tonnes

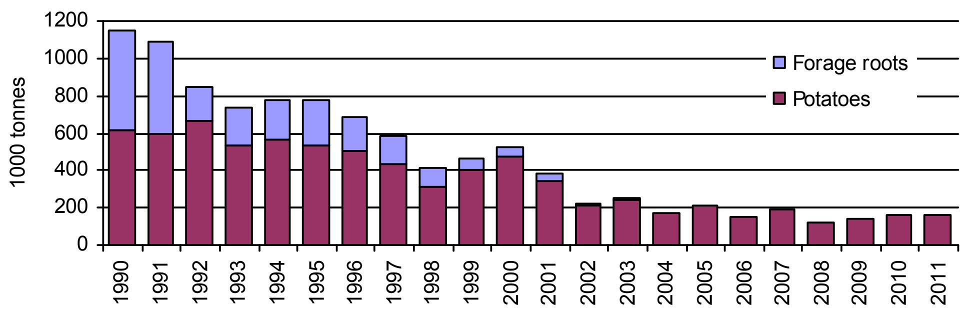

Figure 6.31. Tuber and root production in 1990–2011 in Estonia, 1000 tonnes

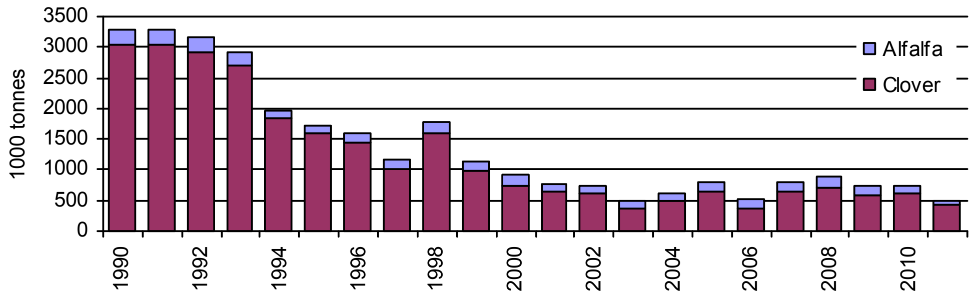

Figure 6.32. Clover and alfalfa production in 1990–2011 in Estonia, 1000 tonnes

The total N_2O emissions from crop residues left on agricultural land was 0.084 Gg in 2011 (Figure 6.33).

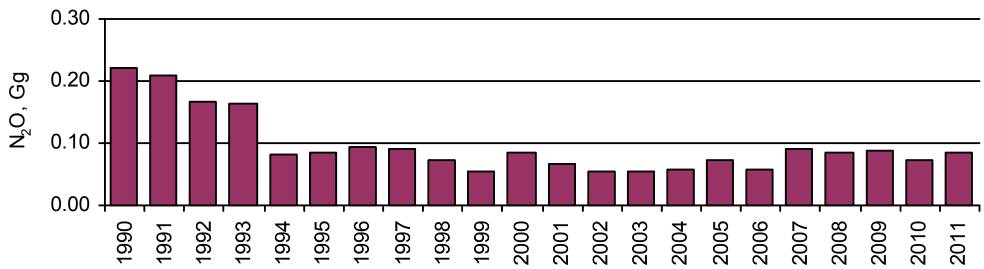

Figure 6.33. N_2O emissions from crop residues left on agricultural fields in 1990–2011 in Estonia, Gg

6.5.7. N_2O emissions from organic soils cultivation (CRF 4.D.1.5)

N_2O emissions occur as a result of cultivation of organic soils due to enhanced mineralization of old, N-rich organic matter. The rate of N-mineralization is determined by N-quality of histosols, management practice and climatic conditions (IPCC, 1997).

6.5.7.1. Methodology, data availability, data sources and emission factors

The *Tier 1* method was applied in order to estimate N_2O emissions from organic soils cultivation (IPCC, 1997) (6.29).

$$N_2O_{direct} = F_{OS} \bullet EF_2 \bullet 44/28 \quad (6.29)$$

F_{OS} – area of cultivated organic soils, ha;

EF_2 – emission factor for organic soil mineralization due to cultivation, kg N_2O-N ha/year (Table 6.50).

Table 6.50. Factors used in the algorithm used to estimate N_2O emission from cultivated organic soils [94]

Factor	Unit
EF_2	8 kg N_2O-N/ha^{-yr}

6.5.7.2. Quantitative overview – N_2O emissions from organic soils cultivated in 2011

N_2O emissions from cultivation of organic soils were 0.267 Gg in 2011 in Estonia (Figure 6.34). The estimation was carried out based on the data received in the framework of National Forest Inventory (see chapter 7).

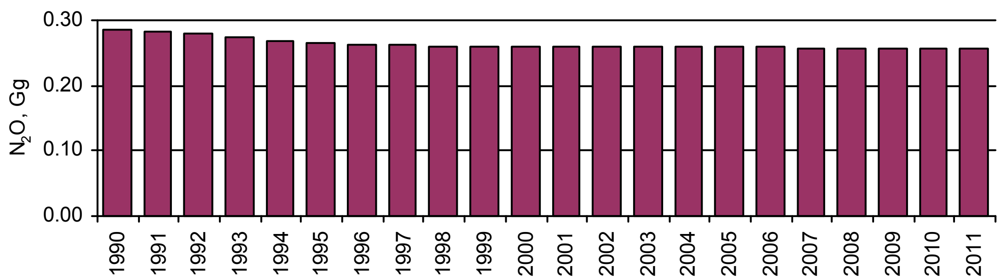

Figure 6.34. N_2O emissions from cultivation of organic soils in Estonia in 1990–2011, Gg

6.5.8. N_2O emissions from sewage sludge applied on agricultural soils (CRF 4.D.1.6)

Sludge from domestic wastewater treatment plants is used on agricultural land. Table 6.51 illustrates amounts of sewage sludge used for improvement of environmental situation (R10). Data for years 1999–2010 were obtained from datasets of EEIC.

The amounts of sewage sludge treated according R10 category in 1990–1998 were extrapolated based on rough assumption – about 50 per cent of the total amount of generated sewage sludge was used for improvement of environmental situation (Table 6.51).

Since 2004, the amount of sewage sludge treated biologically has increased. However, the amounts of sewage sludge directly used for improvement of environmental situation have decreased (see also Waste chapter 8.6, Table 8.27).

Table 6.51. Amounts of municipal sludge application on agricultural land, tonnes[95]

Year	R10
1990	*7 434*
1991	*7 825*
1992	*8 237*
1993	*9 081*
1994	*14 306*

[94] IPCC 2000. Agriculture. Table 4.17, pp. 4.60.
[95] R10 of the European Waste Catalogue (2002) – Land treatment resulting in benefit to agriculture or ecological improvement.

Year	R10
1995	*27 073*
1996	*30 041*
1997	*30 028*
1998	*12 724*
1999	17 302
2000	26 489
2001	2 770
2002	11 385
2003	9 799
2004	1 025
2005	6 992
2006	12 285
2007	4 492
2008	18 948
2009	14 369
2010	20 843
2011	33 287

6.5.8.1. Methodology, data availability and sources, emission factors

The *Tier 1* approach was employed in order to estimate N_2O emissions from sludge applied on agricultural land (IPCC, 1997) (6.30, 6.31).

$$F_{SL} = N_{FERT} \times (1 - Frac_{GASM}) \quad (6.30)^{96}$$

N_{FERT} - Total use of sludge applied on agricultural land in country, kg N/year;

$Frac_{GASM}$ – Fraction of total sludge nitrogen that is emitted as NO_x+NH_3, kg N/kg N.

$$N_2O_{direct} - N = F_{SL} \bullet EF \bullet 44/28_1 \quad (6.31)$$

EF – emission factor.

The emission factors used in the estimates are presented in Table 6.52.

Table 6.52. Parameters and factors used in the estimates

Factor	Value	
FracGASM[97]	0.20	kg NH_3-N+NOx-N/kg of sludge nitrogen applied
EF for F_{SL}	1.25%	
N content of sewage sludge[98]	4.9	% dry matter

6.5.8.2. Quantitative overview – N_2O emissions from sludge applied on agricultural land in 2011 (CRF 4.D.1.6)

The total N_2O emissions from sludge applied on agricultural land were 0.003 Gg in Estonia in 2011 (Figure 6.35).

[96] IPCC 1997. Agriculture. Workbook. Equation1, pp. 4.33.
[97] IPCC 1997. Agriculture. Reference Manual. Table 4-19, pp. 4.94.
[98] (Final report, 2008).

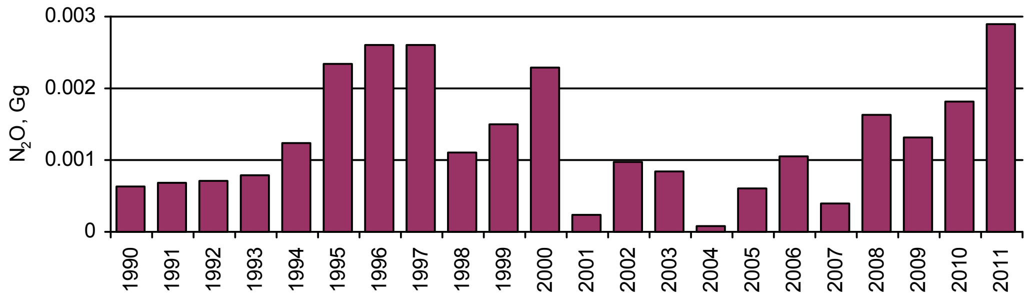

Figure 6.35. N_2O emissions from sewage sludge applied on agricultural land in Estonia in 1990–2011, Gg

6.5.9. Uncertainties and time-series consistency

6.5.9.1. Synthetic fertilizers used (CRF 4.D.1.1)

The estimation of N_2O emissions from synthetic fertilizers used was carried out based on activity data and emission factors.

Investigations made into the estimates of uncertainties related to activity data (synthetic fertilizers applied on agricultural soils) are presented in (Rypdal and Winiwarter, 2001). The authors report uncertainties at ±5% in Austria, at ±5% in Norway, at ±10-50% in the Netherlands, at ±2% in the USA and at ±10% in Finland (Monni and Syri, 2003). No similar research has been carried out in Estonia, therefore the uncertainty of Finland was used in the estimates (Table 6.53).

Nitrogen emission factors have been used as IPCC default in the estimates of N_2O emissions. The IPCC gives an uncertainty of the factor of ±80%, the factor is 0.0125 with a range of 0.0025–0.0225 (IPCC, 1997).

6.5.9.2. Animal manure applied to soils (CRF 4.D.1.2)

The estimation of N_2O emissions from animal manure applied to soils was carried out based on activity data (amounts of nitrogen produced by livestock) and emission factors.

Uncertainties of N generated were described in the 'Manure Management' chapter above.

Nitrogen emission factor was taken as IPCC default. An uncertainty of the factors is given in the IPCC Guidelines (1997) at ±80% (Table 6.53) (IPCC, 1997).

6.5.9.3. N-fixing crops and crop residues (CRF 4.D.1.3 and CRF 4.D.1.4)

The estimation of N_2O emissions from N-fixing crops and crop residue was carried out based on activity data (crop production) and emission factors (N emission factor, crop residue ratios, nitrogen content in crops and fraction of residues left on fields).

Data on uncertainty of crop production (N-fixing and non-nitrogen fixing crops) in Estonia are not available, therefore the uncertainty of activity data was not estimated.

IPCC default nitrogen emission factor has been used in the estimates. IPCC gives an uncertainty of the factor at ±80% (Table 6.53) as the value of the factor is 0.0125 with a range of 0.0025–0.0225 (IPCC, 1997).

Table 6.53. Estimated values of uncertainties used in agriculture sector

Input	Uncertainties	References
Activity data		
Estonia's Livestock Population (cattle, swine, sheep, goats, horses, poultry)	± 10%	Rypdal and Winiwarter, 2001
Synthetic Fertilizers (applied to agricultural soils)	± 10%	Rypdal and Winiwarter, 2001
Emission factors		
Emission factor (synthetic fertilizers, animal manure, N-fixing crops and crop residues)	± 80%	Table 4-18 of the 1996 IPCC Guidelines, pp. 4.89
Fraction of synthetic N fertilizers that volatilizes as NH_3 and NO_x	± 30%	Monni and Syri, 2003
Fraction of animal manure N that volatilizes as NH_3 and NO_x	± 40%	Monni and Syri, 2003

6.5.10. Source-specific QA/QC and verification

The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.1.

The QA/QC plan for the agricultural sector includes the QC activities described in the IPCC GPG (IPCC 2000, Table 8.1). The activities are carried out every year during the inventory. The QC check list is used during the inventory.

6.5.11. Source-specific recalculations

There are several recalculations carried out in the 2013 submission:

(1) Animal manure applied on agricultural soils (CRF 4.D.1.2) – amounts of manure applied on soils were recalculated due to the changes employed in the estimations of nitrogen excretion rates and because of the development of Estonian module on MMS (Table 6.55, Chapter 6.4.1.1);

(2) Cultivation of organic soils (CRF 4.D.1.5) – data on areas of organic soils cultivated were updated in the framework of the NFI (see chapter LULUCF);

(3) Sewage sludge applied on agricultural lands (CRF 4.D.1.6) – nitrogen content in sewage sludge was updated; country-specific value was used in the estimations.

The results of the recalculations performed are presented in Table 6.55–Table 6.57. The total direct N_2O emissions from agricultural soils calculated in the 2012 and 2013 submissions are reported in Table 6.54.

Table 6.54. Direct N_2O emissions from agricultural soils in 1990–2010, Gg

Year	Reported N_2O emissions in the 2012 submission	Recalculated N_2O emissions in the 2013 submission
1990	3.780	3.183
1991	3.687	3.087
1992	3.271	2.697
1993	2.566	2.044
1994	2.034	1.633

Year	Reported N_2O emissions in the 2012 submission	Recalculated N_2O emissions in the 2013 submission
1995	1.773	1.414
1996	1.643	1.313
1997	1.553	1.278
1998	1.812	1.472
1999	1.442	1.179
2000	1.442	1.204
2001	1.363	1.105
2002	1.236	1.028
2003	1.268	1.085
2004	1.344	1.152
2005	1.344	1.127
2006	1.266	1.085
2007	1.456	1.232
2008	1.667	1.439
2009	1.479	1.262
2010	1.298	1.282

Table 6.55. N_2O emissions from application of animal manure on agricultural soils in 1990–2010, Gg

Year	Reported N_2O emissions in the 2012 submission	Recalculated N_2O emissions in the 2013 submission
1990	0.669	0.601
1991	0.628	0.559
1992	0.516	0.455
1993	0.413	0.364
1994	0.382	0.341
1995	0.345	0.307
1996	0.305	0.268
1997	0.304	0.269
1998	0.298	0.263
1999	0.261	0.232
2000	0.262	0.234
2001	0.275	0.245
2002	0.263	0.235
2003	0.262	0.238
2004	0.263	0.241
2005	0.262	0.240
2006	0.260	0.239
2007	0.259	0.240
2008	0.269	0.250
2009	0.265	0.248
2010	0.272	0.255

Table 6.56. N_2O emissions due to cultivation of organic soils in 1990–2010, Gg

Year	Reported N_2O emissions in the 2012 submission	Recalculated N_2O emissions in the 2013 submission
1990	0.283	0.287
1991	0.283	0.283
1992	0.277	0.279
1993	0.277	0.274
1994	0.270	0.270
1995	0.264	0.266
1996	0.264	0.264
1997	0.257	0.262

Year	Reported N_2O emissions in the 2012 submission	Recalculated N_2O emissions in the 2013 submission
1998	0.257	0.261
1999	0.257	0.260
2000	0.257	0.260
2001	0.257	0.260
2002	0.257	0.260
2003	0.257	0.260
2004	0.257	0.260
2005	0.257	0.259
2006	0.257	0.258
2007	0.257	0.259
2008	0.257	0.260
2009	0.264	0.262
2010	0.264	0.264

Table 6.57. N_2O emissions from sewage sludge application on agricultural soils in 1990–2010, Gg

Year	Reported N_2O emissions in the 2012 submission	Recalculated N_2O emissions in the 2013 submission
1990	0.000657	0.000644
1991	0.000692	0.000678
1992	0.000728	0.000714
1993	0.000803	0.000787
1994	0.001265	0.001239
1995	0.002393	0.002345
1996	0.002655	0.002602
1997	0.002654	0.002601
1998	0.001125	0.001102
1999	0.001529	0.001499
2000	0.002341	0.002295
2001	0.000245	0.000240
2002	0.001006	0.000986
2003	0.000866	0.000849
2004	0.000091	0.000089
2005	0.000618	0.000606
2006	0.001086	0.001064
2007	0.000397	0.000389
2008	0.001675	0.001641
2009	0.001343	0.001316
2010	0.001842	0.001806

6.5.12. Source-specific planned improvements

Development of value of FracR (fraction of residues left on agricultural lands) and FracBurn (fraction of crop residues bunt) will be performed in the next submissions.

6.6. N_2O emissions from pasture, range and paddock (CRF 4.D.2)

6.6.1. Methodology, data availability, data sources and emission factors

The method reported in Chapter 6.4.2 was used to estimate N_2O emissions from animal pasture, range and paddock.

6.6.2. Quantitative overview – N_2O emissions from pasture, range and paddock in 2011

The total N_2O emissions from pasture, range and paddock made up 0.240 Gg in 2011. The emission decreased by 63 per cent compared to the base year due to decline in number of livestock population (Figure 6.36).

Figure 6.36. N_2O emissions from pasture, range and paddock in 1990–2011, Gg

6.6.3. Source-specific QA/QC and verification

The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.1.

The QA/QC plan for the agricultural sector includes the QC activities described in the IPCC GPG (IPCC 2000, Table 8.1). The activities are carried out every year during the inventory. The QC check list is used during the inventory.

6.6.4. Source-specific recalculations

There are several recalculations carried out in the 2013 submission to estimate N_2O emissions from Pasture, range and paddock; the list of recalculation performed is presented in Chapter 6.4.2.6. The results of the recalculations are reported in Table 6.58.

Table 6.58. N_2O emissions from pasture, range and paddock manure management in 1990–2010, Gg

Year	Reported N_2O emissions in the 2012 submission	Recalculated N_2O emissions in the 2013 submission
1990	0.620	0.653
1991	0.591	0.617
1992	0.515	0.541
1993	0.397	0.426
1994	0.360	0.382
1995	0.313	0.336
1996	0.294	0.317
1997	0.287	0.311
1998	0.273	0.297
1999	0.232	0.251
2000	0.229	0.249
2001	0.237	0.258
2002	0.228	0.244
2003	0.229	0.236
2004	0.230	0.236

Year	Reported N_2O emissions in the 2012 submission	Recalculated N_2O emissions in the 2013 submission
2005	0.232	0.235
2006	0.232	0.234
2007	0.230	0.229
2008	0.242	0.241
2009	0.238	0.236
2010	0.242	0.237

6.6.5. Source-specific planned improvements

Activity data and the algorithm used for the calculation are kept under consideration and will be updated necessarily.

6.7. Indirect emissions from agricultural soils (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, 2000).

6.7.1. Source category description

The total indirect N_2O emissions from agricultural soils were 0.758 Gg in 2011 (Figure 6.37). The emissions declined by 59 per cent by 2011 due to decrease in number of livestock population and synthetic and sludge application onto agricultural land.

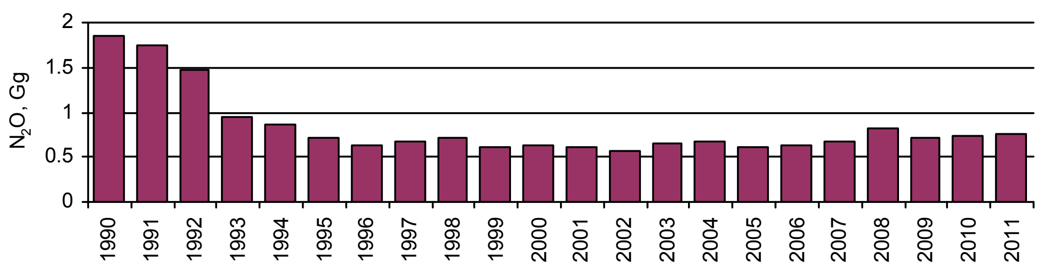

Figure 6.37. Indirect N_2O emissions from agricultural soils in Estonia in 1990–2011, Gg

6.7.2. Atmospheric deposition of NO_X and NH_4 (CRF 4.D.3.1)

Atmospheric deposition of nitrogen compounds such as nitrogen oxides (NO_x) and ammonium (NH_4) fertilizes soils and surface waters, which results in enhanced biogenic N_2O formation (IPCC, 2000).

6.7.2.1. Methodology, data availability, data sources and emission factors

The *Tier 1b* method was used to estimate emissions from the atmospheric deposition (6.32).

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

(6.32)[99]

$N_2O_{(G)}$ – N_2O produced from atmospheric deposition of N, kg N/year;

N_{FERT} – Total amount of synthetic nitrogen fertilizer applied to soils, kg N/year;

$\sum_T(N_{(T)} \bullet Nex_{(T)})$ – total amount of animal manure nitrogen excreted in a country, kg N/year;

$N_{SEWSLUDGE}$ – Total sewage sludge nitrogen applied on agricultural soils, kg N/year;

$Frac_{GASF}$ – 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 (Table 6.59);

$Frac_{GASM}$ – 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 (Table 6.59);

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 6.59).

Table 6.59. Factors used in the algorithm of the estimation of atmospheric deposition

Factor	Value
$Frac_{GASF}$	0.1 kg NH_3-N + NO_x-N/kg of synthetic fertilizer nitrogen applied[100]
$Frac_{GASM}$	0.2 kg NH_3-N + NO_x-N/kg of nitrogen excreted by livestock[101]
EF_4	0.01 kg N_2O-N per kg NH_3-N and NO_x-N emitted[102]

6.7.2.2. Quantitative overview – Atmospheric deposition of NO_x and NH_4 in 2011

Total N_2O emissions from atmospheric deposition were 0.123 Gg in 2011 in Estonia (Figure 6.38). The emissions decreased by 59 per cent by 2011 compared to the base year.

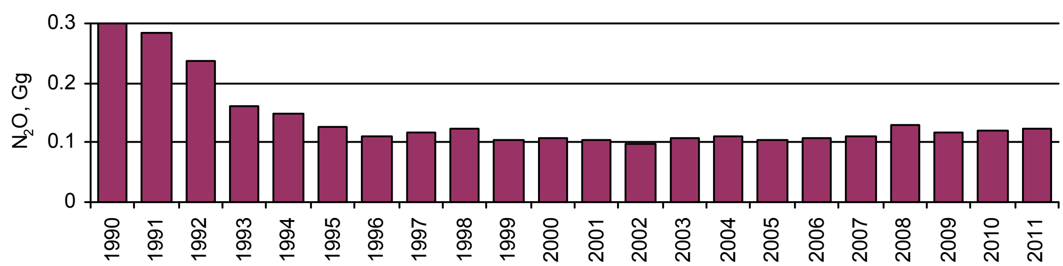

Figure 6.38. Atmospheric deposition of NO_x and NH_4 in 1990–2011, Gg

[99] IPCC 2000. Agriculture. Equation 4.32, pp 4.70.
[100] IPCC 1997. Agriculture. Workbook. Table 4-17, pp. 4.35.
[101] IPCC 1997. Agriculture. Workbook. Table 4-17, pp. 4.35.
[102] IPCC 1997. Agriculture. Reference Manual. Table 4-23, pp. 4.105.

6.7.3. Leaching/run-off of applied or deposited nitrogen (CRF 4.D.3.2)

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, 2000).

6.7.3.1. Methodology, data availability, data sources and emission factors

The *Tier 1b* method was used to estimate emissions from the atmospheric deposition (6.33).

$$N_2O_{(L)} - N = [N_{FERT} + \sum_T (N_{(T)} \bullet Nex_{(T)}) + N_{SEWSLUDGE}] \bullet Frac_{LEACH} \bullet EF_5 \quad (6.33)$$[103]

N_{FERT} – Total amount of synthetic nitrogen fertilizer applied to soils, kg N/year;

$\sum_T(N_{(T)} \bullet Nex_{(T)})$ – Total amount of animal manure nitrogen excreted in a country, kg N/year;

$N_{SEWSLUDGE}$ – Total sewage sludge nitrogen applied on agricultural soils, kg N/year;

$Frac_{LEACH}$ – The amount of applied N that leaches or runs off, kg N/kg (Table 6.60).

Table 6.60. Factors used in the algorithm of the estimation of leaching/runoff

Factor	Value
$Frac_{LEACH}$	0.3 kg N/kg nitrogen of fertilizer or manure[104]
EF_5	0.025 kg N_2O-N per kg NH_3-N and NO_x-N emitted[105]

6.7.3.2. Quantitative overview – Leaching/Run-off of applied or deposited nitrogen in 2011

The total N_2O emissions from leaching and run-off were 0.635 Gg in 2011 in Estonia (Figure 6.39). The emissions decreased by 59% by 2011 in comparison with the base year.

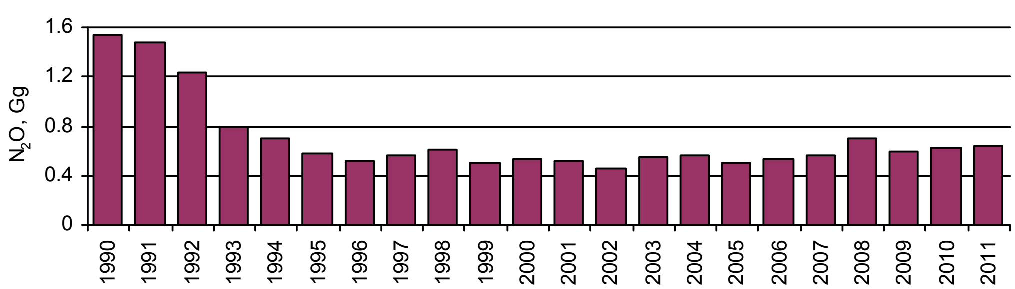

Figure 6.39. Leaching and run-off of NO_x and NH_4 in 1990–2011 in Estonia, Gg

[103] IPCC 2000. Agriculture. Equation 4.36, pp. 4.71.
[104] IPCC 1997. Agriculture. Workbook. Table 4-17, pp. 4.35.
[105] IPCC 2000. Agriculture. Table 4-18, pp. 4.73.

6.7.4. Uncertainties and time-series consistency

6.7.4.1. Atmospheric Deposition (CRF 4.D.3.1)

The estimation of N_2O emissions from atmospheric deposition was carried out based on activity data (synthetic fertilizers and animal manure applied to soils) and emission factors (N emission factor, fraction of synthetic N fertilizers that volatilizes as NH_3 and NO_x and fraction of animal manure N that volatilizes as NH_3 and NO_x).

Uncertainties of fractions of synthetic fertilizers and animal manure that volatilize as NH_3 and NO_x were estimated by a Finnish expert (Monni *et al.*, 2003). These values were used in the estimates in order to calculate Estonia's uncertainties.

Nitrogen (N_2O) emission factor was used from (IPCC, 1997). IPCC Guidelines give the factor at 0.01 with a range 0.002–0.02, which means that the uncertainty of the factor is –80%...+100% (Table 6.61).

6.7.4.2. Nitrogen leaching and run-off (CRF 4.D.3.2)

The estimation of N_2O emissions from nitrogen leaching was carried out based on activity data (synthetic fertilizers and animal manure applied to soils) and emission factors (fraction of the fertilizer, manure nitrogen lost to leaching and surface run-off and N_2O emission factor).

N_2O emission factor is reported in (IPCC, 1997). The value of the factor is 0.025 with a range 0.002–0.12. The uncertainty of emission factor is -92%...+380% (Table 6.61).

Table 6.61. Estimated values of uncertainties used in agriculture sector

Input	Uncertainties	References
Activity data		
Estonia's livestock population (cattle, swine, sheep, goats, horses, poultry)	± 10%	Rypdal and Winiwarter, 2001
Synthetic fertilizers (applied to agricultural soils)	± 5%	Rypdal and Winiwarter, 2001
Emission factors		
Fraction of synthetic N fertilizers that volatilizes as NH_3 and NO_x	± 30%	Monni and Syri, 2003
Fraction of animal manure N that volatilizes as NH_3 and NO_x	± 40%	Monni and Syri, 2003
Emission factor (Atmospheric deposition)	-80%...+100%	Table 4-23 of the 1996 IPCC, pp. 4.105
Emission factor (N leaching and run-off)	-92%...+380%	Table 4-23 of the 1996 IPCC, pp. 4.105
Fraction of the fertilizer and manure nitrogen lost to leaching and surface run-off	-67%...167%	Table 4-24 of the 1996 IPCC, pp. 4.106
Emission factor (Nitrogen leaching and run-off)	-92%...380%	Table 4-23 of the 1996 IPCC, pp. 4.105

6.7.5. Source-specific QA/QC and verification

The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.1.

The QA/QC plan for the agricultural sector includes the QC activities described in the IPCC GPG (IPCC 2000, Table 8.1). The activities are carried out every year during the inventory. The QC check list is used during the inventory.

6.7.6. Source-specific recalculations

The recalculations in 'Indirect N_2O emissions from agricultural soils' category were performed due to the changes employed in the 'Manure management', 'Animal manure applied on agricultural soils' and 'Sewage sludge applied on agricultural soils' categories (Chapter 6.5.11).

The results of the recalculations reported in the 2013 submission are provided in Table 6.62.

Table 6.62. Indirect N_2O emissions from agricultural soils in Estonia in 1990–2010, Gg

Year	Reported N_2O emissions in the 2012 submission	Recalculated N_2O emissions in the 2013 submission
1990	1.893	1.844
1991	1.811	1.757
1992	1.515	1.469
1993	0.981	0.949
1994	0.883	0.854
1995	0.731	0.705
1996	0.653	0.629
1997	0.701	0.678
1998	0.746	0.725
1999	0.625	0.606
2000	0.659	0.641
2001	0.636	0.617
2002	0.582	0.562
2003	0.669	0.650
2004	0.691	0.673
2005	0.627	0.609
2006	0.660	0.641
2007	0.689	0.671
2008	0.845	0.827
2009	0.731	0.714
2010	0.757	0.739

6.7.7. Source-specific planned improvements

Activity data and the algorithm are kept under consideration and will be updated necessarily.

6.8. Field burning of agricultural residues (CRF 4.F)

The burning of agricultural residues is not considered a net source of CO_2 emissions because the carbon released to the atmosphere is reabsorbed during the next growing season, this burning is a source of net emissions of many trace gases including CH_4, N_2O and NO_x (IPCC, 2000).

The default value of the fraction of the crop-residue burned was used in the estimates of emissions in Estonia in 1990–2006. Since, to date there are no reliable quantitative data developed yet. However, an opinion of an expert on practice of crop residue burning was collected during the 2011 submission cycle. The opinion will be adjusted to the quantitative data (i.e., to fraction of crop residue burned in 1990–2006) by the next submission. Since 2007, the burning of crop residues was prohibited by an Estonian law (Põllumajandusministri määrus nr 57, 20.04.2007 and nr 20, 23.02.2011), therefore GHG emissions for the reporting period of 2007–2011 are reported to be 'NO' in Estonia.

6.8.1. Methodology, data availability, data sources and emission factors

Detailed data on crop production is presented on Figure 6.29–Figure 6.31. The data were obtained from SE. Remarkable inter-annual fluctuations in quantities of crops produced are caused by changes in sown area (Appendix A.3.3_VII) and by variations in weather conditions (Appendix A.3.3_VIII).

The *Tier 1* of the Revised 1996 IPCC Guidelines (IPCC, 1997) was employed in the estimates (6.34–6.36):

$$DM_{BN} = Crop_{BN} \times RC_{RATIO} \times DM_{FRACTION} \quad (6.34)$$

DM_{BN} – Dry matter of crop residues burned in fields, Gg;

$Crop_{BN}$ – Quantity of crops, which produce residues burned in fields, Gg;

RC_{RATIO} – Residue-crop ratio for each type of crops;

$DM_{FRACTION}$ – Dry matter fraction of each crop residue, Gg DM/Gg FM.

$$TBB = DM_{BN} \times OX \quad (6.35)$$

TBB – Total biomass burned, Gg;

OX – Fraction of biomass oxidized for each crop type (default 0.9[106]).

$$C\_emission = TBB \times Cfraction \times Ratios\_for\_CH_4\_or\_CO \quad (6.36)$$

$$N\_emission = TBB \times Nfraction \times Ratios\_for\_N_2O\_or\_NO_X$$

C_emission – Emissions of carbon as methane and carbon monoxide (CO), Gg;

Cfraction – carbon content of each crop type, GgC/Gg DM;

Ratios for CH_4 or CO – Emissions ratios for CH_4 or CO (IPCC, 1997) [107];

N_emission – Emissions of carbon as nitrous oxide and nitrogen oxides (NO_x), Gg;

Nfraction – nitrogen content of each crop type, GgN/Gg DM;

Ratios for N_2O or NO_x – Emissions ratios for N_2O or NO_x (IPCC, 1997).

[106] IPCC 1997. Agriculture. Workbook. pp. 4.30

[107] IPCC 1997. Agriculture. Reference Manual. Table 4-16, pp. 4.31

6.8.2. Emissions from field burning of agricultural residues in 1990–2006

CH_4 and N_2O emissions occurred due to the burning of crop residues in 1990–2006 are presented in Figure 6.40, Figure 6.41.

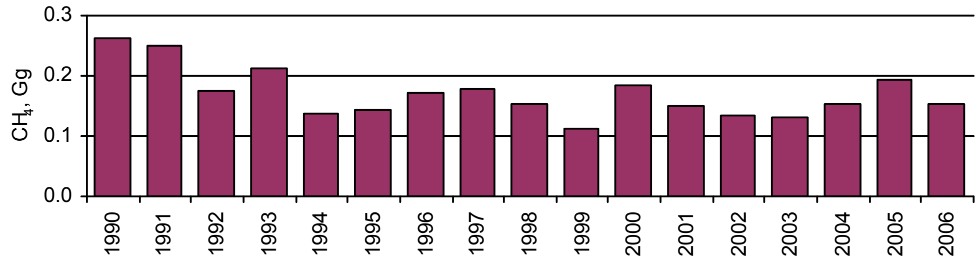

Figure 6.40. CH_4 emissions from field burning of agricultural residues in 1990–2006, Gg

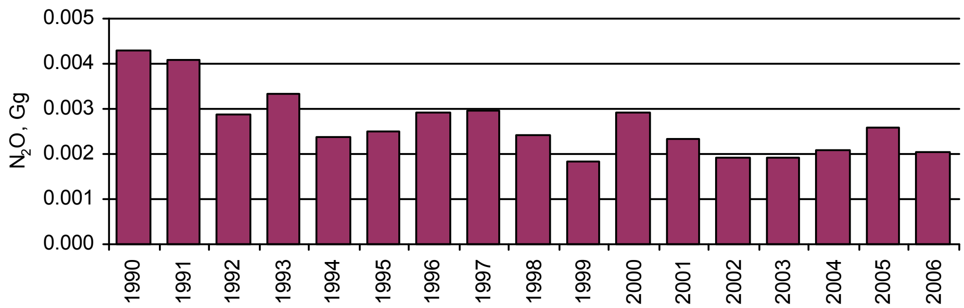

Figure 6.41. N_2O emissions from field burning of agricultural residues in 1990–2006, Gg

6.8.3. Uncertainties and time-series consistency

The estimation of N_2O and CH_4 emissions from agricultural residue burning was carried out based on the activity data (crop residue left on fields) and emission factors reported in the 1996 and 2000 IPCC Guidelines (Table 6.63).

Table 6.63. Estimated values of uncertainties used in the agriculture sector

Input	Uncertainties	References
Activity data		
Crop residue left on agricultural fields	± 20%	IPCC 2000. Agriculture. pp.4.90
Emission factors		
Default emission factor for CH_4	± 40%	Table 4-16 of the IPCC 1996 Guidelines, pp.4.31
Default emission factor for N_2O	± 29%	Table 4-16 of the IPCC 1996 Guidelines, pp.4.31

6.8.4. Source-specific QA/QC and verification

The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.1.

The QA/QC plan for the agricultural sector includes the QC activities described in the IPCC GPG (IPCC 2000, Table 8.1). The activities are carried out every year during the inventory. The QC check list is used during the inventory.

6.8.5. Source-specific recalculations

There are no source-specific recalculations performed.

6.8.6. Source-specific planned improvements

Development of value of FracR (fraction of residues left on agricultural lands) and FracBurn (fraction of crop residues burnt) will be performed in the next submissions.

7. LAND USE, LAND USE CHANGE AND FORESTRY (CRF 5)

7.1. Overview of the sector

7.1.1. Description and quantitative overview

The methodology used to calculate emissions and removals from Land Use, Land-Use Change and Forestry sector follows the IPCC Good Practice Guidance for LULUCF (IPCC 2003 & 2006). GPG-LULUCF suggests the use of six top-level land categories (Forest land, Cropland, Grassland, Wetlands, Settlements and Other land), divided into land remaining in the land-use category and land converted to another land use category. Since 2011 submission, the area of Estonia has been reported using *Approach 2* method that allows to track land-use transitions between categories.

In 2011, LULUCF sector acted as a CO_2 sink, resulting net carbon uptake about 4 263 Gg CO_2 equivalent (Figure 2.9), meaning that total removals arising from the sector exceed total emissions.

In the 2013 annual submission Estonia reports emissions and removals in the following subcategories:

- Forest Land (CRF 5.A): emissions/removals from/by forest land living biomass, dead wood, litter (only to FL), mineral and organic soils, non-CO_2 emissions from wildfires;
- Cropland (CRF 5.B): emissions from cultivated organic soils, mineral soils, liming, emissions/removals from/by orchards' living biomass and N_2O emissions related to land conversion to cropland;
- Grassland (CRF 5.C): emissions/removals from/by grassland living biomass, dead wood, emissions from organic soils and non-CO_2 emissions from wildfires, in addition emissions related to mineral soil and litter on land converted to grassland;
- Wetlands (CRF 5.D): CO_2, N_2O and CH_4 emissions from peat extraction, loss of living biomass and dead organic matter due to forest land conversion to peatland/wetlands;
- Settlements (CRF 5.E): emissions related to Forest Land, Cropland, Grassland and Other Land conversion to Settlements in living biomass, dead organic matter and soil carbon pools;
- Other land (CRF 5.F): emissions from Forest Land, Cropland and Wetlands conversion to Other land.

Estonia does not have currently sufficient data to develop country-specific emission factors for soils and litter for most of the land use categories, as an interim approach, carbon stock change estimates of these pools are based on emission factors obtained from Sweden 2012 annual inventory submission and approved by the UNFCCC expert review held in Tallinn in September 2012. Estonia has taken steps to launch projects aimed to get country-specific data regarding omitted pools for future submissions.

Tier 2 method has been applied to estimate carbon flows associated with living biomass and dead wood on land remaining and land-use change categories (Table 7.1) for the whole time series. Soil and litter estimates based on Swedish EF-s are also considered a *Tier 2* method. Country-specific emission factors were implemented for the first time for calculating peatland emissions. N_2O emissions related to land conversion to cropland were estimated for the first time applying *Tier 1*.

Table 7.1. Methods and emission factors used to estimate the emissions/removals of GHG in the LULUCF sector of Estonia

Greenhouse gases source and sink categories	CO_2		CH_4		N_2O	
	Method Applied	EF	Method Applied	EF	Method Applied	EF
A. Forest land						
Forest Land remaining Forest Land	T1, T2	OTH	NA	NA	NA	NA
Biomass Burning	IE[108]		T2	D	T2	D
Land converted to Forest Land	T1, T2	OTH	NA	NA	NA	NA
B. Cropland						
Cropland remaining Cropland	T1, T2	D	NA	NA	NA	NA
Land converted to Cropland	T1, T2	D	NA	NA	T1	D
C. Grassland						
Grassland remaining Grassland	T1, T2	D	NA	NA	NA	NA
Biomass Burning	IE		T2	D	T2	D
Land converted to Grassland	T1, T2	D, OTH	NA	NA	NA	NA
D. Wetlands						
Wetlands remaining Wetlands[109]	T2	CS	T2	CS	T2	CS
Biomass Burning	IE		T2	D	T2	D
Land converted to Wetlands	T2	CS	T2	CS	T2	CS
Non-CO_2 emission from drainage of soils and wetlands (Peatland)	T2	CS	T2	CS	T2	CS
E. Settlements						
Settlements remaining Settlements[110]	NE	NA	NE	NA	NE	NA
Land converted to Settlements	T2	OTH	NA	NA	NA	NA
F. Other land						
Other Land remaining Other Land	NA	NA	NA	NA	NA	NA
Land converted to Other Land	T1, T2	OTH	NA	NA	NA	NA

EF – Emission Factor, NE – not estimated, NA – not applicable, IE – included elsewhere, T1 – *Tier 1* method , T2 – *Tier 2* method, D – IPCC default, OTH – other, in the case of missing country-specific data, EF-s from Sweden were applied.

LULUCF sector inventory is carried out by Estonian Environment Information Centre (EEIC), department of the National Forest Inventory. Additionally, annual reports published by different institutions (EEIC, Estonian Land Board, Statistics Estonia (SE) etc. (see Table 7.2) have been used in the estimation of carbon fluxes related to the LULUCF sector.

Table 7.2. List of institutions (datasets) involved in the inventory of the LULUCF sector

References	Link	Abbreviation	Activity
Estonian	www.keskkonnainfo.	EEIC	- collecting and providing data for the

[108] Stock-change method used for biomass estimates includes CO_2 loss from burning.
[109] Wetlands are divided into unmanaged wetlands and peatland extraction. Emissions from unmanaged wetlands are not reported, since it is not mandatory according to IPCC GPG-LULUCF.
[110] SS reporting is not mandatory.

References	Link	Abbreviation	Activity
Environment Information Centre	ee		National Forest Inventory; - collecting and providing data on land use categories (forest, cropland, grassland, wetlands, settlements, other land); - collecting and providing data on land use changes (including AR and D areas); - collecting and providing data on forest land, grassland and cropland woody biomass and dead wood stocks; - areas of peat extraction in 1990–2011
Estonian Rescue Service; State Forest Management Centre; Environmental Board	www.rescue.ee www.rmk.ee www.keskkonnaamet.ee	ERS; SFMC; EB	- collecting data on forest fires
Statistics Estonia	www.stat.ee	SE	- providing data on liming (2009–2011) and AR areas;
Ministry of Agriculture	www.agri.ee	MoA	- providing data on liming (1990–2008)
The Agricultural Research Centre; Estonian Research Institute of Agriculture	www.pmk.agri.ee www.eria.ee	ARC; ERIA	- providing *know-how* for calculating cropland mineral soil emissions
Estonian Land Board	www.maaamet.ee	ELB	- collecting and providing data on land areas by land use categories (Land Balances) for 1970–1990;

Figure 7.1 illustrates land use changes during the last four decades in Estonia. The proportion of forests to the total country area has increased from 43.8% in 1970 to 50.0% in 2011 (increase of 279 thousand hectares). The increase has taken place mostly due to abandonment of grasslands and overgrowing of wetlands. The area of grasslands and wetlands decreased 465 and 69 thousand hectares, respectively during the same period. The area of agricultural land – cropland increased until 1990s and started to decline after that due to the economical processes taking place in Estonian agricultural sector. Cropland area has been on a rising trend again since the last decade due to the increasing subsidies from government and the European Union. The area of settlements has been increasing constantly, about 34% during the period of last forty years.

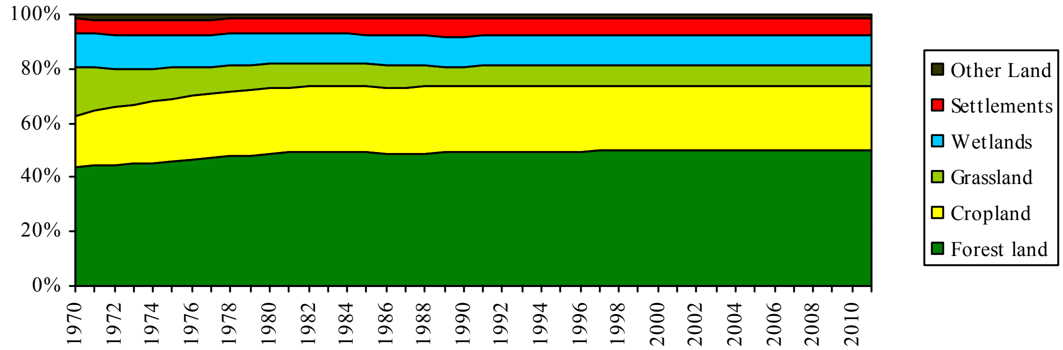

Figure 7.1. Land use in Estonia in 1970–2011, %

The areas of land use defined in accordance with the IPCC land use definitions are reported in Table 7.3. Peat extraction sites are part of Wetlands and generally the area of Wetlands include both peatlands and inland water bodies if not stated otherwise.

Land-use changes are tracked on NFI sample plots, that cover the whole country and are re-inventoried in every fifth year. Formerly, NFI registred only the present type of land use, while starting from 2009, the transition of land-use is determined on each sample plot as well and assessed in retrospect for the past 20 years if necessary.

All area estimates are being re-estimated annually in the GHG inventory due to the method used by National Forest Inventory (NFI). Sampling design of the Estonian NFI and the method of estimation of land use changes are described in subchapter 7.1.3.

Table 7.3. The area of different land use classes in 1990–2011 (NFI), 1000 ha

	Forest land	**Cropland**	**Grassland**	**Unmanaged wetlands**	**Peatland (Wetlands)**	**Settlements**	**Other land**
1990	2 220.9	1 113.3	323.7	487.0	16.1	303.6	58.1
1991	2 224.7	1 110.8	324.3	486.9	16.1	302.9	57.1
1992	2 228.5	1 107.7	325.1	486.8	16.1	302.3	56.2
1993	2 232.3	1 103.6	326.8	486.6	16.1	301.8	55.5
1994	2 236.1	1 098.9	328.8	486.3	16.1	301.6	54.9
1995	2 239.9	1 094.3	330.6	486.1	16.1	301.3	54.5
1996	2 243.4	1 089.5	332.8	485.8	16.1	301.2	53.9
1997	2 246.8	1 085.0	335.2	485.4	16.1	300.9	53.3
1998	2 250.1	1 081.3	337.0	485.1	16.1	300.6	52.6
1999	2 252.8	1 078.0	338.9	484.8	16.1	300.2	51.9
2000	2 255.0	1 074.9	341.0	484.6	16.1	299.9	51.2
2001	2 256.5	1 072.4	342.5	484.5	16.1	300.0	50.8
2002	2 257.5	1 070.5	343.3	484.4	16.1	300.5	50.3
2003	2 258.3	1 068.9	343.7	484.3	16.1	301.5	50.0
2004	2 259.0	1 067.6	343.4	484.3	16.2	302.8	49.4
2005	2 259.6	1 066.8	342.0	484.1	16.5	304.5	49.1

	Forest land	Cropland	Grassland	Unmanaged wetlands	Peatland (Wetlands)	Settlements	Other land
2006	2 260.1	1 066.6	340.4	483.9	16.8	306.4	48.6
2007	2 260.4	1 066.4	339.0	483.8	17.1	308.0	48.1
2008	2 260.3	1 066.5	337.5	483.7	17.4	309.5	47.8
2009	2 260.0	1 066.8	336.3	483.4	17.5	310.9	47.8
2010	2 259.9	1 067.2	335.6	483.1	17.6	311.7	47.6
2011	2 259.8	1 067.5	335.1	482.9	17.6	312.2	47.6

The net CO_2 emissions/removals of the Estonian LULUCF sector are presented in Figure 7.2. The main sink of CO_2 in Estonia is forest land, constituting about 90% of all LULUCF sector uptake (Figure 2.9). Emissions and uptake from forest land is predominantly determined by changes in forest growing stock. For 1990−1998, growing stock of Forest land has been interpolated. In 1999 National Forest Inventory (NFI) was established and since then estimations are based on annual fieldwork data.

Forest is the major land-use category in Estonia. Due to the comparatively intensive use of forest resources, carbon flows derived from forest category have the greatest influence on the whole LULUCF sector's total carbon balance, being also the major cause of emissions in years 2000–2003. From 1999 to 2004, the rate of logging was more than twice as high as in the previous 10 years, which can be explained by the outcome of Land Reform and the economic boom taking place in the early 2000s. In 2002 and 2006, extensive wildfires spread, having some impact on the annual emissions of these years. Variation in inter-annual estimates are also influenced by statistical fluctuation of activity data caused by random error of sampling.

Figure 7.2. Annual change in emissions/removals of CO_2 from Estonian LULUCF sector in 1990−2011, CO_2 Gg

Total quantities of CH_4 and N_2O emitted are presented in Figure 7.3 and Figure 7.4. CH_4 emissions originate from forest, grassland and wetland wildfires and peat extraction. N_2O emissions comprise emissions from wildfires, peatland management and land conversion to cropland.

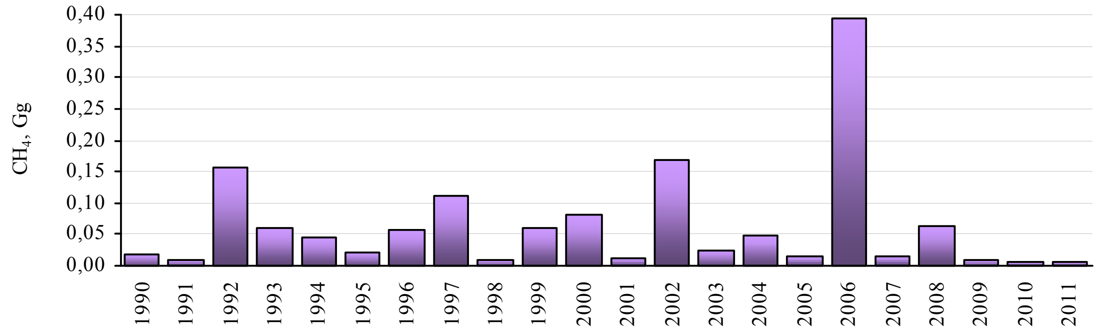

Figure 7.3. Emissions of CH_4 from the LULUCF sector in Estonia in 1990–2011, CH_4 Gg

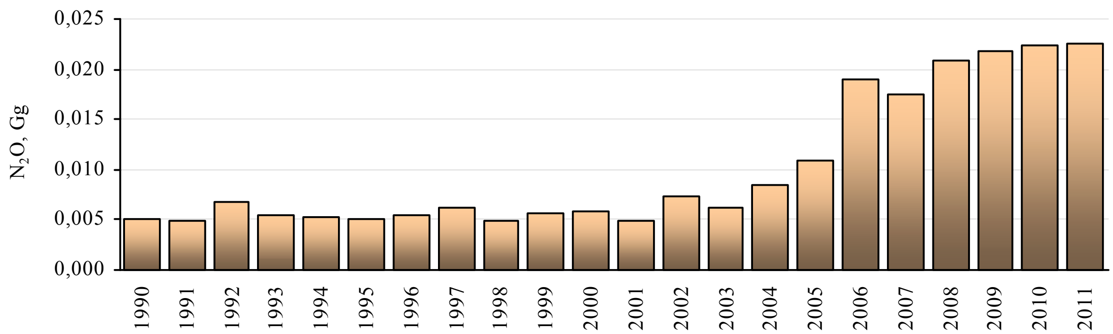

Figure 7.4. Emissions of N_2O from the LULUCF sector in Estonia in 1990–2011, N_2O Gg

Large inter-annual differences in emissions of non-CO_2 gases are caused mainly by the occurrence of wildfires (see Chapter 7.8) and land conversion to cropland (N_2O).

7.1.2. Land areas and land-use categories used in the Estonian inventory

Land areas presented in the inventory reporting are consistent with the land-use categories given in the IPCC GPG-LULUCF (IPCC 2003) (Table 7.6). Area estimates for land-use categories are based on the Estonian National Forest Inventory (NFI) carried out by the Estonian Environment Information Centre. The NFI is a sampling-based forest inventory that covers the whole country (Figure 7.5) and all land-use classes. NFI also provides information on soils, distribution into mineral and organic soils as well as into drained and undrained land. The nationally classified NFI sample plots are reclassified into IPCC land-use categories (Table 7.7). An overview and sampling design of the NFI is described in Subchapter 7.1.3.

Table 7.4 gives an overview of land-use transitions between 31.12.1989 and 31.12.2011. Largest decrease in area has occurred among croplands, most of which have turned into grasslands due to lack of active management. Forest land has increased by 1.9% during the last 22 years. This change is mostly a result of reallocation of grasslands to forest land category, when the tree crown cover of grasslands exceeds 30% due to natural succession, the land is accounted as forest land.

Table 7.4. The land-use change matrix for IPCC land-use categories from 31.12.1989 to 31.12.2011 (1 000 ha)

	Initial						
Final	**Forest land**	**Cropland**	**Grass-land**	**Wetlands**	**Settle-ments**	**Other land**	**Final area**
Forest land	2 202.0	16.0	22.7	5.2	4.2	9.7	2 259.8
Cropland	0	1 057.1	10.4	0	0	0	1 067.5
Grassland	5.4	36.1	288.1	1.3	3.0	1.5	335.1
Wetlands	2.4	0	0	496.4	0	1.8	500.4
Settlements	8.9	3.6	2.4	0	296.6	0.7	312.2
Other land	2.4	0.6	0	0.2	0	44.5	47.6
Initial area	2 217.3	1 115.4	323.2	503.1	304.5	59.3	4 522.7
converted to since 1990	19.1	-56.2	35.5	-6.7	7.0	-13.6	
Change %	1.9	-4.3	3.7	-0.5	2.5	-19.7	

Implementation of IPCC land-use categories in the Estonian inventory is described below.

7.1.2.1. Forest land and definitions

Paragraph 1 of the definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the Kyoto Protocol, as contained in the Annex to decision 16/CMP.1 defines 'forest' as a minimum area of land of 0.05–1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10–30 per cent with trees with the potential to reach a minimum height of 2–5 meters at maturity in situ. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high portion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10–30 per cent or tree height of 2–5 meters are also included as forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting, or natural causes (fires etc) but which are expected to revert to forest.

The definition of forest established by FAO (FRA 2005) is 'land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use'.

Estonian Forest Act and the consequent definition of forest has been amended several times during the last 20 years. Since 2009 it stipulates forest land as land which meets at least one of the following requirements:

i) forest land use is included in land cadastre;

ii) has an area of 0.1 hectares of land, growing woody plants with a minimum height of 1.3 meters and the tree crown cover at least 30 percent.

However, it is practically very difficult to follow the requirement of forest use in cadastre in statistics for the whole country. It should be noted that approximately 13% of forest land has not yet been entered in the cadastre. It also does not exist any international definition of forest based on registering forest land in the cadastre.

In addition, as the criterion of 1.3 m has caused some confusion in earlier reports, it should be noted that it is not 'the minimum tree height' in context of forest land definition. Actually, 1.3 m is criteria for counting unstocked forest area to stocked forest. The minimum tree height *in situ* by forest definition of the Forest Act is defined by tree species, stand's age and site index. Thus, there is not constant criteria for tree height in national definition.

For consistent statistical reasons, NFI has complied in general with the definition of forest, which was sustained in 1999. According to that, forest land is 'a land spanning 0.1 ha or more with tree crown cover (equivalent stocking level) of 30% or more with trees with the potential to reach a minimum height depending on the function of tree species, stand's age and site index. The latter criterion can be interpreted as 'stand productivity at least in Va yield class' (*id est* capability to produce as average of normal cutting cycle minimum 1 solid cubic metre per year per ha). Forest area includes temporary unstocked forest land (clear-cut areas, young regeneration areas, failed stands etc) that has enough potential to be a forest. It does not include land that is predominantly under agricultural or urban land use. According to the NFI definition of forest, estimates reported in national statistics and also in the UN/FAO Forest Resources Assessment (2005, 2010) procedure.

Starting from 2005, FRA 2005 forest criteria and OWL criteria were used in parallel with the national forest definition in the framework of the NFI. The aim was to present more precise and internationally comparable assessments in the future. Despite the fact the NFI could publish nowadays statistics in accordance with the forest definition of FRA, appropriate assessments are not published until now in international reports. Compared to the national definition, area of forest land is about 2% higher according to the FRA forest definition.

Due to the differences between definitions and that given in the decision 16/CMP.1, Estonia has established the 'definition of forest in the context of the Kyoto Protocol' in 2006 with the main parameters of forest definition reported in Table 7.5.

Table 7.5. Parameters for forest definition

Minimum tree crown cover	30%
Minimum land area	0.5 ha
Minimum tree height	2 m

The minimum tree crown cover (equivalent stocking level) criterion corresponds to the national definition of forest.

Since the NFI has been recording information on the forests, which remain in their surface area per hectare between 0.1 and 0.5 (since 2001 – due to the fact that criterion of 0.5 ha has been a minimum forest area in one of the earlier redaction of the Forest Act), there is available information that can be used to exclude these areas from LULUCF statistics. The same information is used for estimating forest area according to the FRA definition.

As mentioned above, there is no strict definition of the criterion of minimum tree height in the national definition of forest. For estimating forest area according to the FRA definition, the criterion 5 m of minimum tree height is used. As there is no forest-tree species that could reach the height of 2 m and not 5 m in the age of maturity, the criterion and data same as for counting forests according to the FRA definition can be used.

All forest land is considered managed in Estonia. All the forests are managed in one way or another – the whole forest land in Estonia is or has been covered with forest management plans. In addition, protected forests are covered with the protection scheme.

7.1.2.2. Cropland

According to the definition used by the NFI, cropland is 'arable land, area where annual and perennial crops are growing (incl. fallow, orchards, short-term and long-term cultural grasslands and greenhouse areas)'. It does not include the built garden land size under 0.3 ha (that is included in Settlements).

Abandoned cropland is classified as cropland until it has not lost arable land features – changes in soil and vegetation have not taken place and the land is still usable as cropland without the implementation of specific treatments.

The national definition corresponds to the IPCC classification.

7.1.2.3. Grassland

According to the national definition, this category includes rangelands and pasture land that is not considered as cropland nor forest land: land with perennial grasses that is proper for mow and pasture, smaller fallows and former cultural grasslands that have lost arable land features, grassland from wild lands (– 'natural grassland'). Overgrown wooded pasture with canopy cover 30...50% is classified to grassland or forest, depending on the main land use purpose.

National land cover class 'bushes' (– area covered with natural or wildered cultivated bush and shrub species where canopy cover is over 50%) is defined as IPCC grassland[111].

7.1.2.4. Wetlands

Land permanently saturated by water and/or area's peat layer is at least 30 cm and minimum potential tree height does not accord to the Forest land term. It does include smaller bog holes.

The NFI wetland areas were defined as IPCC wetlands. In order to give a more detailed overview, peat extraction areas were excluded from wetland land-use category and reported separately in Table 7.3. The data used was obtained from the NFI (for 1990–2011) and Land Balances (for 1970–1989).

7.1.2.5. Settlements

The built-up areas, with roads, streets and squares, traffic and power lines, urban parks, industrial and manufacturing land, sports facilities, airports, legal waste down points, construction sites and buildings with up to 0.3 ha of garden yard, open cast

[111] Area of bushes has been reported under 'Other lands' until the 2009 submission. It was recommended by the ERT to include areas of bushes to 'Grassland' category.

areas (except peat extraction areas) were reported under settlements land use category (Table 7.3). Data on settlements area was obtained from the NFI (for 1990–2011) and Land Balances (for 1970–1989).

7.1.2.6. Other land

Land areas that do not fall into any of the other five land-use categories. Consistent with the IPCC Guidelines, this land-use category is used to allow the total of identified land areas to match the national area.

7.1.3. National Forest Inventory

The estimation of emitted/removed quantities of carbon is carried out based on data received in the process of the NFI. Until the 1990s, the national estimation of forest resources was based on stand-wise forest inventories. Regular inventories, every 10 years, were carried out on most of the forest land: state forest districts as well as the forests of collective and state farms. After independence was regained in Estonia in 1991, the ownership reform program was started. Part of it was land reform. Land, which had been unlawfully expropriated, was to be returned to its initial owners or to their descendants. Borders of the state forests were restored accordingly to the year 1940, and the remaining land was left for privatisation. Changes were carried out in forest survey too. The planned economy, which had existed for 50 years, was replaced by a market economy resulting in intensive cutting of forests. As the land reform was not quick enough (and is still continuing today), a situation arose such that valid, current information was available only for one third of the Estonian forests. Intensified forest management together with the land reform created a need for new inventory methods.

The first National Forest Inventory covering the whole country commenced in 1999. With rather modest means the NFI is able to give a quite precise assessment of forest area, resources and cutting volume. The main objective of the NFI is to give a description of forests, but nowadays the NFI also gives information about subjects such as the distribution of land by land-use classes and the afforestation and growing stock of non-forest land etc.

Methodologically, the NFI is designed as an annual research effort, which using optimal methods, must ensure continuous updating of information and the forest database. A network of sample plots (Figure 7.5), covering the whole country, has been planned for five years with 20% or approximately 275 clusters (ca 4 300 sample plots) measured each year, so that permanent plots will be re-measured every 5 years. Point estimates of parameters are calculated using data from the sample plots and form the basis for inferences to the entire population.

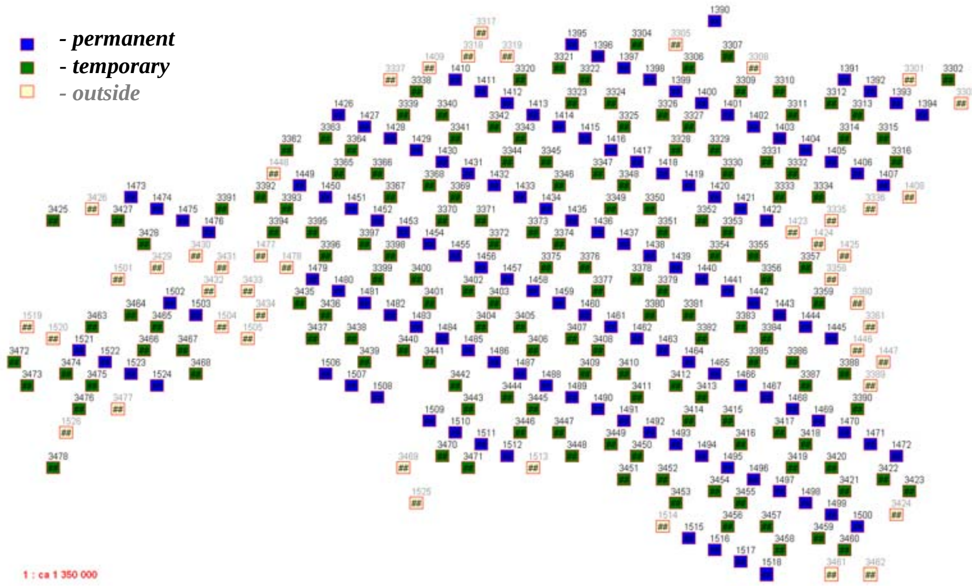

Figure 7.5. Cluster network of Estonian national forest inventory

By 2001 the NFI assessments were used at the state level, as well as in compiling the strategic document "The Development Plan of Forestry until the Year 2010". Since that period the NFI has an important role in decision making on effective management of forests and future projections – in large-area forest management planning such as planning of cutting at the national level. At present, the actual themes of the NFI monitoring system include global carbon cycles and observation of features related to the protection of biological diversity.

The Estonian NFI covers all land use classes, including all forests and other wooded lands in all ownership groups, including protected areas. Assessments of the forest resource by the NFI have become the basis for national and international statistics in Estonia, such as the United Nations/FAO Forest Resources Assessment procedure, the Ministerial Conference on the Protection of Forests in Europe (MCPFE). The NFI also produces information on forest carbon pools and changes for the LULUCF reports of the United Nations Framework Convention on Climate Change.

The statistical design for the Estonian NFI is a systematic sample without pre-stratification. No remote sensing is applied. The network of sample plots covers the whole country and is planned as a five-year cycle. The sampling grid is designed to meet the accuracy requirements at national level. The sampling intensity is the same throughout the whole country. The sample (cluster) distribution is based on a national 5-km x 5-km quadrangle grid, determined by the L-EST co-ordinates system. Sample plots are organized into clusters to increase the efficiency of the survey. An observation unit is an individual field plot that is the centre of sample circles with defined radii. The method of sampling with partial replacement is used. Plots are divided into permanent clusters and temporary clusters that form 800 x 800 metre squares. All the permanent clusters (sample plots) are re-measured every 5 years. The sample plot radius depends on the assessed variables, as well as their values, for example, tree diameter. In addition to plots with the main radii of 10 m and 7 m, where land-use class is determined, plots of other radii are also used.

All population units have equal probability of selection into the sample. The result is point estimates of multiple population parameters based on the measurement data. Although all NFI estimates are based on sampling, they are not absolute. Therefore, each estimate of a general parameter is always accompanied with a sampling error.

More detailed information about sampling scheme, design and density of sampling is described in National Forest Inventories[112] (2010).

In order to collect data about land-use transitions, additional field studies started in 2009 in the framework of the NFI. This method follows the example of Finnish NFI. The fieldwork is ongoing (until 2014 or as long as needed). Collected data provides information on different land use classes (origins retrospectively 20 years), the year of changes and also soil type. During land category registration, "LULUCF former land category" is registered on every sample plot if land category has changed after base point (31.12.1989). The year of change is being estimated first directly in the field. Older maps and aerial photographs are used afterwards as supporting material to determine the exact year more accurately. Since 1999 there is information available on permanent sample plots. Resulting data set is a matrix with the previous and the current land use classes in the timeline. During field study soil types (mineral/organic) are also estimated. All sample plots are assessed with soil type ‚mineral' or ‚organic'. In case the former land category type differs from current one, soil type is estimated by the former land category.

During field study land categories and subcategories shown in Table 7.6 are registered by the NFI.

Table 7.6. National definitions for land use categories and relevant land use category defined in IPCC 2003

National definitions for land use categories and subcategories																
Unstocked forest land (MM)	Forest land (by GFRA 2005 definition) (MV)	Arable land (excluding PK, PR) (PM)	Permanent crops (PK)	Long-term cultural grassland (PR)	Bushes (P)	Natural grassland (RM)	Other wooded land (crown cove 5-10%) (GFRA 2005 definition) (OW)	Swamp, bog (S)	Inland water bodies (SV)	Peat quarry (KT)	Opencast pit (excl. KT) (K)	Settlements (excl. T, TR) (A)	Roads and railways (T)	Lines, power lines etc. (TR)	Unusable mineral land (KK)	Other land (Y)
Relevant category in IPCC GPG LULUCF 2003																
Forest Land		Cropland			Grassland			Wetlands			Settlements				Other Land	

7.1.4. Key Categories

The key categories of LULUCF sector are summarised in Table 7.7. The largest effect on the overall inventory was attributed by Forest Land remaining Forest Land living biomass, constituting 14.7% of the total inventory emissions in absolute values.

Table 7.7. Key categories in LULUCF sector (CRF 5) in 2011 (quantitative approach used, Tier 2)

IPCC source category		Gas	Identification criteria
5.A.1	Forest Land remaining Forest Land - living biomass	CO2	Level (1990, 2011), Trend
5.A.1	Forest Land remaining Forest Land - organic soils	CO2	Level (2011), Trend
5.A.1	Forest Land remaining Forest Land - deadwood	CO2	Level (2011), Trend
5.A.1	Forest Land remaining Forest Land - mineral soils	CO2	Level (1990, 2011), Trend
5.A.2.1	Cropland converted to Forest Land - mineral soil	CO2	Trend
5.A.2.2	Grassland converted to Forest Land - living biomass	CO2	Trend
5.B.1	Cropland remaining Cropland - organic soils	CO2	Level (1990, 2011), Trend
5.B.1	Cropland remaining Cropland - mineral soils	CO2	Level (2011), Trend
5.B.2.2	Grassland converted to Cropland - organic soils	CO2	Trend
5.B.2.2	Grassland converted to Cropland - mineral soils	CO2	Trend
5.C.1	Grassland remaining Grassland - living biomass	CO2	Level (2011), Trend
5.C.1	Grassland remaining Grassland - organic soils	CO2	Trend
5.C.2	Land converted to Grassland - mineral soils	CO2	Trend
5.D.1	Wetlands remaining Wetlands\Peatland - organic soils managed for peat extraction	CO2	Trend
5.E.2	Land converted to Settlements - living biomass	CO2	Level (2011), Trend
5.E.2	Land converted to Settlements - soils	CO2	Trend
5.F.2	Land converted to Other Land - living biomass	CO2	Trend

7.2. Forest Land (CRF 5.A)

7.2.1. Source category description

Since 1970, forest area has been increasing in Estonia, mostly due to abandonment of grasslands and overgrowing of wetlands (Figure 7.5).

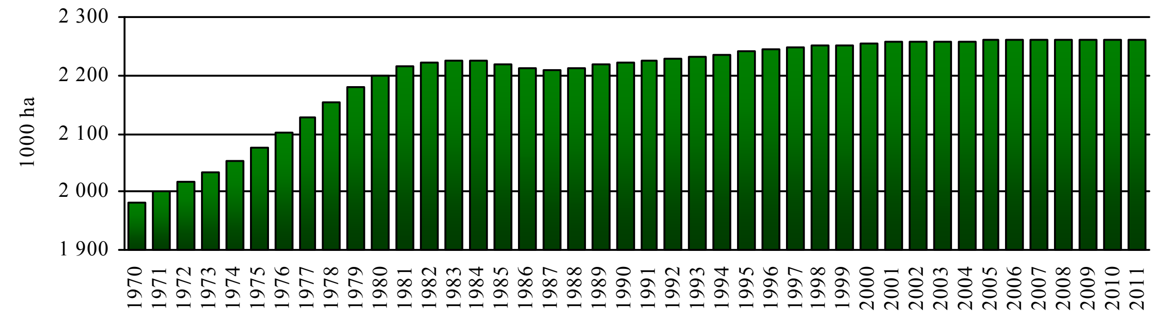

Figure 7.6. Forest land area in Estonia in 1970–2011, 1000 ha

Forest land category constitutes about 90% of all LULUCF sector emissions/removals. The net removal from forest land was 5 184 Gg CO_2 eq. in 2011 (Figure 7.7). During 2000−2003, Forest land category acted as a net source of CO_2 mainly due to intensive harvesting. Estimations in Figure 7.7 include emissions and removals from living biomass, dead organic matter, mineral and organic soils and biomass burning.

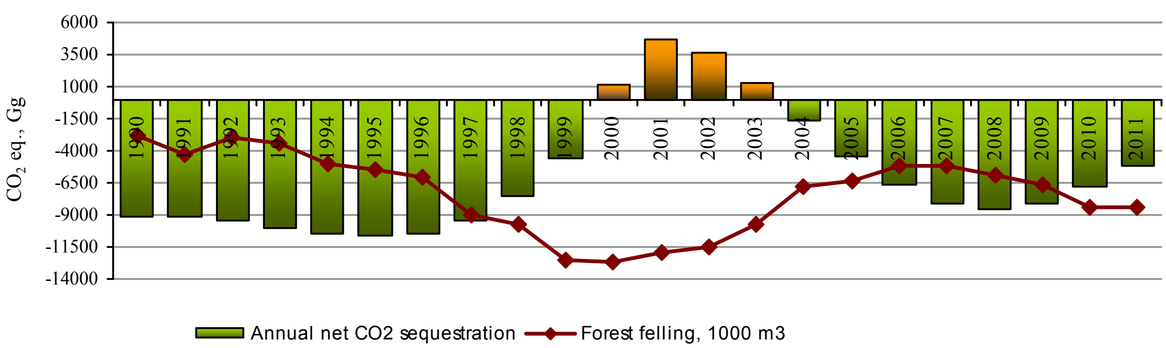

Figure 7.7. Annual net change in CO_2 removals (-)/emissions (+) from Forest Land category in 1990–2011, Gg CO_2 eq.

7.2.2. Methodological issues

Carbon stock change in category 5.A.1 Forest Land remaining Forest Land is given by the sum of changes in living biomass, dead wood and soils. The algorithm employed in order to estimate carbon flows related to ‘Forest Land remaining Forest Land’ is presented below:

Equation 7.1.[113]

$$\Delta C_{FF} = (\Delta C_{FF_{LB}} + \Delta C_{FF_{DOM}} + \Delta C_{FF_{Soils}})$$

Where:

ΔC_{FF} – annual change in carbon stocks from forest land remaining forest land, tC yr^{-1};
$\Delta C_{FF\,LB}$ – annual change in carbon stocks in living biomass (includes above- and belowground biomass) in forest land remaining forest land, tC yr^{-1};
$\Delta C_{FF\,DOM}$ – annual change in carbon stocks in dead organic matter (includes dead wood and litter) in forest land remaining forest land, tC yr^{-1};
$\Delta C_{FF\,Soils}$ – annual change in carbon stocks in soils in forest land remaining forest land; tC yr^{-1}.

Equation 7.1 is also used for calculations in Land converted to Forest Land subcategory.

7.2.2.1. Change in carbon stocks in living biomass

For estimating carbon stock changes in biomass under land remaining Forest Land category, *Tier 2* approach and *Method 2* – the stock-difference method (Equation 7.2) was applied. NFI provides annually data of growing stock and area for forest land remaining forest land, also on land converted to forest land.

It should be noted, that stock change method comprises also carbon loss from biomass burning, thus CO_2 emissions from burning are not presented separately, but included in general carbon stock change figures. However, CH_4 and N_2O emissions from biomass burning on forest areas have been estimated (Chapter 7.8 Non-CO2 emissions from biomass burning (CRF 5 (V)).

Equation 7.2[114]

$$\Delta C_{FF_{LB}} = \Delta C_B = (C_{t_2} - C_{t_1})/(t_2 - t_1)$$

and

$$C = \sum_{i,j} \left\{ A_{i,j} \bullet V_{i,j} \bullet BCEF_{S\,i,j} \bullet \left(1 + R_{i,j}\right) \bullet CF_{i,j} \right\}$$

Where:

ΔC_B – annual change in carbon stocks in biomass (the sum of above- and below-ground biomass) in land remaining in the same category, tonnes C yr^{-1};
C_{t2} – total carbon in biomass calculated at time t_2, tonnes C;
C_{t1} – total carbon in biomass calculated at time t_1, tonnes C;
A – area of land remaining in the same land-use category, ha;
V – merchantable growing stock volume, $m^3\ ha^{-1}$;
i – ecological zone i;
j – climate domain j;

[113] GPG-LULUCF 2003, Equation 3.2.1., p 3.23.
[114] IPCC 2006, Vol 4 (AFOLU), Equation 2.8, p 2.12.

$BCEF_S$ – biomass conversion and expansion factor for expansion of merchantable growing stock volume to above-ground biomass, tonnes above-ground biomass growth (m^3 growing stock volume)$^{-1}$ (Table 7.8);
$BCEF_S=BEF_S \cdot D$;
R – ratio of below-ground biomass to above-ground biomass, tonne d.m. below-ground biomass (tonne d.m. above-ground biomass)$^{-1}$ (Table 7.9);
CF – carbon fraction of dry matter (default = 0.5), tonnes C (tonne d.m.)$^{-1}$.

Equation 7.2 is also used for calculations of carbon stock changes in living biomass under land converted to Forest land subcategory.

According to GPG-LULUCF 2003 and IPCC 2006 Vol. 4, Estonia is in between Boreal and Cold temperate climatic zone, however most recent reports (e.g. State of Europe's Forests, 2011) and the statement by national biologists is that Estonian forest vegetation is typical to boreal forests, thus input values from Boreal zone is selected for Forest Land category. All other land use categories follow the default allocation by IPCC 2003.

Table 7.8. Implemented values of $BCEF_S$[115]

Boreal	Growing stock level (m^3)			
Forest type	< 20	21-50	51-100	> 100
pines	1.2	0.68	0.57	0.5
firs and spruces	1.16	0.66	0.58	0.53
hardwoods	0.9	0.7	0.62	0.55
Weighted average $BCEF_S$	FL rem FL		0.58	
	CL to FL		0.95	
	GL to FL		0.69	
	WL to FL		1.00	
	SL to FL		0.93	
	OL to FL		0.98	

Weighted average $BCEF_S$ values were calculated for land remaining forest land and for each land use conversion to forest separately, depending on the distribution of tree species, age class and growing stock level.

Weighted average R values were calculated based on tree species distribution and above-ground biomass. Land converted to forest land subcategories were divided to human induced (CL to FL, WL to FL, SL to FL = AR) and natural regeneration (GL to FL, OL to FL) classes[116].

Table 7.9. Default values of root-to-shoot ratio R[117]

	Land remaining Forest Land		Land converted to Forest Land	
Domain	Above-ground biomass, t/ha	Root-shoot ratio	Above-ground biomass, t/ha	Root-shoot ratio

[115] IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50.
[116] See more information about dividing land-use changes into human-induced and natural regeneration in Chapter 11.1.3.
[117] IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49.

		R		R
Boreal coniferous forest	> 75	0.24	< 75	0.39
Temperate, other broadleaf forest	75-150	0.23	< 75	0.46
Weighted average		0.235		Human induced 0.39 Natural 0.44

In order to ensure that actual carbon stock changes are reported, and not artefacts resulting from changes in area over time, ERT[118] recommended to implement calculations of carbon stock changes in the following sequence as set out in the IPCC good practice guidance for LULUCF (Chapter 4.2.3.2): i) for each given area the carbon stock change is first calculated as a difference of carbon stocks between times t1 and t2, ii) these stock changes are summed for all areas.

It was also a recommendation of ERT to implement $BCEF_S$ values from the IPCC 2006.[119]

7.2.2.2. Annual change in carbon stock due to biomass changes in forest land

In Estonia, forest area increased 42 500 hectares by 2011 in comparison to the base year. The distribution of main tree species on forest land remaining and land converted to forest land is presented in Table 7.10.

Table 7.10. Distribution of tree species on FL rem FL and to FL

Tree species	Land remaining Forest Land	Land converted to Forest Land	
		Human induced	Natural regeneration
Pinus sylvestris	0.300	0.43	0.18
Picea abies	0.236	0.53	0.11
Betula	0.228		
Populus tremula	0.074		
Alnus glutinosa	0.051		
Alnus incana	0.071		
Salix	0.010		
Quercus robur	0.005		
Fraxinus excelsior	0.010		
Other	0.014	0.05 (mainly *Betula*)	0.7 (broadleaf)

Table 7.11. General characteristics of Estonian forest in 2011[120]

Main tree species	Area, 1000 ha	Relative error ±%	Growing stock, 1000 m^3	Relative error ±%	Increment, 1000 m^3 yr^{-1}
Pine	724.6	*3.0*	174 020	*3.4*	3 481

[118] ARR2012, point 97.
[119] ARR2012, point 126.
[120] Eesti Metsad 2011, Adermann, V. (Forest statistics by NFI, 2013).

Spruce	377.9	*4.4*	83 228	*5.0*	2 868
Birch	699.1	*3.1*	126 558	*3.5*	3 324
Aspen	129.4	*7.7*	30 635	*9.2*	779
Common alder	73.0	*10.4*	17 887	*11.5*	362
Grey alder	182.8	*6.5*	30 365	*7.4*	1 350
Other	35.1	*15.0*	5 924	*18.7*	182
Total	2 221.9	*1.3*	468 618	*1.5*	12 346

In Table 7.12 the cumulative area and proportion of land use changes to Forest Land in 2011 are shown, also applied emission factors for mineral and organic soils. In case of missing or insufficient country-specific data, emission factors from Sweden 2012 annual submission were implemented with the agreement of ERT[121].

Table 7.12. Cumulative land use changes to Forest Land in 2011 and implemented soil emission factors[122]

Land-use change	kha	%	EF mineral soil Mg C ha^{-1}	EF organic soil Mg C ha^{-1}
Cropland→Forest Land	16.0	28%	-0.85	-0.57
Grassland→Forest Land	22.7	39%	-0.225	-0.57
Wetlands→ Forest Land	5.2	9%	0.17	-0.57
Settlements→ Forest Land	4.2	7%	0.17	-0.57
Other Land→ Forest Land	9.7	17%	0.17	-0.57
Total	57.8	100%		

Data presented in Figure 7.8 characterizes carbon stock changes in living biomass under land remaining Forest Land and land converted to Forest Land subcategories in 1990−2011. The estimation for 1990−1998 is based on interpolated data, since no exhaustive forest statistics were carried out during these years. National Forest Inventory that covers the whole country started in 1999.

From 1999 to 2003, the rate of harvesting (see Figure 7.9) was about twice as high than usual due to the economic boom in Estonia. Volume of harvested timber exceeded annual biomass increment in forest, as the result Forest land category acted as a net source during that period (Figure 7.7).

[121] ARR2012, point 94.
[122] All EF-s for organic and mineral soils are taken from the Swedish 2012 annual submission, except CL→FL mineral soil, that is based on Tier 1 method implemented with Estonias country-specific data.

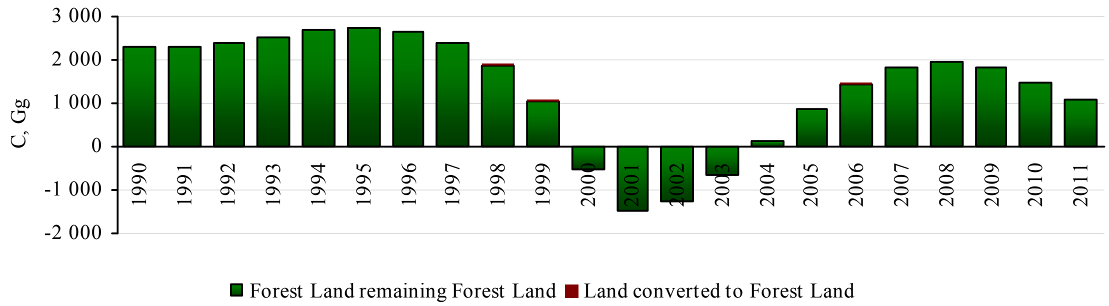

Figure 7.8. Annual carbon stock change in Forest Land living biomass in 1990–2011, Gg C

In the previous annual submission (2012) forest land living biomass was highly fluctuative in the last years. Following the recommendation by ERT[123], the inter-annual fluctuations were reduced by using smoothed data.

Data about forest fellings is estimated by NFI since 1999 (data starting point at 1998). Statistics Estonia (SE) collects forest harvesting data based on loggings planned (so called 'forest notices'). As the latter method underestimates cuttings during the 1990s, the data provided by SE for 1990 to 1997 are adjusted using the differences approach between the statistics of SE and the NFI. Data about total fellings during the last 22 years is illustrated in Figure 7.9.

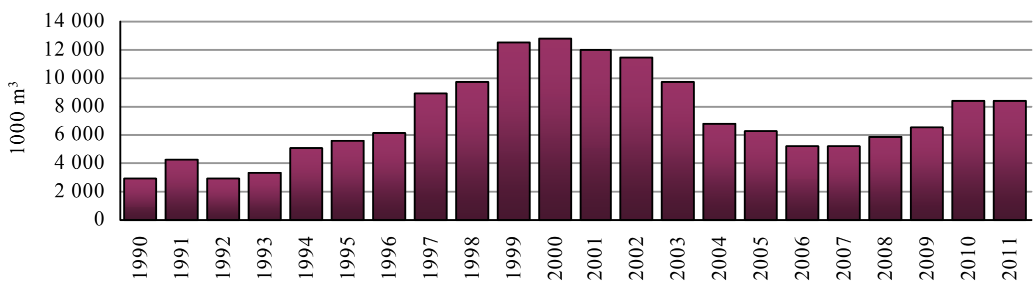

Figure 7.9. Harvested volume[124] on forest land in Estonia in 1990–2011, 1000 m^3

Storm damage in Estonia

During the in-country review in 2012, ERT encouraged Estonia to provide additional information about storm damage in forests.

Based on expert opinion, 200 ha and 40 000 m^3 storm damage per year is a "normal" damage. In figure Figure 7.10 the forest area affected by storms is shown. There is no annual comprehensive statistics regarding volume of wood cut due to storm damage, therefore information can be provided only for some years. The volume of clear cutting and sanitary cutting due to storm damages: 150 000 m^3 (state forests only) in 1999, 908 000 m^3 in 2001, 808 000 m^3 in 2002 and 666 000 m^3 in 2005.

[123] ARR2012, point 98.
[124] Stem volume, over bark, without stump and branches, NFI.

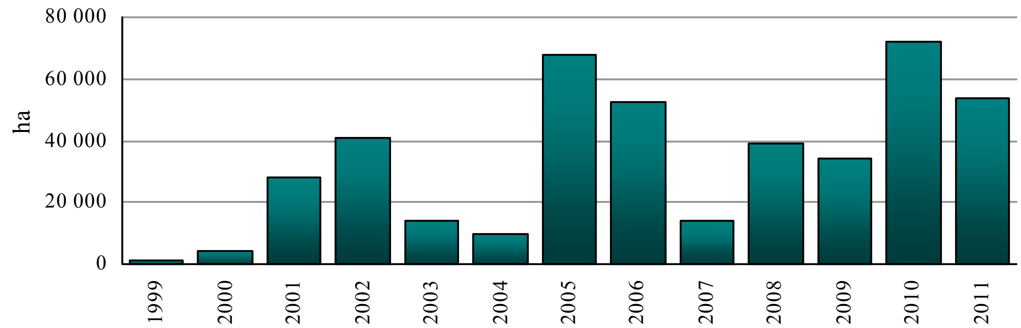

Figure 7.10. Storm-damaged forest area 1999–2011, ha

7.2.2.3. CO_2 emissions/removals from/by dead wood

For estimating carbon stock changes in dead wood pool, *Tier 2* and stock change method was applied. NFI provides annually data about the volume of dead wood for the entire forest area (land remaining and conversion to forest land). Carbon stock change in the dead wood pool was calculated following Equation 7.3, while implementing the same approach as for living biomass, i.e. instead of comparing total stocks between years[125], the annual stock is first converted to stock per area, after which the equation can be applied in order not to confound the estimates of carbon stocks and stock changes due to differences in area. Also inter-annual fluctuations in the carbon stock changes in the dead wood pool were reduced by using smoothed data from NFI. Values of dead wood densities for different tree species were acquired from Sandström *et al*, 2007[126].

Equation 7.3[127]

$$\Delta C_{FF_{DW}} = \left[A \bullet \left(B_{t2} - B_{t1}\right)/T\right] \bullet CF$$

Where:

$\Delta C_{FF\ DW}$ – annual change in carbon stocks in dead wood in forest land remaining forest land, tonnes C yr^{-1};
A – area of managed forest land remaining forest land, ha;
B_{t1} – dead wood stock at t_1 for managed forets land remaining forest land, tonne d.m. ha^{-1};
B_{t2} – dead wood stock at t_2 (the previous time) for managed forets land remaining forest land, tonne d.m. ha^{-1};
$T=(t_2-t_1)$ – time period between time of the second stock estimate and the first stock estimate, yr;
CF – carbon fraction of dry matter (default = 0.5), tonnes C $(\text{tonne d.m.})^{-1}$.

Equation 7.3 is also used for estimating dead wood stock change in land converted to Forest land subcategory.

[125] In previous submission it was implied incorrectly, ARR2012 points 97 and 99.
[126] Sandström, F., Petersson, H., Kruys, N. 2007. Biomass conversion factors (density and carbon concentration) by decay classes for dead wood of Pinus sylvestris, Picea abies and Betula spp. in boreal forests of Sweden. Forest Ecology and Management 243 (1), p. 19-27.
[127] GPG-LULUCF 2003, Equation 3.2.12., p 3.34.

Figure 7.11 illustrates annual dead organic matter stock change on land remaining forest land and land converted to forest land.

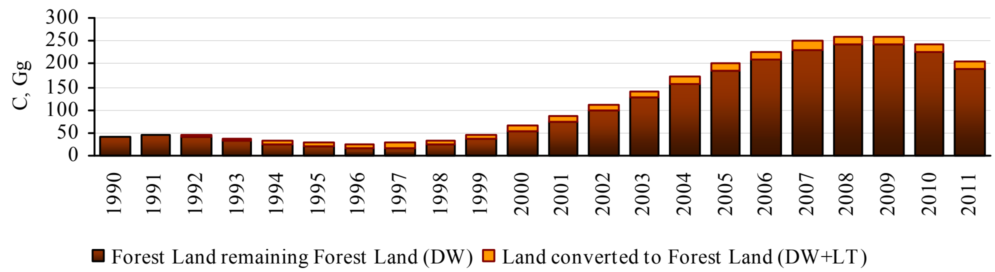

Figure 7.11. Net carbon stock change in forest dead organic matter pool 1990–2011, Gg C

7.2.2.4. CO_2 emissions/removals from/by litter

Estonia does not have sufficient data regarding litter stocks, thus under forest land remaining forest land, for litter pool *Tier 1* method was implemented, assuming that carbon stocks are in equilibrium so that the changes in litter pool are assumed to be zero. Under land conversion to forest land, the emission factor from Sweden (0.3 Mg C ha^{-1} yr^{-1}) is used for litter, assuring consistency between LULUCF and KP-LULUCF emission estimates. It was also possible to apply Swedish EF of litter on land remaining Forest land, but it would have resulted a carbon increase in the pool, therefore Estonia decided to implement a more conservative approach, ie *Tier 1*, assuming no change in the pool.

7.2.2.5. CO_2 emissions/removals from/by mineral forest soils

Due to insufficient data regarding carbon stock changes in forest mineral soil, emission factor from Sweden (0.16 Mg C ha^{-1} yr^{-1}) was implemented for land remaining forest land. For the conversion categories, EF-s from Sweden were applied as well, except for cropland conversion to forest land (Table 7.12).

In 2011, there was a net increase in the carbon stock of forest mineral soils by 259 Gg, of which 275 Gg was contributed by land remaining forest, whereas land conversion to forest resulted a decrease of -16 Gg carbon. On the whole, annual carbon sequestration has decreased by 6% since 1990 by forest mineral soil.

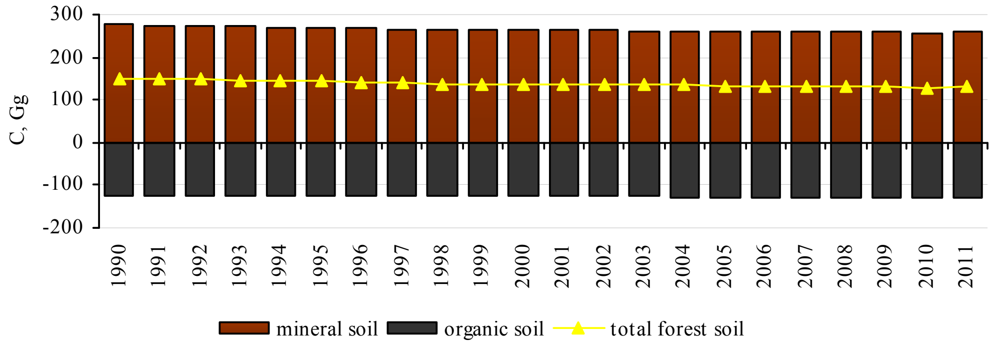

Figure 7.12. Annual stock change in forest land mineral and organic soil pools 1990–2011, Gg C

Mineral soil reference carbon stocks and soil emission factors on land-use changes

Reference carbon stocks were calculated for forest land, cropland and grassland based on available national research data and publications. For verification purposes, obtained values were compared (Table 7.13) with the default SOC_{REF} values given in the IPCC 2006[128] calculated by applying default stock values according to soil type distribution on different land categories in Estonia.

Based on the difference in SOC_{REF} values and assuming default transition period of 20 years, mineral soil emission factors for land conversion from cropland to forest land (CF) and grassland to forest land (GF) were calculated. Obtained values were compared with respective EF-s of neighbouring countries- Finland and Sweden. There was less than 2-fold difference between Estonian EF and Swedish EF for CF and 4.5-fold difference for GF emission factors, therefore only country-specific CF emission factor was implemented in the calculations.

Table 7.13. Comparison of SOC_{REF} stocks estimated based on national research data and IPCC 2006

SOC_{REF} (Mg C ha^{-1})	Forest Land	Cropland	Grassland
National research data	68.15	85.21	88.33
IPCC 2006 default	74.36	85.37	75.88

7.2.2.6. CO_2 emissions from drained organic forest soils

Equation 7.4 was applied for estimating carbon loss from drained organic forest soils.

Equation 7.4[129]

$$\Delta C_{FF\,Organic} = A_{Drained} \bullet EF_{Drainage}$$

Where:

[128] IPCC 2006, Vol 4, Table 2.3, p 2.31.
[129] GPG-LULUCF 2003, Equation 3.2.15, p. 3.42.

$\Delta C_{FF\ Organic}$ – CO_2 emissions from drained organic forest soils, tonnes C yr^{-1};
$A_{Drained}$ – area of drained organic forest soils, ha;
$EF_{Drainage}$ – emission factor for CO_2 from drained organic forest soils, tonnes C ha^{-1} yr^{-1}

Equation 7.4 is also used for calculating emissions from organic forest soils after land transition to forest land.

In previous submissions, default EF of 0.16 (tonnes C ha^{-1}) from GPG-LULUCF 2003 was implemented. ERT recommended Estonia to apply Swedish EF (Table 7.12) for drained organic forest soils, since default EF will likely cause underestimation of emissions.

Approximately 22% of all Estonian forest soils are organic soils, of which about 45% are drained according to NFI. Emissions from drained organic forest soils (Figure 7.12) have increased by 2.7% since 1990.

7.2.3. Uncertainty and time-series consistency

Uncertainty rates of activity data and emission factors are presented in Table 7.14. There are significant changes in emission factor uncertainties due to implementation of IPCC 2006 factors instead of GPG-LULUCF 2003, also previously unreported carbon pools were estimated based on Swedish EFs.

Table 7.14. Estimated values of uncertainties used in Forest Land category

	IPCC Source Category	Activity data %[130]	Emission factor %	EF References
5.A.1	Forest Land remaining Forest Land - living biomass	1.84	46.95	IPCC 2003 & 2006[131]
5.A.1	Forest Land remaining Forest Land - mineral soils	2.16	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.A.1	Forest Land remaining Forest Land - organic soils	4.96	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.A.1	Forest Land remaining Forest Land - dead wood	2.12	12.89	Sandström *et al*. 2007
5.A.2.1	Cropland converted to Forest Land - living biomass	33.19	46.95	IPCC 2003 & 2006
5.A.2.1	Cropland converted to Forest Land - mineral soil	28.17	35.00	Kõlli *et al*. 2004 & 2009
5.A.2.1	Cropland converted to Forest Land - dead wood	42.49	12.89	Sandström *et al*. 2007
5.A.2.2	Grassland converted to Forest Land - living biomass	38.10	46.95	IPCC 2003 & 2006
5.A.2.2	Grassland converted to Forest Land - mineral soils	24.20	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.A.2.2	Grassland converted to Forest Land - organic soils	87.15	35.00	Sweden NIR 2012, Table 7.5, p. 291

[130] All activity data uncertainty estimates are obtained from NFI.
[131] Parameters from the IPCC 2006 were applied, however due to lack of information in the IPCC 2006, the same EF uncertainty as in the GPG-LULUCF 2003 for calculating living biomass emissions was assumed.

5.A.2.2	Grassland converted to Forest Land - dead wood	29.02	12.89	Sandström *et al*. 2007
5.A.2.3	Wetlands converted to Forest Land - living biomass	60.57	46.95	IPCC 2003 & 2006
5.A.2.3	Wetlands converted to Forest Land - organic soils	48.08	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.A.2.3	Wetlands converted to Forest Land - dead wood	69.23	12.89	Sandström *et al*. 2007
5.A.2.4	Settlements converted to Forest Land - living biomass	67.34	46.95	IPCC 2003 & 2006
5.A.2.4	Settlements converted to Forest Land - mineral soils	57.96	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.A.2.4	Settlements converted to Forest Land - organic soils	138.58	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.A.2.4	Settlements converted to Forest Land - dead wood	87.78	12.89	Sandström *et al*. 2007
5.A.2.5	Other Land converted to Forest Land - living biomass	43.86	46.95	IPCC 2003 & 2006
5.A.2.5	Other Land converted to Forest Land - mineral soil	34.81	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.A.2.5	Other Land converted to Forest Land - dead wood	38.89	12.89	Sandström *et al*. 2007

7.2.4. Source specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for LULUCF sector according to IPCC *Tier 1* method. The activities are carried out every year during the inventory. The QC check list is used during the inventory.

7.2.5. Source-specific recalculations

Entire time series of activity data is being annually recalculated for all areas of land categories and land-use conversions, since new data about land-use transitions is collected every year and new estimates will be integrated to overall activity data.

For forest living biomass stock change estimation, root-shoot ratio (R) and biomass conversion and expansion factors ($BCEF_S$) from the IPCC 2006 guidelines were implemented. Also the mistake in applying the stock-change method pointed out by the in-country review in 2012 has been corrected (more information in chapter 7.2.2.1).

The default emission factor for drained organic forest soils was replaced by the EF from Sweden according to ERT recommendation (Table 7.16).

In previous submissions, emissions from mineral forest soils were not estimated due to lack of country-specific data, ie *Tier 1*, assuming zero change in mineral soils were applied. In current submission, land conversion EF-s from Sweden 2012 inventory report were implemented as an interim approach pursuant to ERT recommendations. EF for cropland conversion to forest land was calculated based on national research data and publications (more information in chapter 7.2.2.5).

Carbon stock changes in forest litter pool are estimated for the first time in the 2013 annual submission. Due to lack of country-specific data, EF from Sweden was applied as an interim approach to cover the data gap. Carbon stock change in litter pool was estimated only for land conversion to forest land in order to assure consistency between the Kyoto Protocol accounting and the Convention reporting. It would have been possible to provide litter stock change also for land remaining forest land, but implementing EF from Sweden would have lead to increase in the total CO_2 uptake, therefore a more conservative approach (*Tier 1*) was implemented with the assumption that there is no change in litter pool on land remaining forest land.

In previous submission, under land conversion to forest land, the total cumulative carbon stocks of living biomass and dead wood pools were reported[132], in current submission, the mistake has been corrected and net changes in living biomass and dead wood pool carbon stocks are reported.

More appropriate dead wood densities were used in current submission.

Also see Table 10.5–Table 10.7.

In Table 7.15 quantitative overview of recalculations and in Table 7.16 changes in applied parameters have been shown.

[132] ARR2012, point 101.

Table 7.15. Quantitative overview of recalculations, Gg C (15.09.2012 resubmission and 15.04.2013 submission)

		1990			**1995**			**2000**			**2005**			**2010**		
		Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**
Forest Land remaining Forest Land	Living biomass	2529.2	2316.0	**-9**	2518.3	2737.1	**8**	-1314.0	-520.9	**-152**	1687.5	856.1	**-97**	389.7	1484.6	**74**
	Dead organic matter	33.9	41.6	**18**	33.8	19.6	**-72**	3.2	51.4	**94**	149.8	184.9	**19**	84.3	225.3	**63**
	Mineral soil	NO	277.3	**100**	NO	277.14	**100**	NO	276.9	**100**	NO	276.2	**100**	NO	274.9	**100**
	Organic soil	-35.3	-124.9	**72**	-35.3	-124.8	**72**	-35.3	-124.8	**72**	-35.2	-124.5	**72**	-35.04	-124.07	**72**
Land converted to Forest Land	Living biomass	5.5	2.3	**-139**	66.4	3.4	**-1853**	159.9	6.7	**-2287**	395.6	11.4	**-3361**	640.2	10.1	**-6239**
	Dead organic matter	0.03	1.15	**97**	2.12	7.38	**71**	6.36	12.52	**49**	11.45	15.69	**27**	16.50	18.89	**13**
	Mineral soil	NE/ NO	-0.88	**100**	NE/ NO	-8.07	**100**	NE/ NO	-13.43	**100**	NE/ NO	-15.38	**100**	NE/ NO	-17.01	**100**
	Organic soil	-0.04	-0.16	**75**	-0.43	-1.15	**63**	-0.76	-1.95	**61**	-0.83	-2.77	**70**	-1.11	-4.27	**74**
	TOTAL Forest Land net CO_2	-9288.2	-9212.1	**-1**	-9477.9	-10 672.2	**11**	4328.6	1149.4	**-277**	-8097.3	-4406.3	**-84**	-4013.2	-6850.6	**41**

Table 7.16. Parameters used in Forest Land category recalculations (15.09.2012 resubmission and 15.04.2013 submission)

Land use category	Parameter	2012 Submission		Source	2013 Submission		Source
Forest Land remaining Forest Land	R conifer	Aboveground biomass 50−150 t/ha	0.32	Table 3A.1.8, LULUCF GPG 2003, p. 3.168	Aboveground biomass > 75 t/ha	0.24	IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
	R broadleaf	Aboveground biomass 75−150 t/ha	0.26	Table 3A.1.8, LULUCF GPG 2003, p. 3.168	Aboveground biomass 75−150 t/ha	0.23	IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
	BEF/BCEF	BEF_2 conifer	1.35	Table 3A.1.10, LULUCF GPG 2003, p. 3.178	$BCEF_S$ weighted average	0.58	IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50
		BEF_2 broadleaf	1.30				
	EF mineral soil [Mg C ha^{-1} yr^{-1}]	NE	NA	NA	EF Sweden	0.16	National Inventory Report, Sweden 2012, Common Reporting Format
Land converted to Forest Land	R	R average conifer < 50 t/ha, broadleaf <75 t/ha	0.44	Table 3A.1.8, LULUCF GPG 2003, p. 3.168	R human induced	0.39	IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
					R natural regen.	0.44	
	BEF	BEF_2 upper limit of the range for boreal young forests	2.5	Table 3A.1.10, LULUCF GPG 2003, p. 3.178	$BCEF_S$ weighted average	CL to FL 0.95	IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50
						GL to FL 0.69	
						WL to FL 1.00	
						SL to FL 0.93	
						OL to FL 0.98	
	EF litter [Mg C ha^{-1} yr^{-1}]	NE	NA	NA	EF Sweden	0.3	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84
	EF mineral soil [Mg C ha^{-1} yr^{-1}]	NE	NA	NA	CL to FL	-0.85	Kõlli *et al*. 2004. Organic Carbon pools in Estonian Forest Soils; Kõlli *et al*. 2009. Stocks of organic carbon in Estonian soils; IPCC 2006, Vol 4 (AFOLU), Table 2.3, p. 2.31
					GL to FL	-0.225	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84
					SL to FL	0.17	
					OL to FL	0.17	
Forest Land	EF organic soil [Mg C ha^{-1} yr^{-1}]	EF	-0.16	Table 3.2.3, LULUCF GPG 2003, p. 3.42	EF Sweden	-0.57	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84
	Dead wood density [t m^{-3}]	All tree species	0.266	Merganičová, K., Merganič, J. 2010. Coarse woody debris carbon stocks in natural spruce forests of Babia hora	Pine	0.239	Sandström *et al*, 2007. Biomass conversion factors (density and carbon concentration) by decay classes for dead wood of Pinus sylvestris, Picea abies and Betula spp. in boreal forests of Sweden.
					Spruce	0.226	
					Birch	0.275	

7.2.6. Source-specific planned improvements

A number of improvements are required to be carried out in order to assure complete, transparent and accurate emission estimations for Forest Land category. Based on national research data and publications, it is possible to provide a rough estimation for organic carbon stocks in mineral and organic forests soils, but annual changes in stocks have never been researched nor theoretically assessed.

Estonian Environment Information Centre has initialized in cooperation with the University of Tartu a pilot project aimed to obtain data about below-ground carbon fluxes in coniferous forest soils along the gradient of soil fertility and moisture. Fieldwork includes measuring soil respiration, litterfall and decomposition of litter, organic carbon content and C:N ratio in soil. Preliminary estimates are expected to be obtained by 2014. Also implementation of the Yasso model will be attempted in the future.

7.3. Cropland (CRF 5.B)

7.3.1. Source category description

Total net CO_2 eq. emissions from cropland are presented in Figure 7.13. Cropland category includes emissions from mineral and organic soils, liming, carbon stock changes in living biomass (orchards) and N_2O emissions related to land conversion to cropland, the latter was estimated for the first time in current submission. Emissions from organic soils are evened out by uptake by mineral soils, therefore inter-annual emission fluctuations in cropland category are mainly caused by changes in living biomass and varying liming intensity in different years.

Net CO_2 emissions from cropland were 181.2 Gg and 125.4 Gg, respectively in 2011 and 1990.

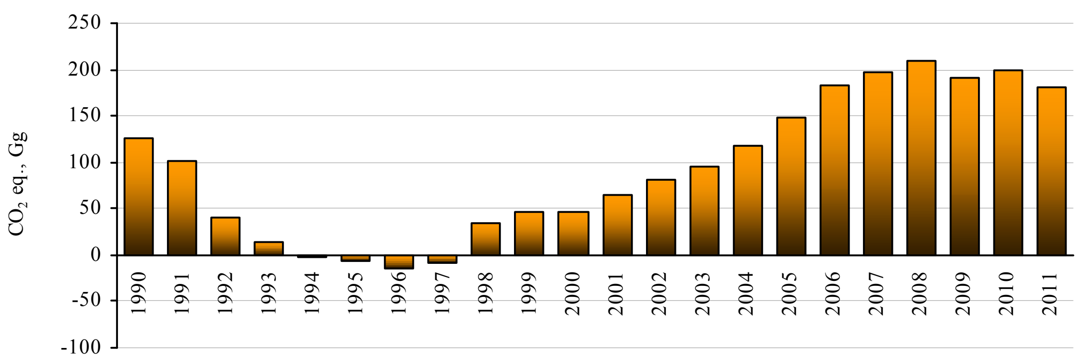

Figure 7.13. Total emissions(+)/uptake(-) from Cropland category in 1990–2011, Gg CO_2 eq.

The area of Cropland (Figure 7.14) increased until the 1990s due to the propitious conditions in agricultural sector in Estonia. The biggest influence on the sector were the remarkable supports provided by early former Soviet Union, large market and raw material basis, also low market price for energy, which kept the agriculture artificially alive. After Estonia regained its independence in 1991, these beneficial conditions were abolished[133]. From 1991 until 2005, an overall downfall characterised Estonia's agriculture, caused by abandonment of arable lands due to reduced demand for local food products, caused by availability of cheap import goods as the result of opened markets and a significant rise in energy prices that decreased profits in the agricultural sector. As from 2005, the area of cropland has been increasing again due to increased investments and subsidiaries from the European Union to Estonian's agricultural sector, expansion of export opportunities and popularization of organic farming.

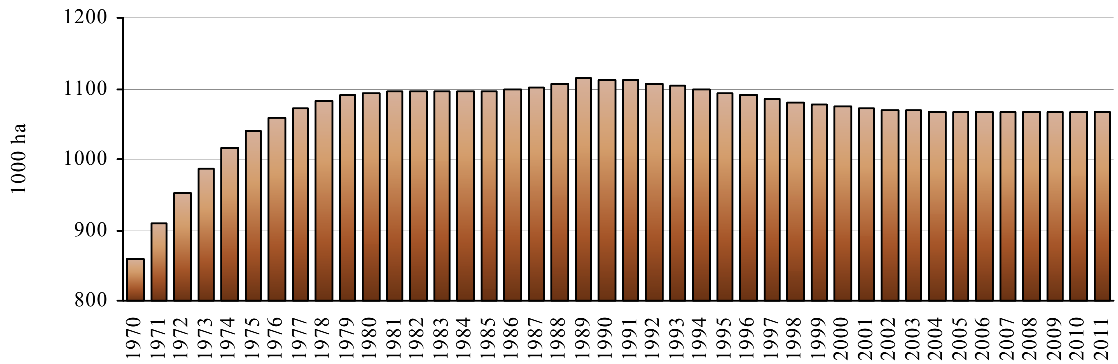

Figure 7.14. Cropland area in Estonia in 1970–2011, 1000 ha

Activity data used to estimate carbon fluxes related to cropland has been obtained from NFI (1990–2011) and Statistics Estonia (till 1990).

7.3.2. Methodological issues

7.3.2.1. Change in carbon stocks in living biomass

In 2012, Estonian Environment Information Centre launched a project in order to determine perennial woody crops biomass stock in croplands with the aim to provide data about orchards' growing stock, which can be used in cropland living biomass carbon stock estimations. Sample plots were randomly selected representing main market gardens and privately owned orchards in Estonia. Fieldwork included determining tree species, age, density per area and measuring individual tree components: tree height, diameter at different heights, height until beginning of the crown and crown length. Measured variables were used as input data in *Repola* [134] biomass function, that was implemented to estimate average above-, belowground and total biomass of orchards. The results are shown in Table 7.17.

Table 7.17. Average biomass stock on cropland orchards

	Living biomass stock, t d.m./ha
Total biomass	20.68
Aboveground	16.60
Belowground	4.07

[133] Mäemets, M. (2006). An Outline of Agriculture in Estonia from the year 1990 until 2004, Bachelor's thesis, University of Tartu.
[134] Repola. J, Ojansuu, R. and Kukkola, M. (2007). Biomass functions for Scots pine, Norway spruce and birch in Finland, Working Papers of the Finnish Forest Research Institute, pp. 53.

Annual carbon stock change was calculated based on interannual area changes (Equation 7.5).

Equation 7.5

$$\Delta C_{CC_{LB}} = [B_{total} \bullet (A_{t2} - A_{t1})] \bullet CF$$

Where:

$\Delta C_{CC\ LB}$ – annual change in cropland (CL remaining CL and land converted to CL) perennial woody crops carbon stock, tonnes C yr^{-1};
B_{total} – total average biomass stock of orchards, t d.m./ha (Table 7.17);
A_{t1} – orchards area in previous year, ha;
A_{t2} – orchards area in current year, ha;
CF – carbon fraction of dry matter (default = 0.5), tonnes C $(tonne\ d.m.)^{-1}$.

Activity data about area of orchards is obtained from Statistics Estonia. The area of orchards has declined constantly, from 9 293 ha in 1990 to 4 077 ha in 2011, thus the carbon stock in orchards has decreased as well as seen in Figure 7.15.

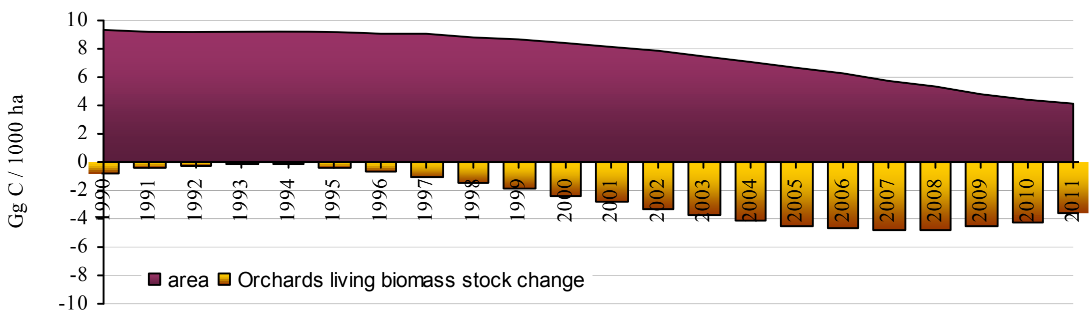

Figure 7.15. Area (kha) and annual change in cropland perennial woody crops (orchards) living biomass stock (Gg C)

7.3.2.2. Mineral soils

Carbon fluxes related to cropland mineral soils were estimated for the first time in current submission. Cropland SOC_{REF} (Table 7.13) was estimated based on available national reasearch data and publications. For verification purposes, obtained SOC_{REF} was compared with SOC_{REF} calculated according to IPCC 2006 default data applied to croplands soil type distribution in Estonia. For estimating annual SOC stock changes in cropland remaining cropland mineral soil, default relative stock change factors (F_{LU}, F_{MG}, F_I) from IPCC 2006[135] were applied.

Grassland conversion to cropland is the only land-use change occurring in Estonia to cropland category. EF for this land-use change was obtained by implementing IPCC *Tier 1* method, estimated as the difference in stocks assuming default transition period of 20 years.

[135] IPCC 2006 (Vol 4), Table 5.5, p. 5.17.

Table 7.18. Cumulative land use changes to Cropland in 2011 and soil emission factors

Land-use	Area, kha	EF mineral soil Mg C ha^{-1}	EF organic soil Mg C ha^{-1}
Cropland remaining Cropland	1 057.1	0.09[136]	-5.0
Grassland→ Cropland	10.4	-1.37	-5.0

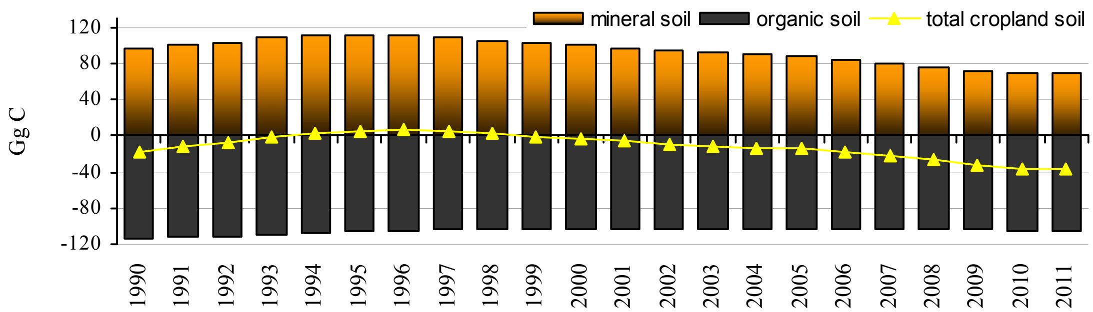

Figure 7.16. Annual stock change in Cropland mineral and organic soil pools 1990–2011, Gg C

7.3.2.3. Organic soils

The *Tier 1* method was applied in order to estimate CO_2 emissions from cultivated organic soils.

Equation 7.6[137]

$$\Delta C_{CCOrganic} = \sum_c (A \bullet EF)_c$$

Where:

$\Delta C_{CC\ Organic}$ – CO_2 emissions from cultivated organic soils in cropland remaining cropland, tonnes C yr^{-1};
A – land area of organic soils in climate type *c*, ha;
EF – emission factor for climate type *c*, tonnes C ha^{-1} yr^{-1}.

The amount of carbon released is converted to CO_2 by multiplying with 44/12.

Equation 7.6 was also used for calculations of organic soil emissions on land converted to Cropland subcategory.

Default EF of 5.0 (tonnes C ha^{-1} yr^{-1}) from the IPCC 2006 guidelines was applied for estimating the loss of soil carbon from drained organic cropland soils, whereby all cropland organic soil is considered drained in Estonia.

Figure 7.16 illustrates annual carbon stock change in cultivated cropland soils. In 2011, total CO_2 emissions from cropland organic soils were 106 Gg, which is 6.8%

[136] 1990-2011 period average.
[137] GPG-LULUCF 2003, Equation 3.3.5, p. 3.79.

less compared to 1990. Decrease in emissions is the result of decline of the overall cropland area since 1990.

7.3.2.4. Nitrous oxide from mineral soils

Land conversion to cropland will result in emissions of N_2O from soils due to enhanced mineralization of soil organic matter. N_2O emissions related to land-use change to cropland were estimated for the first time in current submission. *Tier 1* method (Equation 7.7) and the same emission factor (EF_1=0.0125 kg N_2O-N/kg N) that is used for direct emissions from agricultural land and default C:N ratio [15 kg C $(kg\ N)^{-1}$] were applied.

Equation 7.7[138]

$$N_2O_{net-\min} - N = EF_1 \bullet N_{net-\min}$$

$$N_{net-\min} = \Delta C_{LC_{Mineral}} \bullet 1 / C : N_{ratio}$$

Where:

$N_2O_{net-min}$-N – additional emissions arising from the land-use change, kg N_2O-N yr^{-1};
$N_{net-min}$ = N released annually by net soil organic matter mineralisation as a result of the disturbance, kg N yr^{-1};
EF_1 = IPCC default emission factor used to calculate emissions from agricultural land caused by added N, whether in the form of mineral fertilisers, manures, or crop residues, kg N_2O-N/kg N.

Land use change to cropland first took place in 2002 (observation starting point 1990), when 218 ha of grasslands were converted to cropland, resulting 0.3 tonnes of N_2O emissions. In 2011, 9 644 ha of grasslands on mineral soils had been converted to cropland since 1990, resulting N_2O emission of 13.5 tonnes.

7.3.2.5. CO_2 emissions from liming (CRF 5(IV))

In Estonia, annual precipitation exceeds evapotranspiration, causing calcium and magnesium carbonates to leach out from the surface levels of soil by percolating water. As a result of the leaching carbonates, soil becomes deprived of calcium and magnesium. Over 22% of arable land soils in Estonia are calcium-deficient and acidificated. To eliminate calcium-deficiency in field soils, the quick-acting fine dusty limes are mainly applied[139].

Tier 1 method (Equation 7.8) was used to estimate CO_2 emissions from liming of croplands. Activity data on agricultural land areas on which lime was applied to was obtained from Estonian Ministry of Agriculture for the period 1990–2008. Data about liming is not implicit, since it is based on applied agricultural subsidies only and liming performed by landowner's own expence is left out from the statistics. However, the scope of liming carried out by landowner's own expence is considered to be marginal according to Estonian Ministry of Agriculture. Data about the average quantity of lime applied per one hectare (5 t/ha) was taken from a report published by

[138] GPG-LULUCF 2003, Equation 3.3.13–3.3.15, p. 3.93–3.94.
[139] Loide, V. (2010). Relieving the calcium deficiency of field soils by means of liming, Agronomy Research 8 (Special Issue II), pp. 415–420.

Estonian Research Institute of Agriculture[140]. Since 2009, Statistics Estonia is collecting detailed data about the area and applied amount of liming.

Equation 7.8[141]

$$\Delta C_{CC_{Lime}} = M_{Limestone} \bullet EF_{Limestone} + M_{Dolomite} \bullet EF_{Dolomite}$$

Where:

$\Delta C_{CC\ Lime}$ – annual C emissions from agricultural lime application, tonnes C yr^{-1};
M – annual amount of calcic limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$), tonnes yr^{-1};
EF – emission factor, tonnes C (tonne limestone or dolomite)$^{-1}$; these are equivalent to carbonate carbon contents of the materials (12% for $CaCO_3$, 12.2% for $CaMg(CO_3)_2$).

Area of liming has fluctuated widely over the years. According to the Estonian Ministry of Agriculture, no liming occurred in 2004 and 2007. However, it is more likely, that there is a gap in data, thus the average liming area and amount of lime of adjacent years were used as input data.

Area and emissions from liming of croplands is illustrated in Figure 7.17. Type of lime applied to croplands could not be separated into limestone and dolomite due to combined data, thus the total emission from liming is reported.

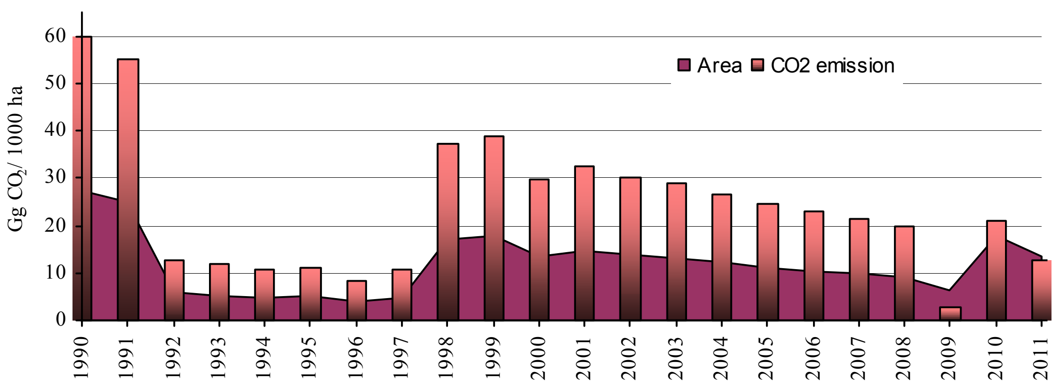

Figure 7.17. Area and CO_2 emissions from lime application on agricultural lands in 1990–2011

7.3.3. Uncertainty and time series consistency

CO_2 emissions from cropland living biomass, organic soils and liming are estimated according to GPG-LULUCF 2003 (N_2O emissions) and IPCC 2006 (mineral and organic soils). Activity data was obtained from Estonian NFI, national statistics and Ministry of Agriculture, emission factors were employed from the IPCC 2006 and GPG-LULUCF 2003. The uncertainty rates of activity data and the emission factors used are reported in Table 7.19.

[140] Järvan, M. (2005). Põldude lupjamine, Eesti Maaviljeluse Instituut, Saku.
[141] GPG-LULUCF 2003, Equation 3.3.6., p. 3.80.

Table 7.19. Estimated values of uncertainties in Cropland category

IPCC Source Category		Uncertainties ± %		EF References
		Activity data[142]	Emission factors	
5.B.1	Cropland remaining Cropland - living biomass	32.42	46.95	NFI, SE, Repola (2007)
5.B.1	Cropland remaining Cropland - mineral soils	3.19	50.00	IPCC 2006; Kõlli *et al*, 2009
5.B.1	Cropland remaining Cropland - organic soils	25.82	90.00	IPCC 2006
5.B.2.2	Grassland converted to Cropland - living biomass	59.67	46.95	IPCC 2003 & 2006
5.B.2.2	Grassland converted to Cropland - mineral soils	37.89	30.00	Kõlli *et al*, 2009
5.B.2.2	Grassland converted to Cropland - organic soils	138.58	90.00	IPCC 2006
5.B.2.2	Grassland converted to Cropland - (5III) mineral soils (N_2O)	37.89	50.00	LULUCF GPG 2003
5.B\5(IV)	CO2 emissions from agricultural lime application	29.15	50.00	LULUCF GPG 2003

7.3.4. Source specific QA/QC and verification

The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level is presented in Section 1.6.1.

The QC/QA plan for the LULUCF sector includes the QC activities described in the IPCC GPG. The activities are carried out every year during the inventory and the QC check list is used during the inventory.

Activity data are checked annually for updating. Emission factors are compared with IPCC default and with emission factors of other countries.

7.3.5. Source-specific recalculations

Emissions from cropland mineral soils were estimated for the first time in current submission. Cropland organic carbon stock of mineral soils were estimated based on available research data and publications. Default stock change factors (F_{LU}, F_{MG}, F_I) were applied to cropland SOC_{REF} (Table 7.13) to obtain annual change in soil carbon stock. Annual net carbon stock change for grassland conversion to cropland was obtained by applying *Tier 1* method and assuming 20 years for the transition period. Implied EF-s are shown in Table 7.20.

For cropland organic soils, default emission factor from GPG-LULUCF was replaced with the EF from IPCC 2006 according to recommendation made by the UNFCCC in-country review (2012).

Nitrous oxide emissions related to land-use change to cropland were estimated for the first time following *Tier 1* method in the GPG-LULUCF 2003.

[142] All activity data uncertainty estimates are obtained from NFI.

ERT recommended to double-check liming input data, since there was no liming at all in some years according to information obtained from the Ministry of Agriculture. Estonia acknowledges the gap in data, since no additional information is available, the average area and amount of lime applied of adjacent years were used as input for years with no data.

Also see Table 10.5–Table 10.7.

In Table 7.21 quantitative overview of recalculations and in Table 7.20 changes in applied parameters have been shown.

Table 7.20. Parameters used in Cropland category recalculations

Land use category	Parameter	2012 Submission		2013 Submission	
		Source		Source	
Cropland remaining Cropland	EF mineral soil [$Mg\ C\ ha^{-1}\ yr^{-1}$]	NE	NA	0.09	Kõlli *et al*, 2009, Stocks of organic carbon in Estonian soils. Estonian Journal of Earth Sciences, 58 (2), 95-108; Table 5.5, p. 5.17, IPCC 2006, Vol 4 (AFOLU)
Land converted to Cropland	EF mineral soil [$Mg\ C\ ha^{-1}\ yr^{-1}$]	NE	NA	GL→ CL -1.37	Kõlli *et al*, 2009, Stocks of organic carbon in Estonian soils. Estonian Journal of Earth Sciences, 58 (2), 95-108; Table 5.5, p. 5.17, IPCC 2006, Vol 4 (AFOLU)
	IEF N_2O [$kg\ N_2O\text{-}N\ ha^{-1}$]	NE	NA	0.89	Chapter 3.3.2.3.1.1, LULUCF GPG 2003
Cropland	EF organic soil [$Mg\ C\ ha^{-1}\ yr^{-1}$]	-1.0	Table 3.3.5, p. 3.79, LULUCF GPG 2003	-5.0	Table 5.6, p. 5.19, IPCC 2006, Vol 4 (AFOLU)

Table 7.21. Quantitative overview of recalculations, Gg C (15.09.2012 resubmission and 15.04.2013 submission)

		1990			1995			2000			2005			2010		
		Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**
Cropland remaining Cropland	Mineral soil	NE	97.1	**100**	NE	110.9	**100**	NE	101.1	**100**	NE	92.8	**100**	NE	82.2	**100**
	Organic soil	-22.6	-144.1	**80**	-21.1	-105.9	**80**	-20.5	-103.4	**80**	-20.5	-103.0	**80**	-20.5	-102.4	**80**
Land converted to Cropland	N_2O	NO	NO	**NO**	NO	NO	**NO**	NO	NO	**NO**	NE	0.01	**100**	NE	0.01	**100**
	Mineral soil	NO	NO	**NO**	NO	NO	**NO**	NO	NO	**NO**	NE	-4.4	**100**	NE	-13.1	**100**
	Organic soil	NO	NO	**NO**	NO	NO	**NO**	NO	NO	**NO**	NO	NO	**NO**	-0.5	-2.7	**81**
	TOTAL Cropland net CO_2 eq.	142.1	125.4	**-13**	90.6	-6.1	**1597**	112.6	46.9	**-140**	115.2	148.6	**22**	103.2	198.8	**48**

7.3.6. Source-specific planned improvements

Ongoing negotiations with the Agricultural Research Centre of Estonia for conducting fieldwork and estimating carbon stock changes in cultivated mineral and organic soils. Project has not started yet due to lack of financial resources.

7.4. Grassland (CRF 5.C)

7.4.1. Source category description

The spatial share of Grassland category is 7.4% of overall Estonian area, ranking grasslands to the fourth largest land-use category after Wetlands. By 2011, the area of grasslands had decreased 58% compared to 1970s (Figure 7.18) due to: i) abandonment of grazing lands, and ii) development of the agricultural sector and cultivation of grasslands. Afforestation of grasslands occurred at the same time, however, having a smaller impact on the area change.

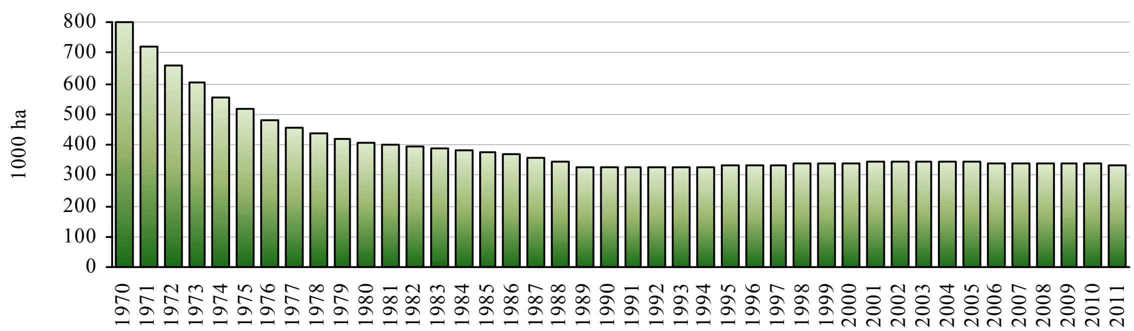

Figure 7.18. Grassland area in Estonia in 1970–2011, 1000 ha (SE, NFI)

Grassland category includes GHG emissions and removals from living biomass, mineral and organic soils, dead wood and loss of litter due to forest conversion to grasslands, also non-CO_2 emissions from biomass burning have been estimated.

Grasslands have been both a net sink and source of GHG-s throughout the accounting period (Figure 7.19), depending mostly on the changes of living biomass.

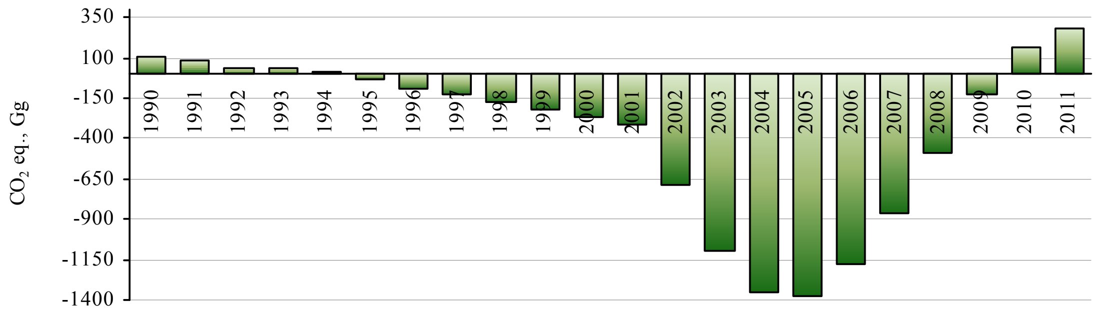

Figure 7.19. Annual CO_2 uptake(-)/emissions(+) from Grassland category in 1990−2011, Gg

7.4.2. Methodological issues

Carbon stock change in category 5.C Grassland remaining Grassland and land converted to Grassland is given by the sum of changes in living biomass, dead organic matter and soils (Equation 7.1).

7.4.2.1. Change in carbon stocks in living biomass

For estimating carbon stock changes in living biomass, *Tier 2* approach and *Method 2* – the stock change method was used. NFI provides annually updated data about the area and volume of growing stock on grasslands. Biomass change is the difference between the biomass at year t_2 and year t_1 (see Equation 7.2). In current submission, the mistake in applying the stock-change method, pointed out by the in-country UNFCCC review in 2012, has been corrected (see more in chapter 7.2.2.1). Also up-to-date living biomass parameters from IPCC 2006 (Table 7.22) were used according to recommendations by the ERT. Land-use changes to grassland can be seen in Table 7.23.

Table 7.22. Parameters used in Grassland living biomass estimations[143]

$BCEF_S$			R
Boreal	Growing stock level (m^3)		Above-ground biomass (t/ha)
	< 20	21-50	< 75
pines	1.2	0.68	0.39
firs and spruces	1.16	0.66	
hardwoods	0.9	0.7	0.46
Weighted average $BCEF_S$[144]	GL rem GL	0.76	0.45
	to GL	0.69…0.96	0.41

[143] IPCC 2006, Vol 4 (AFOLU), Table 4.4 & 4.5.
[144] The weighted average $BCEF_S$ values are dependent on the distribution of tree species, age class and growing stock.

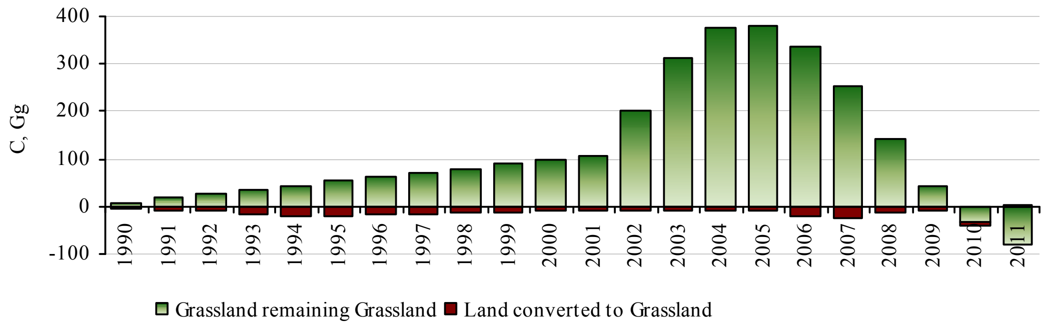

Figure 7.20. Carbon stock change in Grassland living biomass in 1990–2011, Gg C

Figure 7.20 illustrates annual change in living biomass carbon pool in Grassland remaining Grassland and land converted to Grassland subcategories. Decline in living biomass stock change since 2006 can be explained by shifting the areas where tree crown cover exceeds 30% to forest land category.

Stock change method used for living biomass CSC calculations comprises also carbon loss from biomass burning. CH_4 and N_2O emissions from biomass burning on grassland areas are described in Chapter 7.8.

7.4.2.2. CO_2 emissions/removals from/by dead wood

Same method (*Tier 2*, stock-change method) and parameters were used for estimating carbon stock changes in dead wood pool on grasslands as for forest land, more information can be found in chapter 7.2.2.3. NFI estimates annually the volume of dead wood for the whole grassland area, data is provided for land remaining and land converted to Grassland subcategories.

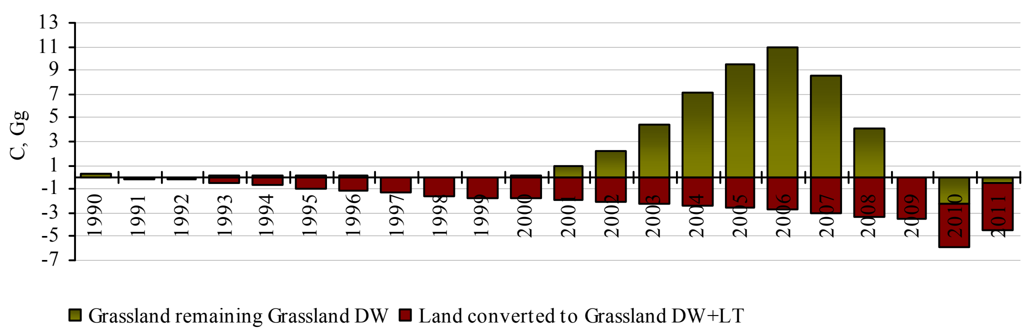

Figure 7.21. Annual change in Grassland dead organic matter pool in 1990–2011, Gg C

7.4.2.3. CO_2 emissions/removals from/by litter

Estonia does not have sufficient data regarding litter stocks, thus under grassland remaining grassland, for litter pool *Tier 1* method was implemented, assuming that carbon stocks are in equilibrium so that the changes in litter pool are assumed to be zero.

Under land conversion to grassland, the UNFCCC in-country review (2012) recommended to use litter emission factor from Sweden (Table 7.23) in order to avoid underestimation of emissions from deforestation (Forest land→Grassland) and assure consistency throughout the KP-LULUCF sector.

7.4.2.4. CO_2 emissions/removals from/by mineral soils

Reference soil organic carbon stock (Table 7.13) was calculated for grassland mineral soils based on national reasearch and published data. Relative stock change factors from IPCC 2006[145] were applied to estimate annual stock changes in grassland remaining grassland category. Since grasslands are not actively managed in Estonia, nor is additional inputs added to grassland soil, all stock change factors (F_{LU}, F_{MG}, F_I) equal to 1, hence no changes are assumed in the grassland remaining mineral soil pool.

Emission estimates for land conversion to grassland are based of corresponding Swedish EF-s (Table 7.23), except cropland conversion to grassland that was obtained by estimating differences in grassland and cropland stocks that were calculated by applying national SOC_{REF} and IPCC 2006 relative stock change factors, assuming 20 years of transition period (additional information in chapter 7.2.2.5).

Table 7.23. Cumulative land-use changes to Grassland in 2011, soil and litter emission factors

Land-use change	kha	%	EF mineral soil Mg C ha^{-1}	EF organic soil Mg C ha^{-1}	EF litter Mg C ha^{-1}
Forest Land→Grassland	5.4	11%	0.225	-1.60	-0.75
Cropland→ Grassland	36.0	77%	1.05	-1.60	NA
Wetlands→ Grassland	1.3	3%	0.21	-1.60	NA
Settlements→ Grassland	2.7	6%	0.21	-1.60	NA
Other Land→ Grassland	1.5	3%	0.21	-1.60	NA
Total	47.0	100%			

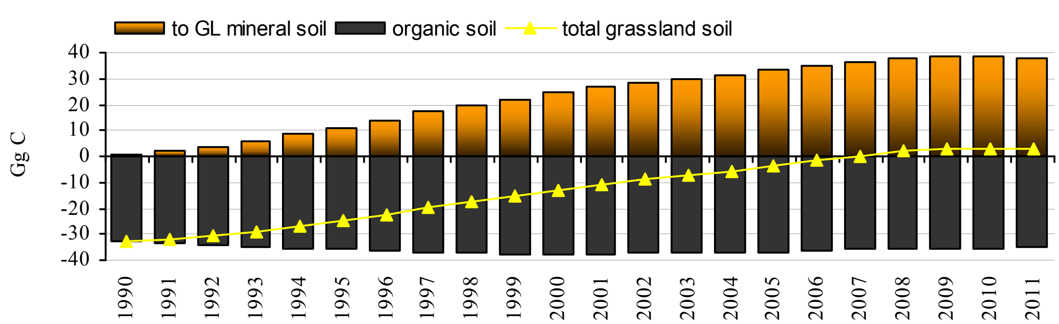

Figure 7.22. Annual stock change in Grassland mineral and organic soil pools 1990–2011, Gg C

[145] IPCC 2006 (Vol 4), Table 6.2, p. 6.16.

7.4.2.5. CO_2 emissions from organic soils

Figure 7.22 illustrates annual changes in grassland organic soils. Equation 7.9 was implemented to estimate loss of carbon from drained grassland soils. In current submission EF from Sweden (Table 7.23) was used instead of default GPG-LULUCF EF according to recommendations made by the ERT. The activity data of grassland organic soil areas are obtained from NFI.

In previous submissions all remaining grassland organic soils were considered drained, in current submission more detailed data was obtained from the NFI and remaining grassland organic soils were divided into drained and undrained. The proportion of drained grassland organic soils is about 55%. All land converted to grassland organic soils are considered drained.

Equation 7.9[146]

$$\Delta C_{GGOrganic} = \sum_c (A \bullet EF)_c$$

Where:

$\Delta C_{GG\ Organic}$ – CO_2 emissions from cultivated organic soils in grassland remaining grassland, tonnes C yr^{-1};
A – land area of organic soils in climate type *c*, ha;
EF – emission factor for climate type *c*, tonnes C ha^{-1} yr^{-1}.

Emissions from grassland organic soils have increased by 5.2% compared to the base year.

7.4.3. Uncertainty and time series consistency

The uncertainty estimates related to the activity data and the emission factors are presented in Table 7.24. Significant changes in emission factor uncertainties are mainly the result of applying IPCC 2006 parameter values instead of GPG-LULUCF 2003 and implementing EFs from Sweden where emissions had not been reported before due to unavailable country-specific data.

Table 7.24. Estimated values of uncertainties used in Grassland (GL) category.

IPCC Source Category		Uncertainties ±%		EF References
		Activity data[147]	Emission factors	
5.C.1	Grassland remaining Grassland - living biomass	10.62	46.95	IPCC 2003 & 2006[148]
5.C.1	Grassland remaining Grassland - organic soils	19.18	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.C.1	Grassland remaining Grassland - dead wood	21.62	12.89	Sandström *et al*. 2007
5.C.2	Land converted to Grassland -	27.92	46.95	IPCC 2003 & 2006

[146] GPG-LULUCF 2003, Equation 3.4.10., p. 3.114.
[147] All activity data references are obtained from NFI.
[148] Parameters from the IPCC 2006 were applied, however due to lack of information in the IPCC 2006, the same EF uncertainty as in the GPG-LULUCF 2003 for calculating living biomass emissions was assumed.

		Uncertainties ±%		
	living biomass			
5.C.2	Land converted to Grassland - mineral soils	16.75	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.C.2	Land converted to Grassland - organic soils	57.53	35.00	Sweden NIR 2012, Table 7.5, p. 291

7.4.4. Source specific QA/QC and verification

The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.1.

The QC/QA plan for the sector includes the QC activities described in the IPCC GPG (IPCC 2000, Table 8.1). The activities are carried out every year during the inventory. The QC check list is used during the inventory.

Activity data are checked annually for updating. Emission factors are compared with IPCC default and with emission factors of other countries.

7.4.5. Source-specific recalculations

Activity data as well as growing stock and dead wood stock volumes are being updated and if necacessary, corrected, each year.

For grassland living biomass stock change estimation, root-shoot ratio (R) and biomass conversion and expansion factors ($BCEF_S$) from the IPCC 2006 guidelines were implemented. Also the mistake in applying the stock-change method pointed out by the in-country review in 2012 has been corrected (more information in chapter 7.2.2.1).

The default emission factor for drained organic grassland soils was replaced by the EF from Sweden according to ERT recommendation.

In current submission, emissions from mineral soils were provided for all land-use changes to grassland, implementing the appropriate EF-s from Sweden 2012 inventory report. Emission factor for Cropland→Grassland mineral soil was calculated following *Tier 1* method in the IPCC 2006.

Due to shortage in data related to litter pool, appropriate EF-s from Sweden was applied as an interim approach to cover the data gap in Estonia.

In previous submission, under land conversion to grassland, total carbon stocks of living biomass and dead wood pools were reported (observation made by the in-country review 2012). In current submission, the mistake has been corrected and net changes in living biomass and dead wood pool carbon stocks are reported.

More appropriate dead wood densities were used in current submission.

Also see Table 10.5–Table 10.7.

In Table 7.25 changes in applied parameters and in Table 7.26 quantitative overview of recalculations are shown.

Table 7.25. Parameters used in Grassland category recalculations

Land use category	Parameter	2012 Submission		Source	2013 Submission		Source
Grassland remaining Grassland	R conifer	Aboveground biomass < 50 t/ha	0.46	Table 3A.1.8, LULUCF GPG 2003, p. 3.168	Aboveground biomass < 75 t/ha	0.39	IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
	R broadleaf	Aboveground biomass < 75 t/ha	0.43	Table 3A.1.8, LULUCF GPG 2003, p. 3.168	Aboveground biomass < 75 t/ha	0.46	IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
	BEF/BCEF	BEF_2 conifer BEF_2 broadleaf	2.5	Table 3A.1.10, LULUCF GPG 2003, p. 3.178	$BCEF_S$ weighted average	0.76	IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50
Land converted to Grassland	R	R average conifer < 50 t/ha, broadleaf < 75 t/ha	0.44	Table 3A.1.8, LULUCF GPG 2003, p. 3.168	R weighted average conifer < 75 t/ha, broadleaf < 75 t/ha	0.41	IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
	BEF	BEF_2 upper limit of the range for boreal young forests	2.5	Table 3A.1.10, LULUCF GPG 2003, p. 3.178	$BCEF_S$ weighted average	0.69… 0.96	IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50
	EF litter [Mg C ha^{-1} yr^{-1}]	FL to GL	-1.20	Average IEF from CRF Sweden from years 2008/2009	EF Sweden	FL to GL -0.75	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84
	EF mineral soil [Mg C ha^{-1} yr^{-1}]	FL to GL	-1.24	Average IEF from CRF Sweden from years 2008/2009	FL to GL	0.225	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84
					CL to GL	1.05	Kõlli *et al*. 2009. Stocks of organic carbon in Estonian soils; Kõlli *et al*. 2007. Organic matter of Estonian grassland soils; IPCC 2006, Vol 4 (AFOLU), Table 5.5 & 6.2
		Other LUC to GL	NE	NA	WL to GL SL to GL OL to GL	0.21	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84
Grassland	EF organic soil [Mg C ha^{-1} yr^{-1}]	EF	0.25	Table 3.4.6 LULUCF GPG 2003, p. 3.118	EF Sweden	-1.60	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84
	Dead wood density [t m^{-3}]	All tree species	0.266	Merganičová, K., Merganič, J. 2010. Coarse woody debris carbon stocks in natural spruce forests of Babia hora	Pine	0.239	Sandström *et al*, 2007. Biomass conversion factors (density and carbon concentration) by decay classes for dead wood of Pinus sylvestris, Picea abies and Betula spp. in boreal forests of Sweden.
					Spruce	0.226	
					Birch	0.275	

Table 7.26. Quantitative overview of recalculations, Gg C (15.09.2012 resubmission and 15.04.2013 submission)

		1990			1995			2000			2005			2010		
		Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**	Previous submission	Current submission	**Difference %**
Grassland remaining Grassland	Living biomass	68.0	6.9	**-884**	69.8	52.9	**-32**	86.9	97.0	**10**	303.4	380.3	**20**	-38.6	-32.9	**-17**
	Dead organic matter	-0.1	0.3	**131**	-0.1	0.2	**162**	0.1	0.2	**26**	11.6	9.5	**-22**	-2.7	-2.2	**-20**
	Mineral soil	NE	NO	**-**	NE	NO	**-**	NE	NO	**-**	NE	NO	**-**	NE	NO	**-**
	Organic soil	-9.1	-32.5	**72**	-8.9	-31.8	**72**	-8.7	-31.3	**72**	-8.7	-30.4	**71**	-8.5	-29.0	**71**
Land converted to Grassland	Living biomass	NO/NE	-4.0	**100**	2.6	-19.4	**113**	12.3	-8.9	**238**	41.2	-8.7	**574**	93.2	-8.2	**1237**
	Dead organic matter	NO/NE	0.02	**100**	-0.6	-0.9	**33**	-0.5	-1.8	**72**	-0.7	-2.5	**72**	1.5	-3.7	**141**
	Mineral soil	NO/NE	0.7	**100**	NO/NE	11.2	**100**	-0.6	24.7	**102**	-1.2	33.2	**104**	NO/NE	38.5	**100**
	Organic soil	NO/NE	-0.6	**100**	-0.7	-4.1	**83**	-1.1	-6.3	**83**	-1.1	-6.3	**83**	-1.1	-6.3	**83**
	TOTAL Grassland net CO_2	-215.5	106.9	**302**	-227.7	-29.7	**-666**	-324.0	-269.8	**-20**	-1262.8	-1374.9	**8**	-160.7	160.6	**200**

7.4.6. Source-specific planned improvements

Estonia is making effort to develop country-specific emission factors for grassland mineral and organic soils.

7.5. Wetlands (CRF 5.D)

7.5.1. Source category description

The area of Wetlands cover 11% of total Estonia's territory. Wetlands (including peatland and inland water bodies) decreased until the beginning of 1990s, since then the area has remained stable (Figure 7.23). Decrease in wetlands area has taken place mostly due to drainage of bogs and mires for agricultural and forestry purposes. Carbon fluxes related to Wetlands land category have been estimated for peat extraction areas and forest land conversion to wetland.

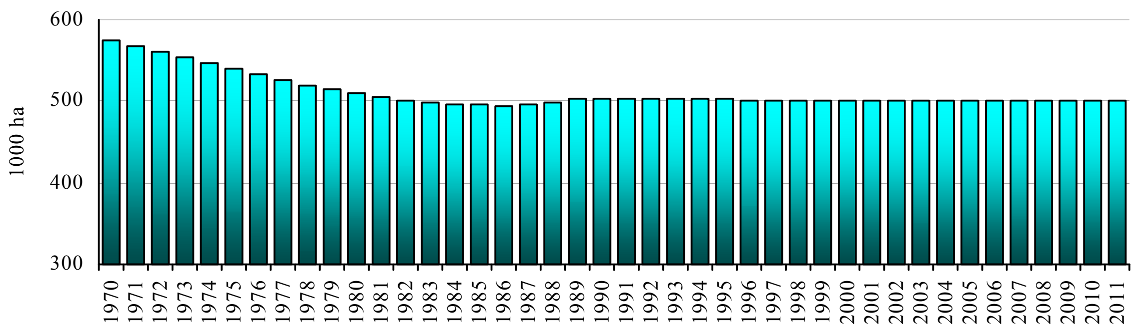

Figure 7.23. Area of Wetlands (including inland water bodies and peatland) in Estonia in 1970–2011, 1000 ha (SE, NFI)

In Estonia, peat is the third important indigenous fuel, after oil shale and wood. More detailed overview of usage of peat for energy production is given in under Energy sector (CRF 1), Chapter 3.

Activity data for the estimation of emissions related to peat extraction was obtained from NFI. In 2011, the total area of managed peat extractions fields, including actively managed and abandoned peatlands, was 16 072 ha (Figure 7.24).

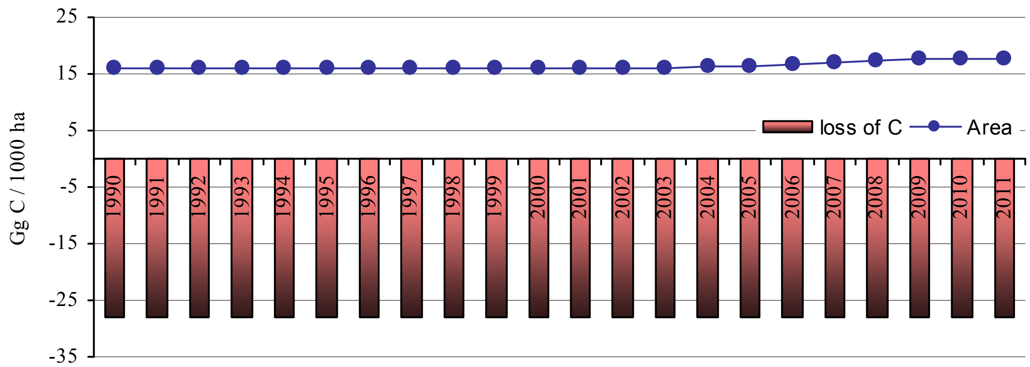

Figure 7.24. Peatland area and loss of carbon due to active peat extraction

7.5.2. Methodological issues

Equation 7.10 was implemented in order to estimate CO_2 emissions from organic soils managed for peat extraction.

Equation 7.10

$$\Delta C_{WWpeat\_Soil,extraction} = A_{peatland} \bullet EF_{CO2}$$

Where:

$\Delta C_{WW\ peat\ Soils,\ extraction}$ – CO_2 emission from organic soils managed for peat extraction expressed as carbon, tonnes C yr^{-1};
$A_{peatland}$– area of managed peatland soils, ha;
EF_{CO2} – emission factor for CO_2 from managed peat extraction, tonnes C ha^{-1} yr^{-1} (Table 7.27).

The amount of carbon released is converted to CO_2 by multiplying with 44/12.

First time, country-specific emission factors[149] were applied for estimating emissions from peatland management.

Table 7.27. Emission factors for CO_2–C, N_2O–N and CH_4-C for active peatland management

	Annual soil efflux, median value [kg ha^{-1} yr^{-1}]
CO_2-C	1741
N_2O-N	0.19
CH_4-C	0.12

[149] Salm *et al*. 2012. Emissions of CO_2, CH_4 and N_2O from undisturbed, drained and mined peatlands in Estonia. Hydrobiologia, vol 692, issue 1, p 41-55.

Equation 7.11

$$\text{Direct } CH_4 \text{ emissions}_{WWpeat} = \left(A_{peatland} \bullet EF_{CH4}\right) \bullet 16/12 \bullet 10^{-6}$$

Where:

CH_4 emissions $_{WW\,peat}$ – emissions of CH_4, Gg CH_4 yr^{-1};
$A_{peatland}$ – area of drained peatland soils, ha;
EF_{CH4} – emission factor for actively managed peatland soils, kg CH_4–C ha^{-1} yr^{-1} (Table 7.27).

CH_4 emissions directly associated with the change in soil carbon during peat extraction are showed in Figure 7.25. Emissions have increased by 9.3% compared to the base year due to the enlargement of peat extraction sites.

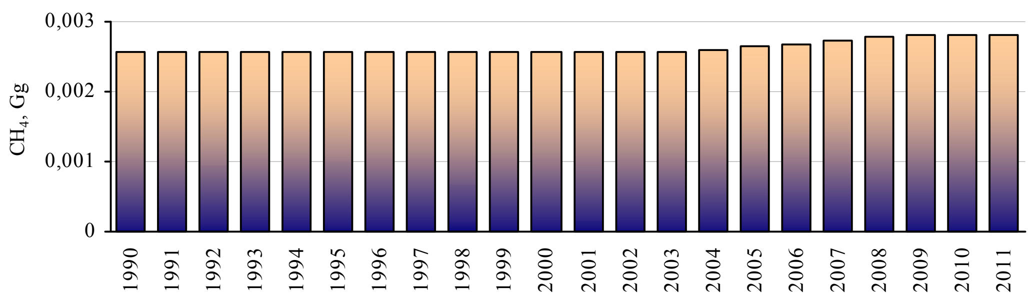

Figure 7.25. CH_4 emissions from peat extraction in 1990–2011, Gg

Equation 7.12 were used for estimating of N_2O emissions from drained peatlands. Results are illustrated in Figure 7.26.

Equation 7.12[150]

$$\text{Direct } N_2O \text{ emissions}_{WWpeat} = \left(A_{peatland} \bullet EF_{N2O}\right) \bullet 44/28 \bullet 10^{-6}$$

Where:

N_2O emissions $_{WW\,peat}$ – emissions of N_2O, Gg N_2O yr^{-1};
$A_{peatland}$ – area of managed pratland soils, ha;
EF_{N2O} – emission factor for actively managed peatland soils, kg N_2O–N ha^{-1} yr^{-1} (Table 7.27).

[150] GPG-LULUCF, 2003, Equation 3a.3.7, p. 3.283.

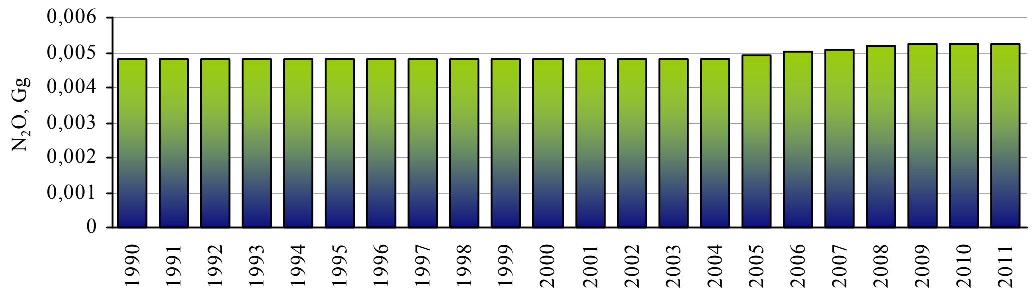

Figure 7.26. N_2O emissions due to industrial peat extraction in 1990–2011, N_2O Gg

Loss of living biomass and dead organic matter under Forest Land conversion to unmanaged wetlands and peatland were estimated using *Tier 2* approach and Equation 7.2. Annual carbon loss from living biomass and DOM after land-use change were 4.5 Gg and 0.2 Gg respectively in 2011 (Figure 7.27).

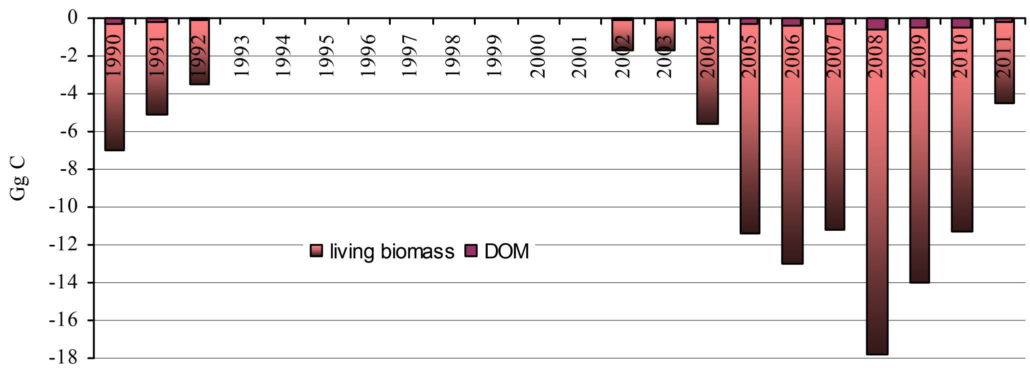

Figure 7.27. Loss of living biomass and dead organic matter from forest land conversion to unmanaged wetlands and peatlands

7.5.3. Uncertainty and time series consistency

The uncertainty rates related to the activity data and the emission factors used in the estimates are presented in Table 7.28. Significant changes in emission factor uncertainties are due to implementation of country-specific peatland EFs, in previous submissions, default EF from GPG-LULUCF 2003 were applied.

Table 7.28. Estimated values of uncertainties used in Wetlands category in 2011.

IPCC Source Category		Uncertainties ±%		EF References
		Activity data[151]	Emission factors	
5.D.1	Wetlands remaining Wetlands\Peatland - organic soils managed for peat extraction CO_2	26.34	50.00	Salm, *et al*. 2012
5.D.2	Land converted to Wetlands - (5II) Non-CO2 emissions from drainage of soils and wetlands\Peatland CH_4	26.34	50.00	Salm, *et al*. 2012

[151] All activity data references are obtained from NFI.

		Uncertainties ±%		
5.D.2	Land converted to Wetlands - (5II) Non-CO2 emissions from drainage of soils and wetlands\Peatland N_2O	26.34	50.00	Salm, *et al*. 2012
5.D.2.1	Forest Land converted to Wetlands - living biomass	85.82	46.95	IPCC 2003 & 2006
5.D.2.1	Forest Land converted to Wetlands - organic soils managed for peat extraction CO_2	87.64	50.00	Salm, *et al*. 2012
5.D.2.1	Forest Land converted to Wetlands - dead wood	61.62	12.89	Sandström *et al*. 2007

7.5.4. Source specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for LULUCF sector according to IPCC *Tier 1* method. The activities are carried out every year during the inventory. The QC check list is used during the inventory.

7.5.5. Source-specific recalculations

Country-specific emission factors of CO_2, N_2O and CH_4 were applied for the first time in current submission. Updated growing stock and dead wood data from NFI was used for estimating of losses due to forest land conversion to wetlands and peatlands.

Table 7.29. Parameters used in Wetlands category recalculations

Land use category	Parameter kg ha^{-1} yr^{-1}	2012 Submission		2013 Submission	
		Source		Source	
Wetlands remaining Wetlands/ Peatland extraction	CO_2-C	200	GPG-LULUCF 2003, Table 3a.3.2, p 3.280	1741	Salm *et al*. 2012. Emissions of CO2, CH4 and N2O from undisturbed, drained and mined peatlands in Estonia. Hydrobiologia, vol 692, issue 1, p 41-55
	N_2O-N	0.1	GPG-LULUCF 2003, Table 3a.3.4, p 3.284	0.19	
	CH_4-C	NA		0.12	

Also see Table 10.1 and Table 10.5–Table 10.7.

7.5.6. Source-specific planned improvements

Updated data derived from the NFI fieldwork for land-use changes will be used.

7.6. Settlements (CRF 5.E)

7.6.1. Source category description

Settlements, including all built-up areas, cover about 6.5% of Estonia's territory. The area of settlements has been increasing constantly in Estonia (Figure 7.28) mainly on behalf of forest lands (Table 7.4). Carbon flows related to Settlements remaining Settlements have not been calculated in current submission due to lack of detailed data. Furthermore, it is not mandatory for Parties to prepare estimates for the category contained in appendix 3a.4 (Settlements remaining Settlements) of the IPCC good practice guidance for LULUCF.

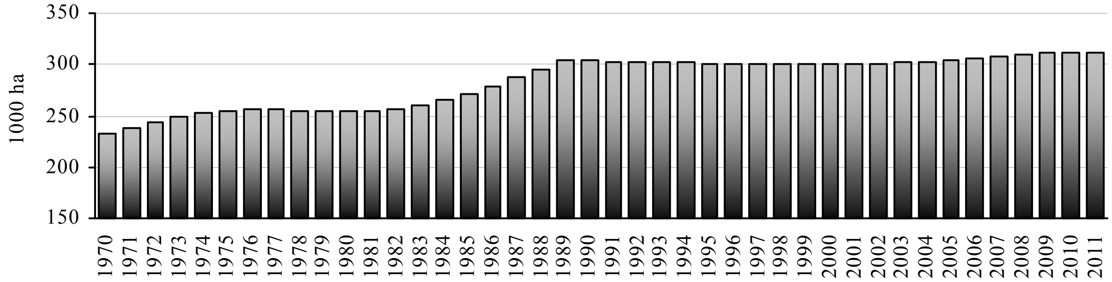

Figure 7.28. Area of Settlements in Estonia in 1970–2011, 1000 ha (SE, NFI)

7.6.2. Methodological issues

Emissions estimates were provided for forest land, cropland, grassland and other land conversion to Settlements (Figure 7.29). Under FL to SL emissions from living biomass and dead organic matter were provided implementing methods and parameters described in Chapter 7.2.2. Due to missing country-specific soil emission factors, EFs from Sweden were implemented (Table 7.30). Under grassland conversion to Settlements, emissions from living biomass, dead wood and soils were provided. Under cropland and other land conversion to settlements emissions from soils are provided.

Table 7.30. Cumulative land-use changes to Settlements in 2011, soil and litter emission factors[152]

Land-use change	kha	EF mineral soil Mg C ha^{-1}	EF organic soil[153] Mg C ha^{-1}	EF litter Mg C ha^{-1}
Forest Land→Settlements	8.9	-1.30	-	-1.25
Cropland→Settlements	3.6	-2.5	-	NA
Grassland→Settlements	2.4	-2.75	-	NA
Other Land→ Settlements	0.7	-1.3	-	NA
Total	15.5			

[152] Emission factors were obtained from Sweden annual submission 2012.
[153] Since there are no EFs for land converted to Settlements for organic soils, the same EF was implemented as for mineral soils.

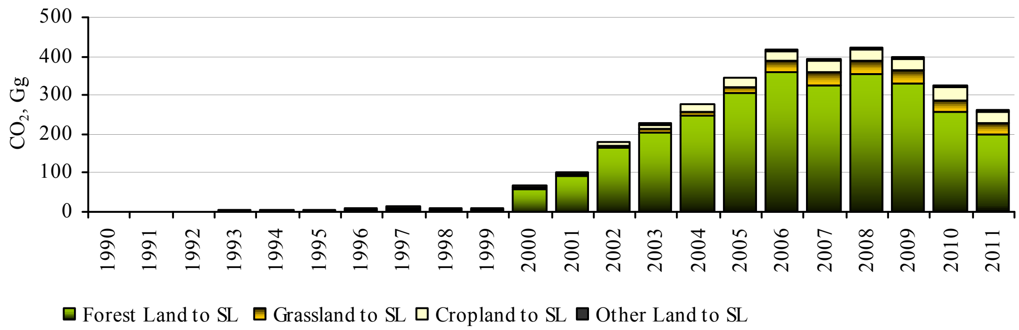

Figure 7.29. CO_2 emissions related to land conversion to Settlements, 1990–2011

7.6.3. Uncertainty and time series consistency

The uncertainty rates related to the activity data and the emission factors used in the estimates are presented in Table 7.31. Significant changes in emission factor uncertainties compared to previous submissions are due to implementing EFs from Sweden.

Table 7.31. Estimated values of uncertainties used in land converted to Settlements category.

IPCC Source Category		Uncertainties ±%		EF References
		Activity data[154]	Emission factors	
5.E.2	Land converted to Settlements – living biomass	72.75	46.95	IPCC 2003 & 2006
5.E.2	Land converted to Settlements – soils	28.74	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.E.2	Land converted to Settlements – dead wood	28.74	12.89	Sandström *et al*. 2007

7.6.4. Source specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for LULUCF sector according to IPCC *Tier 1* method. The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Chapter 1.6.1.

7.6.5. Source-specific recalculations

In the 2012 submission only Forest land and Grassland conversion to Settlements were reported. In current submission emissions in all land-use conversions to Settlements and all carbon pools are reported implementing corresponding emission factors from Sweden. Recalculations made in Forest land and Grassland living biomass also give effect to emission estimates under Settlements category.

[154] All activity data uncertainty estimates are obtained from NFI.

Table 7.32. Parameters used in Settlements category recalculations

<table>
<tr><th rowspan="2">Land use category</th><th rowspan="2">Parameter
Mg C ha^{-1} yr^{-1}</th><th colspan="2">2012 Submission</th><th colspan="2">2013 Submission</th></tr>
<tr><th colspan="2">Source</th><th colspan="2">Source</th></tr>
<tr><td rowspan="5">Land converted to Settlements</td><td>EF F→S litter</td><td>-1.24</td><td>Sweden CRF 2011</td><td>-1.25</td><td rowspan="5">National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84</td></tr>
<tr><td>EF F→S soil</td><td>-0.25</td><td>GPG-LULUCF 2003, Table 3.4.6, p 3.118 Cold Temperate</td><td>-1.30</td></tr>
<tr><td>EF C→S soil</td><td>NE</td><td>NA</td><td>-2.50</td></tr>
<tr><td>EF G→S soil</td><td>NE</td><td>NA</td><td>-2.75</td></tr>
<tr><td>EF OL→S soil</td><td>NE</td><td>NA</td><td>-1.30</td></tr>
</table>

Also see Table 10.5–Table 10.7.

7.6.6. Source-specific planned improvements

Updated data derived from the NFI fieldwork for land-use changes will be used.

7.7. Other Land (CRF 5.F)

7.7.1. Source category description

Other land category includes all land that does not fall into the five previously described land-use categories.

7.7.2. Methodological issues

In the 2013 submission, emissions from Forest land, Cropland and Wetlands to Other land category were estimated (Figure 7.30) implementing emission factors obtained from Sweden annual submission 2012 (Table 7.33). Conversion to other land has been detected only since 2004.

Table 7.33. Cumulative land-use changes to Other Land in 2011, soil and litter emission factors

Land-use change	kha	EF mineral soil Mg C ha^{-1} [155]	EF organic soil Mg C ha^{-1}	EF litter Mg C ha^{-1}
Forest Land→Other Land	2.4	-1.30	-	-1.25
Cropland→Other Land	0.6	-2.5	-	NA
Wetlands→Other land	0.2	-1.3	-	NA
Total	3.1			

[155] Since there are no Swedish EFs for land converted to Other Land, the same emission factors as under land converted to Settlements were applied. Same EFs were implemented for mineral and organic soils.

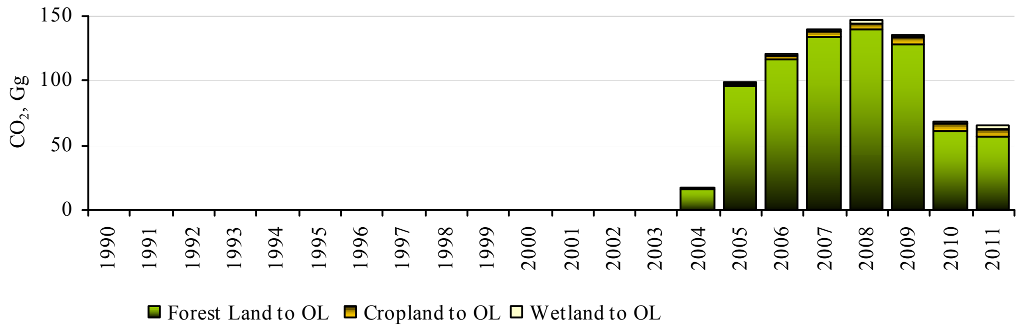

Figure 7.30. Emissions related to land-use changes to Other land, 1990–2011

7.7.3. Uncertainty and time series consistency

The uncertainty rates related to the activity data and the emission factors used in the estimates are presented in Table 7.34.

Table 7.34. Estimated values of uncertainties used in land converted to Other Land category.

IPCC Source Category		Uncertainties ±%		EF References
		Activity data[156]	Emission factors	
5.F.2	Land converted to Other Land – living biomass	72.75	46.95	IPCC 2003 & 2006
5.F.2	Land converted to Other Land – soils	61.03	35.00	Sweden NIR 2012, Table 7.5, p. 291
5.F.2	Land converted to Other Land – dead wood	78.78	12.89	Sandström *et al*. 2007

7.7.4. Source specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for LULUCF sector according to IPCC *Tier 1* method. The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in 1.6.1.

7.7.5. Source-specific recalculations

Table 7.35. Parameters used in Other Land category recalculations

Land use category	**Parameter** Mg C ha^{-1} yr^{-1}	**2012 Submission**		**2013 Submission**	
		Source		**Source**	
Land	EF F→OL litter	-1.24	Sweden CRF 2011	-1.25	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84

156 All activity data uncertainty estimates are obtained from NFI.

converted to Other Land	EF F→OL soil	-1.20		-1.30	
	EF C→OL soil	NE	NA	-2.50	
	EF WL→S soil	NE	NA	-3.73	

Also see Table 10.5–Table 10.7.

7.7.6. Source-specific planned improvements

Updated data derived from the NFI fieldwork for land-use changes will be used.

7.8. Non-CO_2 emissions from biomass burning (CRF 5 (V))

This source category includes CH_4 and N_2O emissions from biomass burning on wooded lands due to wildfires. CO_2 emissions caused by wildfires are included in living biomass emission estimates due to stock change method used for calculations, thus CO_2 emissions are not reported under current category in order to avoid double accounting.

Controlled fires are not a common practice in Estonia, furthermore the standpoint of the public and the national authorities is opposed to prescribed burnings. For example, pursuant to the Forest Act, local administrations shall implement measures to prevent forestfires and according to the Estonian Fire Safety Act, it is forbidden to burn dead grass around the year.

7.8.1. Methodology, data availability and sources, emission factors

Tier 2 method and Equation 7.13 was used to estimate the emissions of non-CO_2 greenhouse gases. Country-specific activity data on areas damaged by fires (Figure 7.31) was obtained from Estonian Rescue Service, State Forest Management Centre and Environmental Board, average values for growing stock of forest land and grasslands were employed from the NFI database. The area and emissions from grassland and wetland fires has been presented together due to the combined statistical data available. It should be noted, that wetlands biomass comprises only a minor part of the combined data, therefore the estimation applies essentially for grasslands.

Equation 7.13[157]

$$L_{fire} = A \bullet B \bullet C \bullet D \bullet 10^{-6}$$

Where:

L_{fire} – quantity of GHG released due to fire, tonnes of GHG;
A – area burnt, ha;
B – mass of 'available' fuel, kg dry matter ha^{-1};
C – combustion efficiency (or fraction of the biomass combusted), dimensionless;
D – emission factor, g (kg dry matter.)$^{-1}$.

[157] GPG-LULUCF 2003, Equation 3.2.20, p. 3.49.

Parameters used for biomass burning emission calculations are shown in Table 7.36.

Table 7.36. Factors used for estimation of non-CO_2 greenhouse gas emissions from fires

	Combustion efficiency, C[158]	CH_4 Emission factor, D[159]	N_2O Emission factor, D[160]
Forest Land	0.15	9	0.11
Grassland and Wetlands	0.15	2	0.1

The total area of Estonian forests, grasslands and wetlands affected by wildfires is presented in Figure 7.31. Wide fluctuations are caused mainly by the weather conditions in different years (e.g. extremely hot and dry summers).

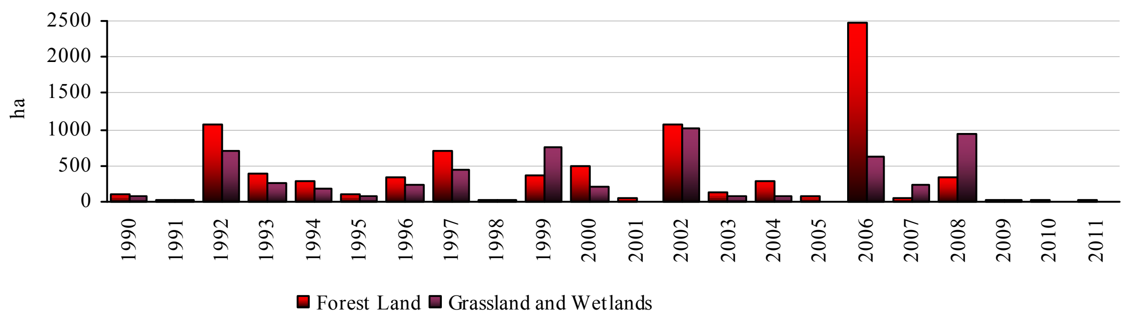

Figure 7.31. Annual area of forest land, grassland and wetlands affected by fires in 1990−2011, ha

Emissions of CH_4 and N_2O from land burnings are illustrated in Figure 7.32 and Figure 7.33. In 2011, only 3.8 hectares of grasslands/wetlands and 15.5 hectares of forest land were affected by fire. The total amount of CH_4 and N_2O released after wildfires were 2.6 t and 0.03 t respectively. Non-CO_2 emissions from grassland wildfires are rather insignificant compared to forest land, since there is approximately 10 times less growing biomass on grasslands.

[158] GPG-LULUCF 2003, Table 3A.1.12, p. 3.179, Boreal forest, surface fire (expert opinion).
[159] GPG-LULUCF 2003, Table 3A.1.16, p. 3.185, Forest fires (Delmas *et al.* (1995)).
[160] GPG-LULUCF 2003, Table 3A.1.16, p. 3.185, Moist-infertile grassland (Scholes (1995)).

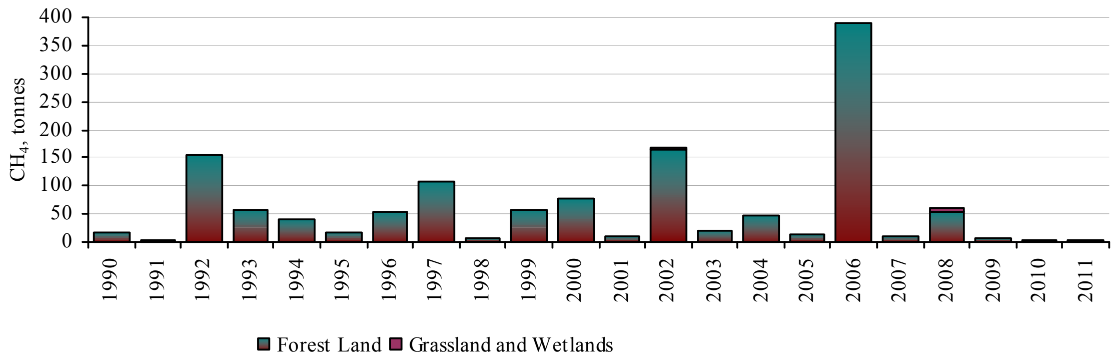

Figure 7.32. CH_4 emissions from wildfires in Estonia in 1990–2011, t

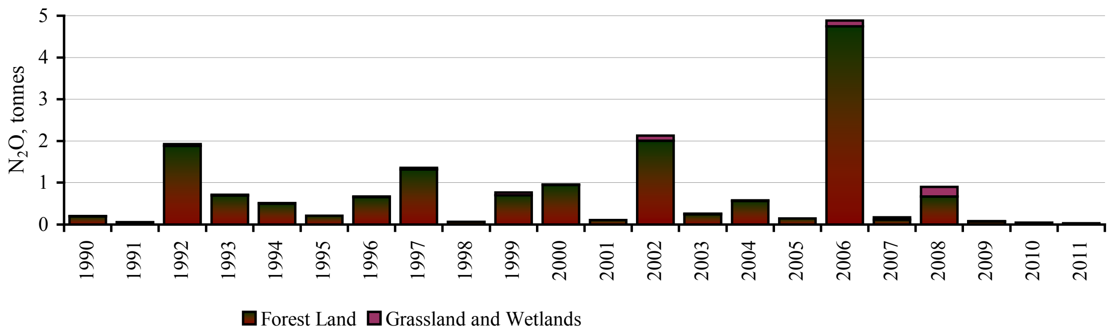

Figure 7.33. N_2O emissions from wildfires in Estonia in 1990–2011, t

7.8.2. Uncertainties and time series consistency

Uncertainty estimates of CH_4 and N_2O emissions from wildfires were carried out based LULUCF GPG (2003) guidelines. Activity data concerning area burnt was obtained from Estonian Rescue Service, State Forest Management Centre and Environmental Board, average values for growing stock of forest land and grasslands were employed from the NFI database. Emission factors were taken from the LULUCF GPG (2003). The uncertainty rates are shown in Table 7.37.

Table 7.37. Estimated values of uncertainties used in non-CO_2 emission estimates from biomass burning subsection.

IPCC Source Category	Uncertainties ±%		EF References
	Activity data[161]	Emission factors	
Biomass burning (CH_4)	34.50	70.00	LULUCF 2003, p. 3.50; Table 3A.1.12, p. 3.179
Biomass burning (N_2O)	34.50	70.00	LULUCF 2003, p. 3.50; Table 3A.1.12, p. 3.179

[161] All activity data uncertainty estimates are obtained from NFI.

7.8.3. Source specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for LULUCF sector according to IPCC *Tier 1* method. The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Chapter 1.6.

Activity data are checked annually for updating. Emission factors are compared with IPCC default and with emission factors of other countries.

7.8.4. Source-specific recalculations

Due to more accurate R and BCEF values used for biomass calculations (Table 7.16), the quantity of fuel burnt was re-estimated, therefore also new emission estimates for non-CO_2 emissions from fires were provided.

Also see Table 10.1 and Table 10.5–Table 10.7.

7.8.5. Source-specific planned improvements

Activity data will be updated.

8. WASTE (CRF 6)

8.1. Overview of the sector and methodology

In Estonia waste management policy bases on the EU legislation and national laws and acts, including National Waste Management Plan for years 2008–2013[162]. The main purpose of the national waste policy is to reduce the volume of the waste deposited in landfills, enlarge the potential of recoverable waste and minimize the hazardousness of wastes to the limit, where negative influence to the environment would be minimal. Waste management system in Estonia has been organized through four levels: national government, local governments, organization level and households.

Ministry of the Environment (MoE) in association with local governments and organizations coordinate realization of the waste policy and organize the supervision over the waste handling in the country.

The most important level concerning municipal waste management is related to local governments. According to the law, local authorities have a responsibility to organize the municipal waste handling and separate collection of wastes in their administrative territory, called as organized waste transport, because since 1st of January 2008 it is not allowed to deposit unsorted municipal wastes to the landfills.

According to the local waste handling regulations, in the level of households several activities have to be taken into consideration, as joining the organized waste transport system, sorting the wastes, collecting separately hazardous wastes, etc.

The Estonian inventory of GHG in waste sector covers CH_4 emissions from solid waste disposal sites including solid municipal and industrial waste, domestic and industrial sludge. The waste sector also covers GHG emissions from waste incineration (incl biogas burnt in a flare), biological treatment and wastewater handling including domestic, commercial and industrial wastewater. Emissions from wastewater handling basically do not occur in Estonia, as all wastewater is mostly treated using aerobic processes. However a small percentage of wastewater in wastewater treatment plants is treated using anaerobic processes.

Table 8.1 summarizes the data on approaches and emission factors employed in estimations of GHG emissions from each sub-sector of the waste sector. Due to lack of national research results in order to use country-specific emission factors, the IPCC default values are used instead. The process of choosing among methods rely on the decision trees in IPCC Guidelines and, the *Tier 1* and Tier 2 (The FOD) methods are applied. The choice of activity data to calculate emissions depends on formulas used.

[162] Waste Management Plan, Riigi Jäätmekava 2008-2013.

Table 8.1. Methods and emission factors used in estimations of emissions from waste sector

	Method applied/EF		
GREENHOUSE GASES SOURCE AND SINK CATEGORIES	**CO_2**	**CH_4**	**N_2O**
6. WASTE			
A. Solid Waste Disposal on Land		T2/D	
B. Wastewater Handling		T1/D	
B. Human Sewage			T1/D
C. Waste Incineration	T1/D		T1/D
D. Biological Treatment		T1/D	T1/D
D. Biogas Burnt In a Flare		T1/D	T1/D

T1 - *Tier 1* method, T2 - *Tier 2* method, D - IPCC default value.

8.1.1. References-sources of information

The inventory has been carried out by researchers at Estonian Environmental Research Centre (EERC). The main providers of activity data used in the estimates are Estonian Environment Information Centre (EEIC) and Statistics Estonia (SE).

Table 8.2. List of institutions (datasets) involved in the inventory for the waste sector

Reference	Link	Abbreviation	Activity/Data
Estonian Environmental Research Centre	www.klab.ee	EERC	- Activity data gathering - Estimation of emissions - Reporting
Statistics Estonia	www.stat.ee	SE	- Collection and reporting of data on product production in Estonia
Estonian Environment Information Centre -Waste Bureau	www.keskkonnainfo.ee	EEIC	- Collection of data on solid waste generation, disposal, and recovery, incl. waste incineration and biological treatment
-Water Bureau			- Collection of data on waste water generation
-Air Bureau			- Collection of data on methane recovery

8.1.2. Quantitative overview of the waste sector

CO_2 equivalent emissions from waste sector in 2011 were 390.76 Gg. It made up 1.86% of the total GHG emission in 2011 (Figure 8.1). CH_4 emission from waste disposal, N_2O from human sewage and emissions (CH_4 and N_2O) from biological treatment are the most significant emissions of the waste sector in Estonia in 2011.

Due to recalculations in estimations (solid waste disposal on land, municipal sewage, domestic and commercial wastewater and waste incineration sub-categories), the whole time series since 1990 was updated (Table 8.3).

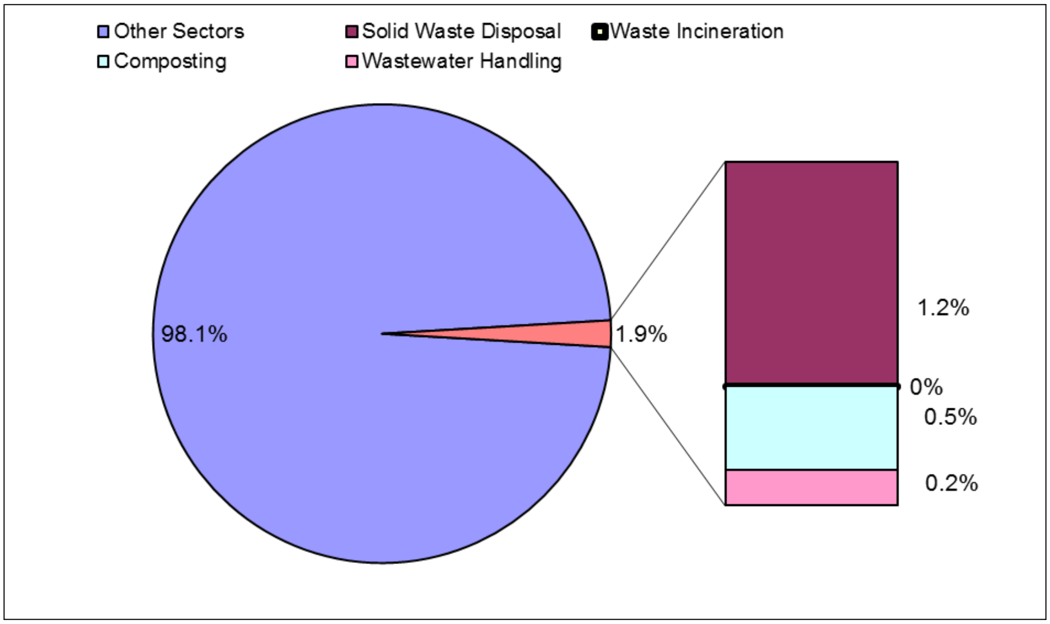

Figure 8.1. CO_2 equivalent emissions from the waste sector compared to the total GHG emissions in Estonia in 2011

The total CO_2 equivalent emission from waste sector in 2011 increased 13.7% compared to the base year: the emission from solid waste landfilled increased 41.5% and emission from waste composting processes increased about hundred fold – from 1.26 Gg to 96.1 Gg in 2011 (Figure 8.2).

As seen from the table (Table 8.3) in 1995 GHG emissions from waste sector have decreased, as a result of decreased CH_4 emissions from paper and sludge waste from solid waste disposal on land in 1995. There have been sharp fluctuations in the quantities of CO_2 and N_2O emissions from waste incineration in 1998–2001, as large amounts of inert, naphta, oil and wood were burnt in 2008 and 2009. Since 2007 CO_2 emission have not occurred, as no non-biogenic waste was incinerated, in 2008 and 2011 no wastes were incinerated without energy recovery which resulted in no emerged emissions. The total CO_2 equivalent in 2007 is the highest during the whole period due to steady increase in emissions from biological treatment, which is related to the obligations stated in the Waste Act. The total CO_2 equivalent in 2011 has decreased significantly compared to previous years mainly because of the change in national currency, which uplifted the prices in the country and therefore lessened the consumption habits and waste generation.

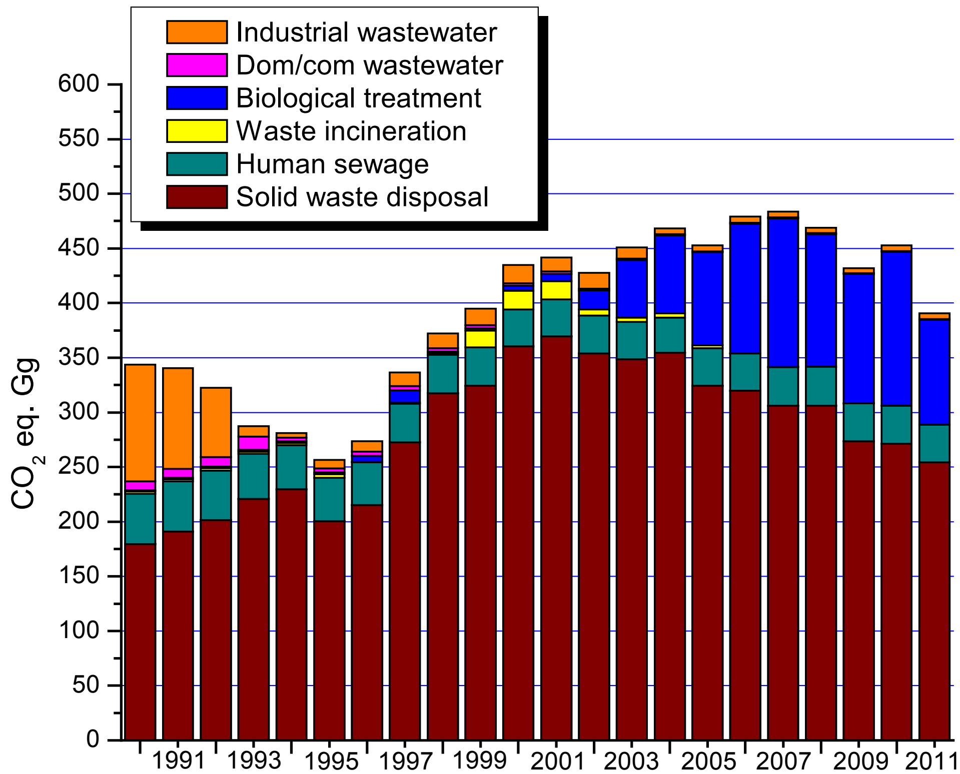

Figure 8.2. Trends of GHG emissions in the waste sector by source categories in 1990–2011**,** Gg CO_2 eq.

Table 8.3. GHG emissions from waste sector in Estonia in 1990–2011, Gg

Year	Solid Waste Disposal	Waste Incineration				Biological Treatment		Wastewater Treatment			Biogas Burnt in a Flare		Total CO_2 eq. emissions
		non-biogenic	biogenic	biogenic	non-biogenic			Human Sewage	Domestic and Commercial Wastewater	Industrial Wastewater			
	CH_4	CO_2	CO_2	N_2O	N_2O	CH_4	N_2O	N_2O	CH_4	CH_4	CH_4	N_2O	CO_2 eq.
1990	8.556	0.034[163]	*0.0082*[164]	0.0016	0.0050	0.029	0.002	0.148	0.387	5.082	NO	NO	343.72
1991	9.103	0.034	*0.0082*	0.0016	0.0050	0.030	0.002	0.148	0.386	4.379	NO	NO	340.40
1992	9.592	0.034	*0.0082*	0.0016	0.0050	0.032	0.002	0.146	0.426	3.017	NO	NO	322.58
1993	10.517	0.034	*0.0082*	0.0016	0.0050	0.033	0.002	0.133	0.579	0.449	NO	NO	287.24
1994	10.940	0.034	*0.0082*	0.0016	0.0050	0.035	0.003	0.130	0.162	0.198	NO	NO	281.17
1995	9.543	0.025	*0.0237*	0.0048	0.0061	0.037	0.003	0.128	0.159	0.375	NO	NO	256.49
1996	10.259	0.013	*0.0078*	0.0008	0.0004	0.126	0.009	0.125	0.195	0.442	NO	NO	273.54
1997	12.985	0.034	*0.0012*	0.0008	0.0007	0.262	0.020	0.114	0.192	0.584	NO	NO	336.45
1998	15.118	0.057	*0.0001*	0.0009	0.0048	0.026	0.002	0.113	0.153	0.645	NO	NO	372.22
1999	15.453	0.041	*0.0002*	0.0373	0.0126	0.043	0.003	0.112	0.151	0.717	NO	NO	395.01
2000	17.166	0.062	*0.00004*	0.0069	0.0473	0.107	0.008	0.109	0.113	0.790	NO	NO	434.83
2001	17.606	0.045	*0.0003*	0.0099	0.0443	0.143	0.011	0.108	0.112	0.608	NO	NO	441.62
2002	16.846	0.016	*0.0396*	0.0035	0.0140	0.396	0.030	0.113	0.075	0.689	NO	NO	427.76
2003	16.600	0.013	*0.0381*	0.0023	0.0105	1.192	0.089	0.110	0.074	0.483	NO	NO	450.98

[163] CO_2 emissions from oxidation during incineration of carbon in waste of fossil origin (e.g., plastics, rubber, liquid solvents, waste oils) are considered net emissions and are reported under Waste sector.
[164] CO_2 emissions from combustion of biomass materials (e.g., paper, food waste, wood) contained in the waste are biogenic emissions and should not be included in national total emission estimates, but reported as an information item under Waste Sector.

2004	16.892	0.013	*0.0942*	0.0026	0.0106	1.614	0.121	0.103	0.037	0.250	NO	NO	468.18
2005	15.446	0.008	*0.0517*	0.0015	0.0072	1.920	0.144	0.111	0.037	0.267	NO	NO	452.93
2006	15.234	0.0002	*0.0117*	0.0003	0.0001	2.682	0.201	0.110	0.037	0.268	NO	NO	479.04
2007	14.578	NO	*0.0041*	0.0002	NO	3.079	0.231	0.113	0.037	0.255	NO	NO	483.74
2008	14.582	NO	*NO*	NO	NO	2.741	0.206	0.115	0.037	0.241	NO	NO	468.96
2009	13.023	NO	*0.00004*	0.00002	NO	2.671	0.200	0.112	0.037	0.210	0.00055	0.000011	431.72
2010	12.919	NO	*0.00005*	0.0002	NO	3.183	0.239	0.112	0.037	0.250	0.00055	0.000011	452.94
2011	12.110	NO	*NO*	NO	NO	2.171	0.163	0.111	0.037	0.248	0.00056	0.000011	390.76

8.1.3. Key categories

Waste key categories in 2011 (without LULUCF) calculated with the *Tier 2* method[165] are:

6.A	Solid Waste Disposal on Land	L, T[166]
6.B.1	Industrial Wastewater (CH_4)	T
6.D	Biological Treatment (N_2O)	T
6.D	Biological Treatment (CH_4)	T

8.1.4. Uncertainty assessment

All calculated uncertainties of emission factors and activity data used are in accordance with methodology used in emission estimations, derived from IPCC Guidelines. In the following table (Table 8.4) all categories comprised in uncertainty estimates are presented, detailed uncertainty values used in uncertainty assessment are presented under sub-categories' descriptions below. The combined uncertainties for activity data and emission factors used are calculated as follows[167]:

$$Utotal = \sqrt{U1^2 + U2^2 + \cdots Un^2}$$

The combined uncertainties of activity data and emission factor related to the Waste Sector in 2011 are as follows:

Table 8.4. The combined uncertainties related to waste sector (%)

Source category	**Uncertainties %**
6.A Solid Waste Disposal on Land (CH_4)	83.67
6.B.1 Industrial Wastewater (CH_4)	107.35
6.B.2 Domestic and Commercial Wastewater (anaerobic) (CH_4)	42.72
6.B.2.2 Domestic and Commercial Wastewater - human sewage (N_2O)	100.12
6.C Waste Incineration (N_2O)	100.12
6.C Waste Incineration (CO_2)	40.31
6.D Biological Treatment (CH_4)	100.5
6.D Biological Treatment (N_2O)	100.5
6.D Biogas Burnt in a Flare (C_H4)	25.5
6.D Biogas Burnt in a Flare (N_2O)	25.5

[165] GHG emissions/removals of LULUCF sector are not included.
[166] L-Level Assessment method; T-Trend Assessment method.
[167] IPCC GPG 2000. Chapter 6, pp 6.12.

8.2. Solid Waste Disposal on Land (CRF 6.A)

8.2.1. Source category description

In 2011, there were 5 landfills (Jõelähtme, Uikala, Väätsa, Torma, Paikre) where municipal wastes were deposited. These landfills are totally conformed to environmental and technical requirements or standards and are capable to serve more than one county or service area (Figure 8.3). Due to rearrangements in waste management system, all landfills not in accordance with environmental requirements applied to landfills were closed in summer 2009. Also there are still several landfills in Estonia, that are closed but uncovered, all arrangements concerning covering, will be finished in 2013.

In the existing landfills, classified as managed solid waste disposal sites, different kind of activities of waste management are taking place: treatment and temporary storage of recoverable waste; separation of preliminarily separated waste, separation and destruction of wood; composting; collection of hazardous waste; separation of demolished constructional waste; etc.

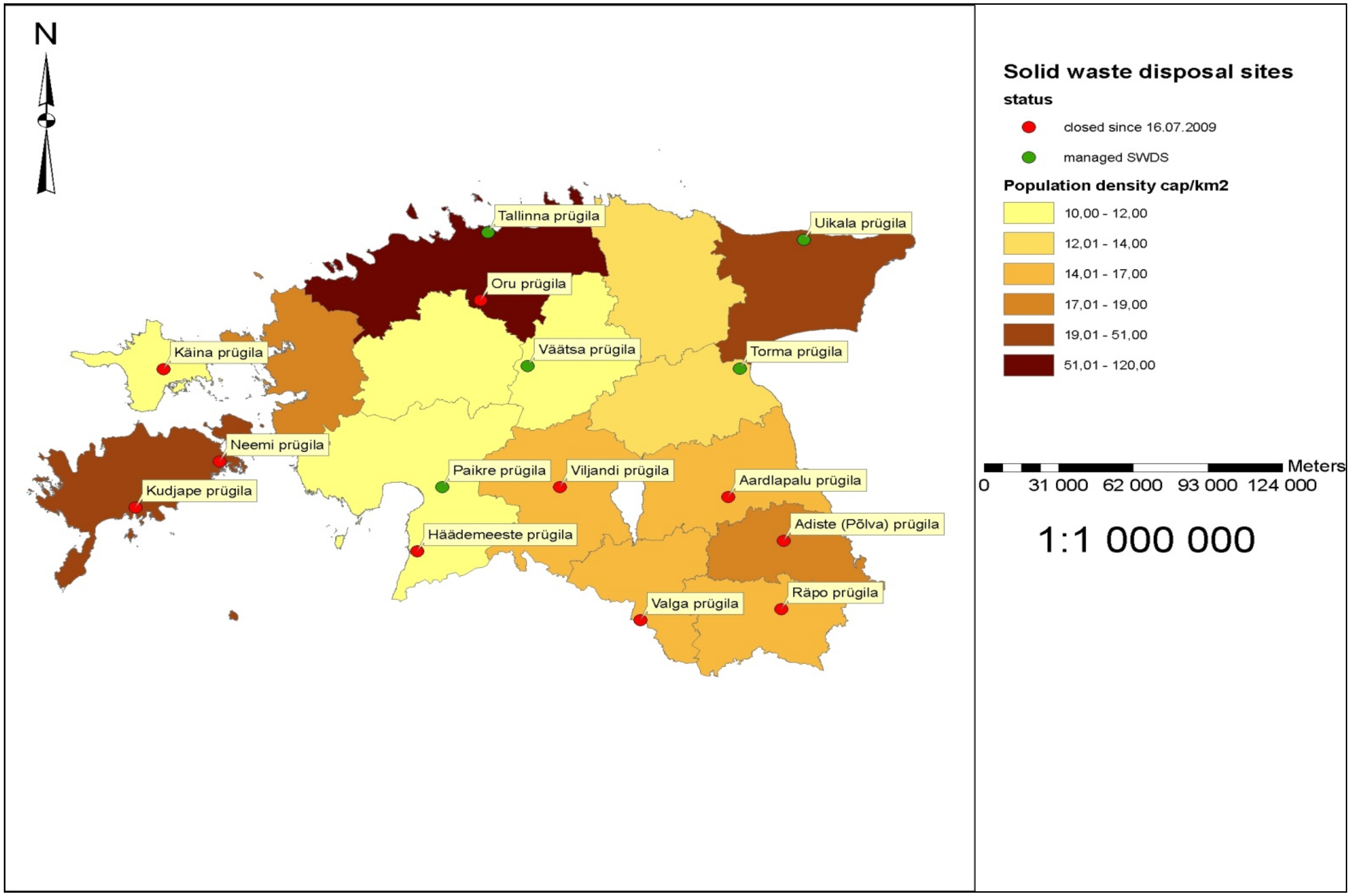

Figure 8.3. The map of Estonia's population, population density and operating landfills of municipal wastes in 2011

The annual trend of inert[168] and degradable waste generated in Estonia in 1990–2011 is presented in Figure 8.4. Since 1992 the EEIC has started to collect data in accordance with the Estonian waste classification, however in 1999 the adapted classification system was changed and the European Waste Catalogue was employed. The data for 1990–1991 were interpolated based on the data of 1992–1998. The forecast function of the Excel software was used to calculate the quantities of waste generated in the period 1990–1991[169]. As seen from the figure, amount of inert and degradable waste generated in 2011 has increased appreciably compared to 2010. The quantity of waste generation in 2011 was about 21.7 mln tonnes, in contrast with 2010 it has risen 10% due to increase in consumption habits. The falloff in 2009 is related to economic downfall and decrease in consumption in the country. The proportion of degradable and inert waste generation in 2011 is accordingly 8% and 92%.

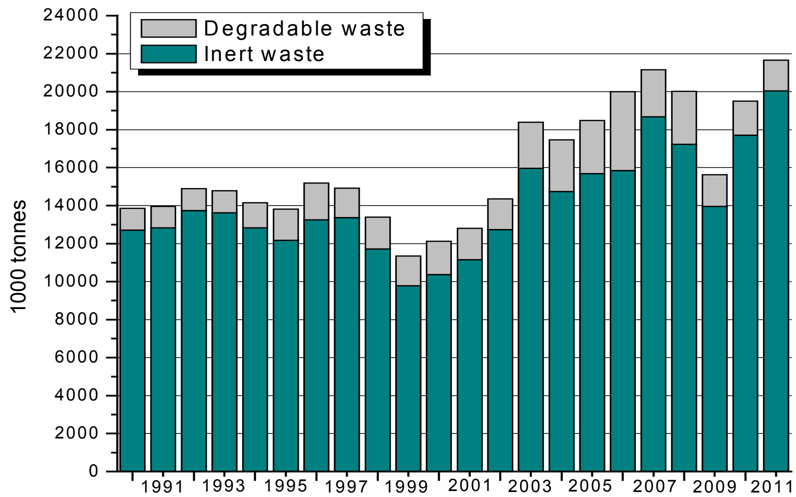

Figure 8.4. Amounts of waste generated in Estonia in 1990–2011, 1000 tonnes

As seen from the Figure 8.5 the quantity of DOC[170] generated has increased 2.3 times in 2011, compared to the base year. Although in comparison with the year 2010 the amount of DOC generated in 2011 has decreased 6%, and the ratio of DOC landfilled to DOC generated has made a fallout from 10.5% to 10.1%.

The reason why the amount of DOC generated has decreased in 2008 is mainly because the generation of industrial wood waste (in DOC tonnes) decreased about 31% compared to the year 2007 and therefore, the quantity of wastes in DOC tonnes reduced. The upturn in the ratio of DOC landfilled to DOC generated in 2008 is due to quantities of the solid municipal and industrial waste in DOC tonnes disposed onto landfills, enlarged. The reason why the amount of DOC generated has decreased in 2009 is mainly because the generation of municipal waste and industrial organic and wood waste (in DOC tonnes) decreased. The rise

[168] Inert waste – non-biodegradable wastes e.g glass, metal, plastic, pottery, clinical waste and other inert waste (wastes from mineral excavation; inorganic chemical processes, etc.).
[169] The calculations with Forecast function were based on the Estonian GDP in 1990, 1991–1998 and quantities of waste generated in 1991–1998. Source of GDP is Statistics Estonia and source of data on waste generation in period 1992–1998 is Estonian Environment Information Centre.
[170] DOC-Degradable Organic Carbon.

in 2010 in the quantity of DOC generated is reasoned by an increase in generation of industrial wood waste.

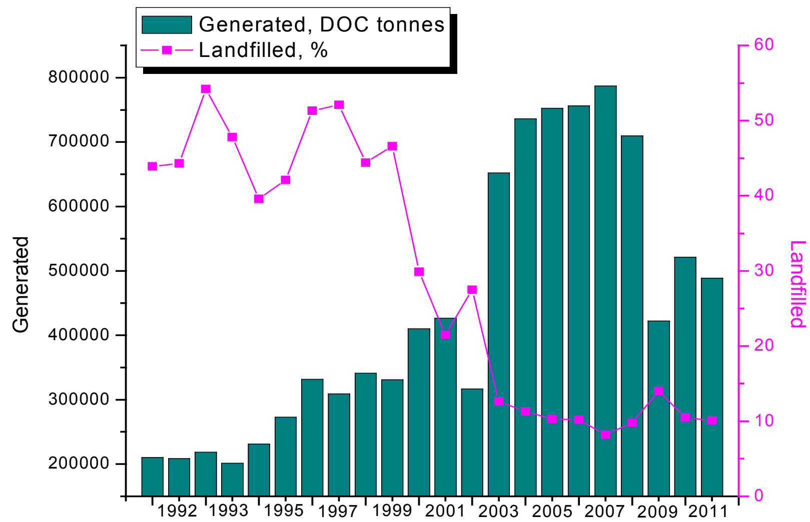

Figure 8.5. Quantity of DOC generated (tonnes) and ratio of DOC landfilled to DOC generated (%) in 1990–2011

Production of biogas

Biogas is a gas fuel obtained via anaerobic fermentation, which is comprised of 50–70% methane (CH_4), 30–40% carbon dioxide (CO_2) and other components such as N_2, O_2, NH_4, H_2S. A biogas station in landfills is provided with pre-preservation storage and mixing containers, biogas reactors, fermenting waste storage area, gas storage units, heating and power station for the use of gas.

In a production process first the biodegradable waste is directed from the mixing tanks to the biogas reactor, where an anaerobic process takes place with a temperature in the range of 35–42˚C. During the process biogas, which is comprised mainly of methane and carbon dioxide, is produced from organic substances in an oxygen poor environment. The gas is then directed to the gas storage tanks (at the head of the biogas reactor) and from there to the station, where biogas is transformed into heat and electricity.

The data on methane recovery is obtained from EEIC Air bureau, as the landfills with the system of biogas collection report their quantities of recovered biogas directly to the Air bureau. Accordingly, the summary amount of CH_4 recovered in 2011 was 4.19 Gg (Figure 8.6). During the UNFCCC in-country review in 2012 it was recommended that amounts of flared biogas deducted from the total quantity of biogas collected in 2012 Submission (for years 2009–2010) should be still count in under CH_4 recovery, where the total gas collected is taken into account in recovered methane calculations (in calculations it is considered that landfill gas contains approximately 55% of methane with a density of 0.717 kg/m^3), although emissions derived from flaring process should be reported separately and considered as net emissions. According to the ERT's recommendation, CH_4 recovery was recalculated for years 2009 and 2010, which resulted summary amount of CH_4 recovery in 2009 4.07 Gg and in 2010 3.8 Gg.

In the period 1995–2006[171] only one landfill in Estonia collected and recovered methane (Pääsküla landfill in Tallinn). The amount of reused CH_4 during this period fluctuates due to changes in the quantity of waste generation and percentage of organic waste in the total amount of waste generated. In 2007 Jõelähtme landfill started to collect landfill gas, which causes the increase in the total amount of reused CH_4. Additionally, in 2009 one more landfill started to collect biogas (Väätsa) and in 2010 another landfill accrued (Paikre), so currently there are 4 landfills in Estonia where biogas is collected and then recovered or flared. The quantity of collected methane in biogas is presented in the following table (Figure 8.6).

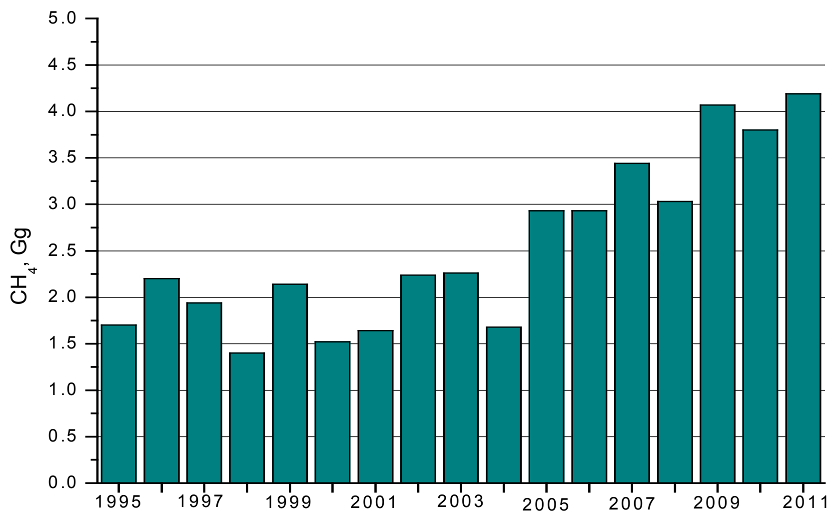

Figure 8.6. CH_4 recovered from landfills 1995–2011, Gg

8.2.2. Methodological issues

Activity data

Calculating emissions from solid waste disposal sites the total amount of municipal and industrial waste generated and deposited in 2011 (collected from Estonian Environment Information Centre (EEIC)) and amount of methane recovered (obtained from the EEIC Air bureau) are used as activity data.

In 2011 21.7 million tonnes of waste was generated in Estonia. About 84% of the waste generated was produced by oil shale industry (wastes from mining and physical-chemical treatment, thermal processes, and other oil shale wastes[172]). Wastes from oil shale industries are not taken into account in the estimations of GHG emissions from solid waste disposal. The quantity of municipal waste generated in 2011 was about 317 447 tonnes in addition to separated collected fraction, which summed up about 35.5 thousand tonnes. The total amount of municipal waste generated was about 2% of the total waste generation. The total amount of

[171] Since 1995 CH_4 is collected and recovered in Estonia.
[172] Wastes from the treatment of the oil shale and coal, e.g a pitch.

waste disposed onto landfills was 9.3 millions of tonnes, about 237 thousand tonnes of it comprised municipal waste and 9 million tonnes industrial wastes (Table 8.5, Table 8.6) [173].

Table 8.5. Amounts of waste disposed in SWDS (Mixed Municipal Waste), Gg

Year	Food	Garden	Paper	Wood	Textile	Sludge	Inert	Deposited MSW
1990	141.6	3.4	84.3	11.1	3.4	7.30	94.4	337.1
1991	141.6	3.4	84.3	11.1	3.4	7.68	94.4	337.1
1992	181.7	4.3	108.1	14.3	4.3	2.46	121.1	432.6
1993	156.1	3.7	92.9	12.3	3.7	0.54	104.1	371.8
1994	149.0	3.5	88.7	11.7	3.5	1.30	99.3	354.7
1995	192.1	4.6	114.3	15.1	4.6	0.95	128.0	457.3
1996	237.2	5.6	141.2	18.6	5.6	1.93	158.1	564.7
1997	249.2	5.9	148.3	19.6	5.9	3.07	166.1	593.3
1998	234.0	5.6	139.3	18.4	5.6	2.80	156.0	557.2
1999	239.4	5.7	142.5	18.8	5.7	18.55	159.6	569.9
2000	231.0	5.5	138.8	18.1	4.9	8.22	150.3	548.7
2001	168.0	4.0	101.0	13.2	3.6	4.25	109.3	399.1
2002	175.5	4.2	105.5	13.8	3.8	1.36	114.2	416.8
2003	155.0	3.7	93.2	12.2	3.3	-	100.9	368.2
2004	156.8	3.7	94.2	12.3	3.4	-	102.0	372.3
2005	152.7	3.6	91.8	12.0	3.3	0.16	99.4	362.7
2006	154.9	3.7	93.1	12.1	3.3	0.01	100.8	367.9
2007	130.4	3.1	78.3	10.2	2.8	0.02	84.8	309.7
2008	103.0	16.6	59.8	3.3	14.7	0.04	136.2	332.3
2009	88.7	14.3	51.5	2.9	11.4	0.04	117.3	286.0
2010	82.2	13.3	47.7	2.7	10.6	0.11	108.7	265.0
2011	73.6	11.9	42.7	2.4	9.5	0.05	97.3	237.3

Table 8.6. Amounts of industrial waste disposed in SWDS, Gg

	Organic	Textile	Wood	Paper	Leather	Rubber	Sludge	Inert
1990	36.0	0.7	11.5	2.8	0.5	0.3	43.7	10 186.8
1991	36.7	0.7	11.4	2.5	0.6	0.3	46.0	10 248.5
1992	45.3	1.9	17.9	1.5	1.9	0.7	118.0	10 644.5
1993	37.4	0.6	10.8	1.0	0.7	0.3	47.8	10 886.1
1994	11.6	0.0002	10.0	0.6	0.6	0.4	126.1	8 768.6
1995	48.7	0.1	8.0	1.2	0.2	0.4	32.2	10 071.5
1996	127.9	0.7	23.3	1.8	0.5	0.7	303.9	10 579.2
1997	74.4	0.7	19.0	4.2	0.3	1.1	152.8	11 174.9
1998	61.5	0.6	26.9	5.4	0.3	1.2	71.9	10 004.0
1999	90.5	0.3	22.7	0.5	0.1	-	23.4	8 505.5
2000	47.3	0.9	5.3	0.2	0.2	-	25.5	9 262.1
2001	24.8	-	16.1	0.5	0.1	0.2	2.1	9 063.2
2002	2.5	0.4	4.7	0.1	0.1	0.05	2.3	9 447.1
2003	2.9	0.9	15.6	0.4	-	-	3.6	11 556.4
2004	3.4	1.3	13.3	0.7	-	-	3.3	11 132.7

[173] Amounts of waste disposed onto landfills (as activity data) were added to the NIR as the recommendation by the ERT 2012.

	Organic	Textile	Wood	Paper	Leather	Rubber	Sludge	Inert
2005	3.6	1.1	5.9	0.3	-	-	1.6	11 061.6
2006	4.2	1.0	2.3	0.1	-	-	4.6	10 589.4
2007	2.6	0.9	3.3	0.02	-	-	5.8	11 758.0
2008	0.0	1.0	4.0	-	-	-	2.2	12 094.5
2009	1.5	0.7	2.1	0.04	-	-	2.1	8 233.4
2010	0.7	0.6	1.7	0.02	-	-	1.6	11 389.9
2011	0.6	0.5	1.9	0.02	-	-	2.6	9 054.0

Methods

In order to estimate CH_4 emissions from solid waste disposal on landfills, the First Order Decay (the FOD) approach was employed, which is the IPCC *Tier 2* method given in the IPCC Good Practice Guidance (IPCC 2000). Due to obtainable waste disposal activity data for the current inventory year and available waste disposal activity data for previous years, however country-specific key parameters are not available, the FOD method with default parameters and country-specific activity data were used.

$$CH_4\text{, Gg/year} = \sum_x [A \bullet k \bullet MSW_{T(W)} \bullet MSW_{F(X)} \bullet L_0(x) \bullet e^{-k(t-x)}] \quad (8.1)$$ [174]

for x=initial year to t

t- year of inventory;
x- years for which input data should be added;
A- $(1-e^{-k})/k$ normalization factor which corrects the summation;
k- methane generation rate constant, 1/year;
$MSW_{T(W)}$ – total municipal solid waste (MSW) generated in year x, Gg/year;
$MSW_{F(X)}$ – fraction of MSW disposed at landfills in year x.

$L_0(x)$ – methane generation potential

$$L_0(x) = MCF_{(x)} \bullet DOC_{(X)} \bullet DOC_F \bullet F \bullet 16/12\text{, GgCH}_4\text{/Gg waste} \quad (8.2)$$

$MCF_{(x)}$ – methane correction factor in year x (fraction);
$DOC_{(X)}$ – degradable organic carbon (DOC) in year x (fraction), Gg C/Gg waste;
DOC_F – fraction of DOC degraded;
F – fraction by volume of CH_4 in landfill gas;
16/12 – conversion from C to CH_4.
Sum the obtained results for all years (x).

$$CH_4\text{, Gg/year} = [\,CH_4 \text{ generated in year } t - R(t)] \bullet (1 - OX) \quad (8.3)$$ [175]

R(t) – recovered CH_4 in inventory year t, Gg/year;
OX – oxidation factor (fraction).

Emission factors

Emission factors (EFs) used in calculations of emissions from solid waste disposal sites are default emission factors from *IPCC 2000 Good Practice Guidance* and *IPCC 2006 Guidelines for National Greenhouse Gas Inventories*. The choices of the parameters are in

[174] Equation 5.1 of the IPCC, 2000, pp 5.6.
[175] Equation 5.2 of the IPCC 2000, pp 5.7.

full agreement with the information and data ranges given in the *Good Practice Guidance* (IPCC 2000).

As no accurate analysis of DOC in different waste types achieved by sampling waste and measuring DOC in that waste have been made in Estonia, default DOC contents for FOD model are used in calculations (Table 8.7).

Table 8.7. Default DOC content of different waste types (wet basis)[176]

Waste group	DOC content
Municipal solid waste	
Food/Grease	0.15
Municipal	Table 8.10
Garden	0.2
Paper	0.4
Textile	0.24
Wood	0.43
Municipal sludge	0.05
Industrial waste	
Organic	0.15
Textile	0.24
Wood	0.43
Paper	0.4
Leather	0.39
Rubber	0.39
Industrial sludge	0.045

Table 8.8. Emission factors and parameters used in calculations

Factor/Parameter	Value	Reference
MCF	0.6/1	IPCC 2000, Waste, pp 5.9
DOCf	0.5	IPCC 2000, Waste, pp 5.9
F	0.5	IPCC 2000, Waste, pp 5.10
OX	0	IPCC 2000, Waste, pp 5.10
Methane generation rate constant		
k1=paper/textile waste	0.06	IPCC 2006, Waste, pp 3.17
k2=wood/rubber waste	0.03	IPCC 2006, Waste, pp 3.17
k3=organic/garden and park waste	0.1	IPCC 2006, Waste, pp 3.17
k4=food waste/sewage sludge	0.185	IPCC 2006, Waste, pp 3.17
k5=industrial waste	0.09	IPCC 2006, Waste, pp 3.17

Calculating CH_4 emissions IPCC 2000 GPG FOD method is applied, although *waste model* presented in IPCC 2006 Guidelines is used in the estimates, which is in accordance with IPCC 2000 GPG. Some of the parameters and EF-s used in the calculations are derived from IPCC 2006 Guidelines as in the model more waste types (sewage sludge, industrial wastes) in addition to MSW are included, therefore more accurate DOC and k values are needed which

[176] Table 2.4 and Table 2.5 of the 2006 IPCC Guidelines, pp 2.14-2.16.

are only presented in IPCC 2006 Guidelines (GPG 2000 gives DOC values for wood, food, garden and paper/textiles wastes and k value for total MSW).[177]

In the FOD model country-specific data on waste composition of solid municipal waste is used in the estimates. There have been two research made in Estonia about waste composition in municipal waste, the first one in 2000 and the second one in 2008. Time period since 1950 to 1999 is retroactively covered with composition data derived from research made in Estonia in 2000, also time period from 2000–2007 is covered with data from research in 2000. Since 2008 new composition data is employed in the FOD model (Table 8.9, Table 8.10).

Table 8.9. The waste composition of solid municipal waste, %

	1950-1999[178]	**2000-2007**[12]	**2008-onward**[179]
Organic household waste and non-defined non separated waste	42.1	42.1	36.65
Paper and cardboard	25.3	25.3	17.53
Wood	3.3	3.3	0.44
Textiles	0.9	0.9	4.43

Table 8.10. DOC content of mixed municipal waste in Estonia in 1950–2011

	1950-1999	**2000-2007**	**2008-onward**
DOC content in MSW	0.201	0.201	0.156

8.2.3. Quantitative overview - CH_4 emissions from solid waste disposal (CRF 6.A)

In 2011 the total CH_4 emission from solid waste disposed onto landfills in Estonia was 12.1 Gg (Figure 8.7). The trend of CH_4 emission emitted from disposal of different type of waste is presented in Table 8.11. As seen from the table, in 2011 a light decrease has taken place in the quantities of methane emitted from different types of biodegradable solid waste, except the emission from the garden and textile waste, which has risen. The driver for the decreasing trend in these emissions is the increasing amount of landfill gas recovered and waste recycled.

The amount of recovered landfill gas, waste recycled and unstable population which fluctuate during the time period affect also the implied emission factor (IEF) of CH_4. The main reason of the unstable population is mostly migration to abroad. Information about CH_4 recovery practices are described under 8.2.1 sub-category (Production of biogas).

Generally it can be said, that CH_4 emission from organic and food waste, paper, sludge and emission from leather and rubber waste has decreased significantly during the last year, while emissions from garden and textiles waste have appreciably increased. CH_4 emission from the

[177] Justification to the parameters used from IPCC 2006 was added as the recommendation by the ERT 2012.
[178] The data on waste composition of 2000 was taken from (Olmejäätmete koostise… 2000).
[179] The data on waste composition of 2008 was taken from (Eestis tekkinud olmejäätmete… 2008).

wood waste has grown until the year 2008, after that it has been decreasing slightly (Table 8.11).

Table 8.11. Quantities of CH_4 emission and recovery from biodegradable solid waste disposed onto landfills in 1990–2011, Gg

Year	Organic/ Food	Garden	Paper	Wood	Textiles	Sludge (M+Ind)	Leather/ Rubber	Recovery	Total CH4 from SWDS
1990	3.59	0.08	3.63	0.72	0.11	0.38	0.044		8.556
1991	3.89	0.09	3.82	0.75	0.12	0.40	0.045		9.103
1992	4.13	0.09	4.00	0.79	0.12	0.41	0.045		9.592
1993	4.58	0.10	4.28	0.85	0.13	0.53	0.050		10.517
1994	4.79	0.10	4.47	0.88	0.14	0.51	0.051		10.940
1995	4.80	0.11	4.62	0.91	0.14	0.62	0.052	-1.70	9.543
1996	5.56	0.12	5.05	0.96	0.15	0.58	0.052	-2.20	10.259
1997	6.89	0.13	5.57	1.06	0.16	1.05	0.054	-1.94	12.985
1998	7.72	0.15	6.11	1.15	0.17	1.16	0.056	-1.40	15.118
1999	8.25	0.16	6.58	1.26	0.18	1.11	0.059	-2.14	15.453
2000	8.89	0.19	7.01	1.35	0.19	1.00	0.057	-1.52	17.166
2001	9.11	0.20	7.40	1.38	0.20	0.90	0.056	-1.64	17.606
2002	8.85	0.20	7.58	1.44	0.20	0.76	0.055	-2.24	16.846
2003	8.52	0.20	7.78	1.46	0.21	0.64	0.054	-2.26	16.600
2004	8.15	0.21	7.91	1.51	0.21	0.54	0.053	-1.68	16.892
2005	7.85	0.22	8.04	1.55	0.22	0.45	0.051	-2.93	15.446
2006	7.58	0.22	8.14	1.56	0.22	0.38	0.050	-2.93	15.234
2007	7.37	0.23	8.25	1.57	0.23	0.33	0.048	-3.44	14.578
2008	7.01	0.23	8.25	1.57	0.23	0.28	0.047	-3.03	14.582
2009	6.54	0.30	8.15	1.54	0.28	0.24	0.045	-4.07	13.023
2010	6.20	0.36	8.07	1.52	0.32	0.20	0.044	-3.80	12.919
2011	5.85	0.41	7.97	1.49	0.36	0.17	0.043	-4.19	12.110

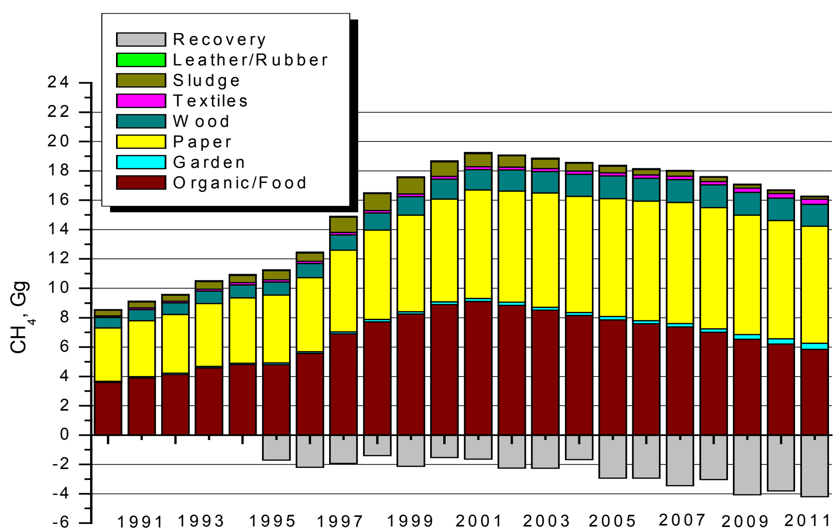

Figure 8.7. CH_4 emissions and recovery from landfills in Estonia in 1990–2011, Gg

8.2.4. Uncertainties and time series consistency

The estimation of CH_4 emission from municipal waste disposal is carried out based on activity data and emission factors (methane correction factor-MCF, degradable organic carbon-DOC, fraction of DOC, fraction of CH_4 in landfill gas-F, methane generation rate constant-k).

Uncertainties of default emission factors and activity data used in the estimations are derived accordingly to methodology from IPCC Good Practice Guidance. Values are presented in Table 8.12.[180]

The combined uncertainty rates related to solid waste disposal sub-category are reported in Chapter 8.1.4.

Table 8.12. Default uncertainty ranges for 'Solid Waste Disposal'

Input	Uncertainties	Reference
Activity data		
Total municipal solid waste	± 10%	2000 IPCC, Waste, Table 5.2, pp 5.12
Total uncertainty of waste composition	± 10%	2006 IPCC, Waste, Table 3.5, pp 3.27
Methane recovery (R)	± 10%	2006 IPCC, Waste, Table 3.5, pp 3.27
Emission factors		
Degradable Organic Carbon (DOC)	-50%, +20%	2000 IPCC, Waste, Table 5.2, pp 5.12
Fraction of DOC Dissimilated	-30%, +0%	2000 IPCC, Waste, Table 5.2, pp 5.12
Methane correction factor		
=1.0	-10%, +0%	2000 IPCC, Waste, Table 5.2, pp 5.12
=0.6	-50%, +60%	2000 IPCC, Waste, Table 5.2, pp 5.12
Fraction of CH_4 in Landfill Gas	-0%, +20%	2000 IPCC, Waste, Table 5.2, pp 5.12
Methane generation rate constant (k)	-40%, +300%	2000 IPCC, Waste, Table 5.2, pp 5.12

8.2.5. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Waste sector according to the IPCC *Tier 1* method. The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.

8.2.6. Source-specific recalculations

During the UNFCCC in-country review in 2012 activity data under 6.A Solid Waste Disposal on Land category was revised due to underestimation of CH_4 emissions in period 1990–2010. In 2012 Submission landfills where municipal solid waste were disposed of were classified for the years 1990–2008 as *uncategorized* and for years 2009–2010 as *managed* disposal sites. As one landfill in Estonia (Pääsküla) started to collect and recover methane in 1995, the reclassification of landfills was needed, as landfill that recovers methane should be classified/reported as *managed* instead of *uncategorized*. Pääsküla landfill was closed in

[180] In some cases (methane recovery, waste composition) 2006 IPCC is used for uncertainties, as in GPG 2000, no values were available for these parameters.

2007, the last year when municipal solid waste was disposed there was in 2002. Since 2009 all operating landfills in Estonia are managed waste disposal sites and data for these years was not changed.

As distribution of waste disposals (by mass) between site types (managed, uncategorized) was needed in FOD model (*Tier 2, IPCC 2000*) to calculate CH_4 emission, the amounts of municipal solid waste (MSW) disposed onto Pääsküla landfill in 2001 and 2002 were used as activity data in estimations of distribution of waste disposals (earlier data from Pääsküla landfill was not available at the time of revision). At first waste per capita (kg/cap/yr) was calculated for years 2001 and 2002 based on the population in Tallinn and MSW disposed in Pääsküla. Subsequently interpolation (based on the population in Tallinn and weighted average of waste generation per capita) was used to calculate quantities of MSW disposed in Pääsküla for all other years. Finally distribution of waste disposals (for years 1995–2008) was calculated based on the amounts of MSW disposed in Pääsküla and total amounts of MSW disposed in Estonia.

During the UNFCCC in-country review in 2012 it was also recommended that amounts of flared biogas deducted from the total quantity of biogas collected in 2012 Submisson should be still counted under CH_4 recovery, where the total gas collected is taken into account (incl. flared biogas). According to the ERT's recommendation, CH_4 recovery was recalculated for years 2009 and 2010, which resulted in summary amount of CH_4 recovery in 2009 4.07 Gg and in 2010 3.8 Gg.

Thirdly Estonia's GDP was updated during the compilation of 2013 Submission according to the latest version of database available in Estonian Statistics. The results of recalculated values of CH_4 emissions in 2013 Submission are presented in the following table (Table 8.13).

Table 8.13. Recalculation under 'Solid Waste Disposal' in 1990–2010

2012 Submission					2013 Submission			
	Managed	Uncategorized			Managed	Uncategorized		
	MCF 1	MCF 0.6			MCF 1	MCF 0.6		
Year	Distribution of waste by waste management type		CH_4 recovery, Gg	CH_4, Gg	Distribution of waste by waste management type		CH_4 recovery, Gg	CH_4, Gg
1990		100%		8.65		100%		8.56
1991		100%		9.18		100%		9.10
1992		100%		9.66		100%		9.59
1993		100%		10.58		100%		10.52
1994		100%		10.99		100%		10.94
1995		100%	1.70	9.59	43%	57%	1.70	9.54
1996		100%	2.20	9.75	34%	66%	2.20	10.26
1997		100%	1.94	11.83	32%	68%	1.94	12.99
1998		100%	1.40	13.54	34%	66%	1.40	15.12
1999		100%	2.14	13.53	33%	67%	2.14	15.45
2000		100%	1.52	14.94	34%	66%	1.52	17.17
2001		100%	1.64	15.17	45%	55%	1.64	17.61
2002		100%	2.24	14.24	45%	55%	2.24	16.85
2003		100%	2.26	13.88	50%	50%	2.26	16.60
2004		100%	1.68	14.06	49%	51%	1.68	16.89
2005		100%	2.93	12.50	50%	50%	2.93	15.45
2006		100%	2.93	12.19	50%	50%	2.93	15.23

2007		100%	3.44	11.45	47%	53%	3.44	14.58
2008		100%	3.03	11.72	55%	45%	3.03	14.58
2009	100%		1.90	12.29	100%		4.07	13.02
2010	100%		1.63	12.50	100%		3.80	12.92

8.2.7. Source-specific planned improvements

Historical data on waste generation per capita and distribution of waste by waste management type will be kept under investigation and updated when data available.

8.3. Wastewater Handling (CRF 6.B)

8.3.1. Source category description

Wastewater can be a source of CH_4 and N_2O when treated or disposed anaerobically, CO_2 emissions from wastewater treatment are not considered as greenhouse gases, for being biogenic origin. The most common wastewater treatment method in developed countries, including Estonia, is centralized aerobic wastewater treatment, that consists of primary, secondary, and tertiary treatment.

In Estonia (e.g. Paljassaare wastewater plant in Tallinn) domestic and industrial wastewater is treated as follows:

At first wastewater from households and commercial institutions is collected by drains to the main pumping station, where primary mechanical clearance takes place. After that the wastewater is canalized to the wastewater treatment plant, where physical barriers remove larger solids from water as well as greases, oils and sand. During the secondary treatment coagulants are added and settled organic particulates are removed. Tertiary/biological treatment includes biodegradation by microorganisms in aerobic environment, and activated sludge processes with effluent of phosphor and nitrogen. Biogas, diverged in anaerobic stabilization process of sludge, is reused to heat up the buildings situated in the plant's territory, and in several wastewater treatment processes. Purified water is led into the sea 3 km away from the coast with a pipeline reaching 26 m below sea level. The similar wastewater treatment is also used in other cities in Estonia.

Sludge treatment

The sludge separated in several processes of cleaning the wastewater, is treated as follows:

At first, the sludge is pumped to the sludge treatment plant, where it is fermented in the methane tanks and dehydrated in centrifuges. In the anaerobic process the significant amount of biogas (including plenty of methane) is emitted, which is reused by canalizing it back to the biological treatment section, or it is used as a fuel for heat generation.

The sludge dehydrated and mixed with supporting substances is either composted or landfilled. Composted sludge is used as a fertilizer. The CH_4 emissions from domestic and industrial sludge were not estimated as the amount of sludge was added to the total amount of waste transferred to the landfills.

The total amount of wastewater generated in 2011 was 1.9 billion m^3, out of which 1.5 billion m^3 was used as cooling water for the production of energy and therefore no water treatment was needed. 357.61 million m^3 of the total amount of wastewater generated needed treatment, the quantity of wastewater, which was actually treated, using mostly aerobic treatment, was about 357.18 million m^3. As seen from the Figure 8.8, the decrease has taken place in the amounts of wastewater treated in Estonia in 1990–2010, which is likely caused by decreased water consumption due to saving measures (water meters in households, water saving in technological processes) and as a result of large number of closed industries.

Wastewater generation by type and economic sectors in Estonia in 2011 is presented in Table 8.14 and Table 8.15.

Table 8.14. Wastewater generation by type, 1000 m^3

Year	Total	Cooling Water	Total wastewater, exp cooling water	Mining water	Sewage	Rainfall water
2011	1 933 015	1 530 364	402 651	264 012	116 920	21 625

Table 8.15. Wastewater generation by economic sectors in Estonia, 1000 m^3

Year	Energy	Cooling/industry	Other	Agriculture	Domestic	Industry
2011	7 069	1 530 267	5 522	4 150	46 572	29 727

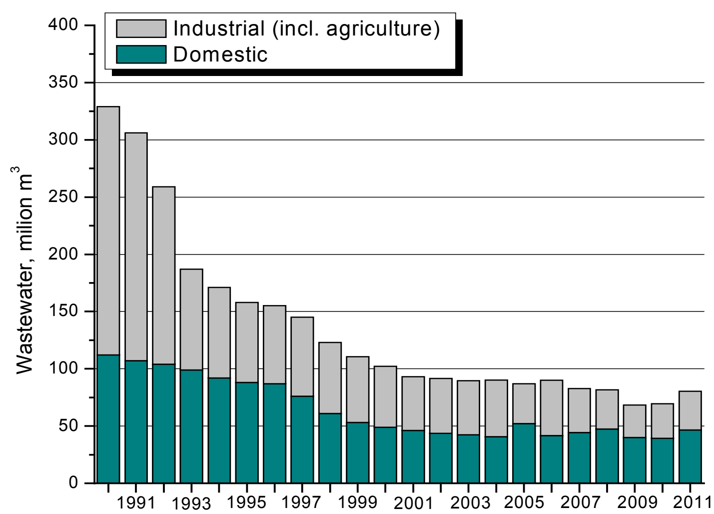

Figure 8.8. Amounts of wastewater treated in Estonia in 1990–2011, million m^3

8.3.2. Methodological issues

Activity data

The quantities of domestic and industrial wastewater generation and treatment were obtained from the datasets of the EEIC Water Bureau. The data on the population of Estonia and the amount of products produced (for equation 8.6) were derived from the SE. The amount of products produced has been used as activity data, when calculating CH_4 emissions from industrial wastewater handling. The data on the population of Estonia have been used for activity data of the CH_4 estimations from domestic/commercial wastewater handling.

Emission factors and other parameters

Emission factors and parameters for domestic/commercial and industrial wastewater are IPCC default values in accordance with method used in the estimations and are presented in Table 8.16.

Methodology

Estimating the emissions from domestic and industrial wastewater in anaerobic conditions, *Tier 1* method from IPCC 1996 was used. Due to country-specific parameters are not available, the IPCC *Tier 1* method and default parameters were used.

CH_4 Emissions= (TOW ● EF) – Methane Recovery (8.4)[181]

Domestic wastewater (CH_4):

$TOW_{dom} = P \bullet D_{dom}$ (8.5)[182]

TOW_{dom} - Total domestic/commercial organic wastewater in kg BOD/year;
P – Population in 1000 persons;
D_{dom} – Domestic/commercial degradable organic component in kg BOD/1000 persons/year.

Industrial wastewater (CH_4):

TOW_{ind} (kg COD/year) = $W \bullet O \bullet D_{ind} \bullet (1\text{-}DS_{ind})$ (8.6)[183]

TOW_{ind} – Total industrial organic wastewater in kg COD/year;
TOS_{ind} – Total industrial organic sludge in kg Cod/year;
W – Wastewater consumed in m^3/tonne of product;
O – Total output by selected industry in tonnes/year;
D_{ind} – Industrial degradable organic component in kg COD/m3 wastewater;
DS_{ind} – Fraction of industrial degradable organic component removed as sludge.

$EF_i = B_0 \bullet \sum (WS_{ix} \bullet MCF_x)$ (8.7)[184]

EF_i – emission factor (kg CH_4/kg DC) for wastewater type;
B_{0i} – maximum methane producing capacity (kg CH_4/kg DC) for wastewater type;
WS_{ix} – fraction of wastewater type i treated using wastewater handling system x;
MCF_x – methane conversion factors of each wastewater system x.

Estimating methane emission from domestic and commercial wastewater the selected emission factors are multiplied by the organic wastewater production, which resulted from multiplication of country's population and BOD value in domestic wastewater (D_{dom}).

Estimating methane emission from industrial wastewater, total industrial output (products in tonnes per year) was calculated based on the main industry types producing wastewater in Estonia (food/beverage, paper/pulp, paints, fertilizers, soap/detergents). As activity data for 1990–1994 was insufficient, total industrial output for years 1990–1994 was calculated based

[181] IPCC 1996, Waste, pp. 6.22, equation 12.
[182] IPCC 2000, Waste, pp. 5.18, equation 5.10.
[183] IPCC 1996, Waste. pp 6.19, equation 8.
[184] IPCC 1996, Waste. pp 6.21, equation 10.

on the wastewater output data derived from CRF Reporter and default Wastewater generation rates[185]. Multiplying total industrial output and default industrial wastewater data (GPG 2000, pp 5.22, Table 5.4) total organic wastewater from specific industrial source was found. Net methane emission from industrial wastewater handling was calculated based on the default emission factors and quantities of total organic wastewater derived from industrial source.

Table 8.16. Emission factors and parameters used in the calculations of 'Wastewater handling'

Domestic Wastewater (CH4)	**Value**	**Reference**
Bo (kg CH_4/kg BOD)	0.25	IPCC 1996, Waste. pp 6.20
Ddom (kg BOD/1000per/yr)	18 250	IPCC 1996, Waste, pp 6.23
MCF	0.6	Estonian NIR 2006, Waste, Table 6.14, 6.15
WS	variable	Estonian NIR 2006,Table 6.14
Industrial Wastewater (CH4)		
Bo (kg CH_4/kg COD)	0.25	IPCC 1996, Waste. pp 6.20
COD (kgCOD/m^3)	variable	IPCC 2000, Waste, pp 5.22
W (m^3/tonne of product)	variable	IPCC 2000, Waste, pp 5.22
MCF	0.6	Estonian NIR 2006, Waste, Table 6.14, 6.15
WS	variable	Estonian NIR 2004, Waste, Table 6.15

8.3.3. Quantitative overview – CH_4 and N_2O emissions from domestic/ commercial (w/o human sewage) and industrial wastewater handling

In 2011 the total amount of CH_4 emission from domestic and commercial wastewater handling was 0.0367 Gg (Figure 8.9). So far, the quantity of CH_4 emission has been the highest in 1993, as the amount of wastewater treated by the anaerobic handling system was the greatest. As seen from the figure, the trend of CH_4 emission from domestic and commercial wastewater has stabilized since 2004 because the fraction of the anaerobic treatment in wastewater handling system has decreased, as wastewater is mostly treated using aerobic treatment.

[185] IPCC 2000. Waste. Table 5.4, pp 5.22.

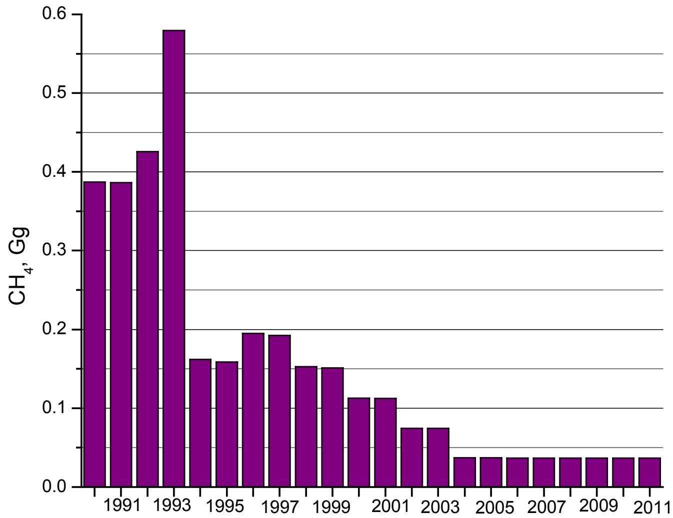

Figure 8.9. CH_4 emissions from domestic/commercial wastewater handling in 1990–2011, Gg

In 2011 the total amount of CH_4 emission from industrial wastewater handling was 0.248 Gg (Figure 8.10). As seen from the figure in period 1990–1993 quantities of CH_4 emissions decreased, which is due to the collapse of The Soviet Union market, that caused Estonia's pulp and paper industry breakdown and a large number of closed industries (in 1991 Maardu chemical combine stop working). The increase in the quantities of methane emissions from industrial wastewater in the period 1995–2000 is related to the rise in the production output of pulp and paper industries and the upsurge of the fraction of wastewater treated by the anaerobical handling system.

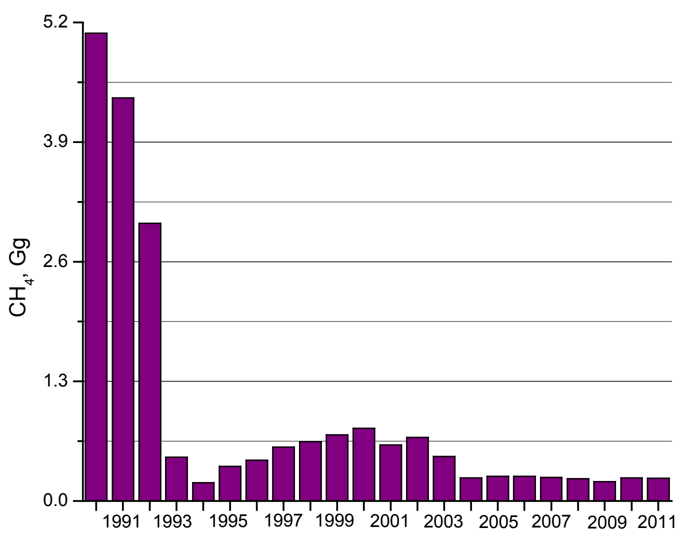

Figure 8.10. CH_4 emissions from industrial wastewater handling in 1990–2011, Gg

8.3.4. Uncertainties and time series consistency

The estimation of CH_4 emissions from wastewater handling is carried out taking into account activity data (industrial production, human population) and emission factors. Default uncertainty ranges for domestic and industrial wastewater are presented in Table 8.17[186].

Table 8.17. Default uncertainty ranges for 'Wastewater handling'

Input	Uncertainties	Reference
Domestic wastewater (CH_4)		
Human Population	±5%	IPCC GPG 2000, pp 5.19, table 5.3
BOD/person	±30%	IPCC GPG 2000, pp 5.19, table 5.3
Maximum Methane Producing Capacity (B_o)	±30%	IPCC GPG 2000, pp 5.19, table 5.3
Industrial wastewater (CH_4)		
Industrial Production	±25	IPCC GPG 2000, pp 5.23, table 5.5
Wastewater /unit production COD/unit wastewater	-50%, +100%	IPCC GPG 2000, pp 5.23, table 5.5
Maximum Methane Producing Capacity (B_o)	±30%	IPCC GPG 2000, pp 5.23, table 5.5

8.3.5. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Waste sector according to IPCC *Tier 1* method. The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.

8.3.6. Source-specific recalculations

Under industrial wastewater handling CH_4 emission in 2010 was recalculated due to update in activity data of production output in databases of Estonian Statistics in 2012 (Table 8.18).

Table 8.18. Total industrial output and CH_4 emissions from industrial wastewater handling in 2010

Industry type	Total industrial output (t/year) (2012 Submission)	Reported emissions of CH_4 in 2010, Gg (2012 Submission)	Total industrial output (t/year) (2013 Submission)	Recalculated emissions of CH_4 in 2010,Gg (2013 Submission)
Soap/detergents	9 300	0.250	9 000	0.249
Food/beverage	1 186 485		1 183 355	

[186] Although IPCC 1996 Guidelines are used to calculate CH_4 emissions, IPCC GPG values for uncertainties are used, as in 1996 Guidelines the uncertainties are unavailable.

Under domestic and commercial wastewater handling N_2O emissions were removed. During the in-country review in 2012 it was noted that, firstly, it is not recommended to use 2006 IPCC Guidelines without reasonable explanation when there is method also available in 1996 Guidelines. Secondly, corresponding N_2O emissions are already reported under 6.B.2.2 Human sewage category (using 1996 Guidelines), which lead to double estimation of emissions. Thus, in order to be in accordance with IPCC Guidelines and to avoid double-counting of emissions, N_2O emissions under domestic and commercial wastewater treatment were discounted from the inventory[187].

8.3.7. Source-specific planned improvements

The activity data is kept under consideration and will be updated necessarily.

8.4. N_2O emission from human consumption followed by municipal sewage treatment (CRF 6.B.2.2)

8.4.1. 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 underground systems, be disposed or spread directly on land, or be discharged into a water source e.g. rivers and estuaries (IPCC 2000).

8.4.2. Methodological issues

Activity data

The data on population of Estonia was used as activity data and obtained from the dataset of the SE. The annual per capita protein consumption was used from FAO statistical databases and was updated for whole time series in 2013 Submission as the recommendation by the ERT 2012.

Methodology

The default IPCC (the *Tier 1*) method was used to estimate emissions from the atmospheric deposition. Due to country-specific EF values are not available, the IPCC *Tier 1* method and mix of country-specific (the national population) and other available data (protein consumption) and default EF was used.

$$N_2O - N = [(PROTEIN \bullet Nr_{PEOLPE} \bullet Frac_{NPR}) - Nsewsludge] \bullet EF_6 \qquad (8.10)$$ [188]

PROTEIN – the annual per capita protein consumption, kg protein/person/year;
Nr_{PEOLPE} – the national population;
$Frac_{NPR}$ – the fraction of protein that is nitrogen, kg N/kg of protein.

Emission factors

Emission factors used in the calculations are default emission factors from IPCC 1996 and IPCC 2000 Agriculture chapter.

[187] N_2O emissions were discounted as the recommendation by the ERT 2012.
[188] IPCC 2000. Agriculture. Equation 4.40, pp. 4.72.

Table 8.19. Factors used in the algorithm of human consumption followed by municipal sewage treatment

Factor	Value
$Frac_{NPR}$ EF_6	0.16 kg N/kg of protein[189] 0.01 kg N_2O-N/ kg N discharged sewage effluent[190]

8.4.3. Quantitative overview – Human consumption followed by municipal sewage treatment

The total N_2O emission from human sewage in Estonia in 2011 was 0.111 Gg (Figure 8.11). Emissions have been slightly declining during the whole time series, due to decreasing population. In addition, minor fluctuations in time series are related to changes in per capita protein consumption' values.

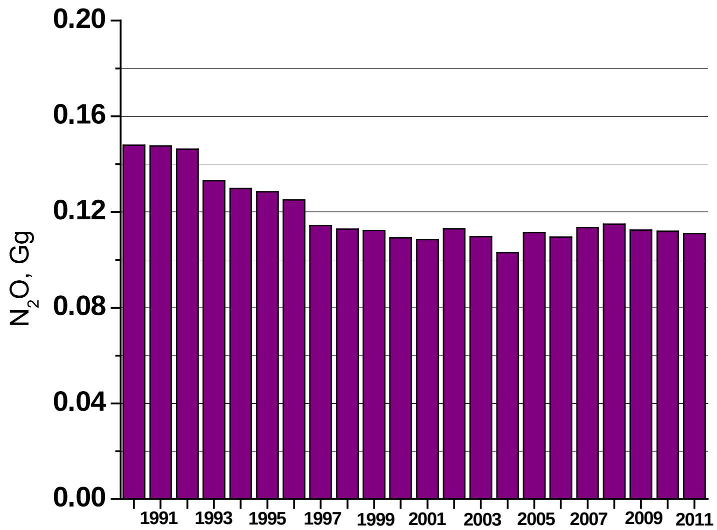

Figure 8.11. N_2O emissions from human sewage in Estonia in 1990–2011, Gg

8.4.4. Uncertainty and time series consistency

The data on protein consumption per capita was plotted from FAO databases; the uncertainty of this parameter is not recorded. The uncertainty of population was described in the Domestic and Commercial Wastewater chapter.

The nitrogen (N_2O) emission factor is presented in Revised 1996 IPCC Guidelines, which gives an uncertainty of the factor –80%…100%, as a value of the factor is 0.01 with a range of 0.002-0.02.

[189] IPCC 1996. Agriculture. Reference manual. Table 4-24 – Default values of parameters for indirect emissions. pp. 4.106.
[190] IPCC 1996. Agriculture. Reference Manual. Table 4-23 – Default emission factors for indirect emissions. pp. 4.105.

The combined uncertainty rates related to human sewage sub-category are reported in Chapter 8.1.4.

Table 8.20. Default uncertainty ranges for 'Human Consumption'

Input	Uncertainties	Reference
Activity data		
Population	±5%	IPCC, 2000. Waste, pp. 5.19
Emission factor		
Emission factor (human sewage)	-80%…100%	IPCC 1996. Agriculture, pp 4.105

8.4.5. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Waste sector according to IPCC *Tier 1* method. The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.

8.4.6. Source-specific recalculations

N_2O emissions from human sewage were recalculated for whole time series due to change in methodology, quantity of N in sludge was deducted from total protein consumption referring to double counting, as N in sludge is already used in calculations under Agriculture sector. Also protein consumption from FAO databases was revised (Table 8.21).

Table 8.21. N_2O emissions from human consumption in 1990–2010 in Estonia, Gg

Year	Protein consumption (kg/per/yr) 2012 Submission	N_2O emission (Gg) in 2012 Submission	Updated per capita protein consumption (kg/per/yr) 2013 Submission	Nitrogen in sludge, kg	Recalculated N_2O emission (Gg) in 2013 Submission
1990	35.405	0.140	37.588	36 427.66	0.148
1991	35.405	0.140	37.588	38 344.90	0.148
1992	35.405	0.138	37.588	40 363.05	0.146
1993	35.405	0.135	35.186	44 497.89	0.133
1994	35.405	0.131	35.259	70 099.40	0.130
1995	34.675	0.126	35.843	132 658.93	0.128
1996	34.675	0.124	35.539	147 199.51	0.125
1997	34.675	0.123	32.960	147 134.75	0.114
1998	34.675	0.121	32.485	62 345.91	0.113
1999	34.675	0.120	32.777	84 779.80	0.112
2000	32.485	0.112	32.208	129 796.59	0.109
2001	32.485	0.112	31.609	13 574.47	0.108
2002	32.485	0.111	33.252	55 784.05	0.113
2003	32.485	0.111	32.376	48 015.10	0.110
2004	32.485	0.110	30.341	5 020.71	0.103
2005	33.215	0.113	33.033	34 259.78	0.111
2006	33.215	0.112	32.668	60 197.19	0.110

2007	33.215	0.112	33.726	22 011.78	0.113
2008	33.215	0.112	34.514	92 845.20	0.115
2009	33.215	0.112	33.690	74 423.65	0.112
2010	33.215	0.112	33.690	102 129.62	0.112

8.4.7. Source-specific planned improvements

The activity data is kept under consideration and will be updated necessarily.

8.5. Waste Incineration (CRF 6.C)

8.5.1. Source category description

Waste incineration is defined as a high temperature combustion of solid and liquid waste in controlled incineration facilities. Types of waste incinerated include municipal solid waste, industrial waste, sewage sludge, and hazardous and clinical waste. Relevant greenhouse gases emitted in the processes of incineration and open burning of waste include carbon dioxide, methane and nitrous oxide. In this chapter emissions of CO_2 and N_2O are covered.

In Estonia there are several enterprises, where waste incineration system is used to generate fuel and energy to keep equipment in work. Mostly hazardous wastes e.g solvents, paint and petroleum, are burnt in “Kunda Nordic Tsement AS” factory, which produces constructional cements and crused limestone, and factory of constructional materials “Maxit Estonia” in Pärnu County. Also one of the Estonians biggest hazardous wastes handling company “Epler & Lorenz AS” has a waste incineration system with a purpose to incinerate hazardous waste.

According to Estonian National Waste Management Plan for years’ 2008–2013 one possible scenario to improve waste management system points out the idea that extra two waste incineration plants should be planned with a purpose to generate heat and energy, and reduce the amount of municipal wastes deposited on to landfills.

8.5.2. Methodological issues

Activity data

Under Waste Sector emissions from waste incineration without energy recovery are reported. The activity data on amounts of waste incinerated is collected and reported by the EEIC. The data on 1990–1994 was interpolated based on rough assumptions.

In 2011 the quantity of waste from waste incineration without energy recovery did not occurre as all wastes were combusted to generate fuel or energy (Table 8.22). As waste incineration with energy recovery is part of the energy sector, the data and emissions are reported under the energy sector.

Table 8.22. Amounts of waste incinerated without energy recovery in Estonia in 1990–2011, tonnes[191]

Year	Inert waste	Leather and Rubber	Municipal Waste	Petroleum-products and Oils	Organic Waste	Paper	Plastic	Sludge	Textiles	Wood	Clinical	Total
1990[192]	41	6	12	165	27	117	10	1	22	0	2	402
1991	41	6	12	164	27	117	10	1	22	0	2	401
1992	41	6	12	163	27	117	10	1	22	0	2	401
1993	41	6	12	164	27	117	10	1	22	0	2	402
1994	41	6	12	167	27	117	10	1	22	0	2	404
1995	41	15	23	292	15	389	5	2	61	0	5	847
1996		2	14	149	24	35	4		25	0	2	253
1997		4	2	90	55	40	12		2	0	1	206
1998	41	5	8	135	14	7	19		0	90		319
1999	122			145		16	10			4 643	3	4 940
2000	466		3	2	41	2	5			815	6	1 341
2001	436			2	482	19		13		3	7	961
2002	125			124	15	10			135	272	15	696
2003	86			203	3	3		1	130	122	19	566
2004	87			52	1	2			321		19	481
2005	63			106	0	2			176	10	9	366
2006					0				40		1	41
2007									14	7		21
2008												
2009						2						2
2010						3				18		21
2011												

[191] D10 operation of the waste disposal activities – Incineration on land.
[192] The data of 1990–1994 was interpolated.

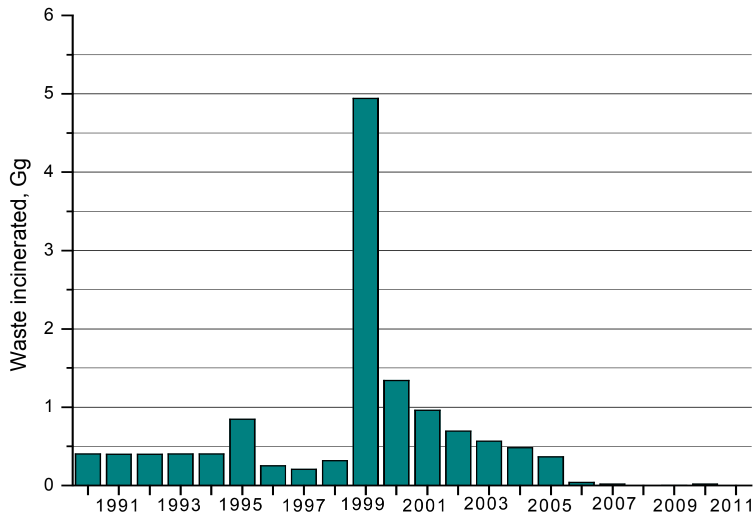

Figure 8.12. Amounts of waste incinerated without energy recovery in Estonia in 1990–2011, Gg

As seen from the previous figure there has been a sharp increase in the amounts of waste incinerated in 1995 and 1999–2000. The remarkable fluctuation of quantities is due to large amounts of waste from paper, wood, inert, petroleum-products and oils were incinerated in these years. Generally the trend of waste incineration has decreased through the years since 2000 and has reached 21 tonnes in 2010, as more and more waste is recycled, composted or incinerated with the purpose to generate energy and the amount of waste appropriate for combustion without energy recovery is therefore minimized. In 2008 and 2011 no wastes were incinerated without energy recovery.

Methods

IPCC 2006 Tier 1 approach was employed in order to estimate CO_2 emissions from solid waste burnt in controlled incineration facilities (IPCC, 2006)[193]. CO_2 emission estimate bases on the total amount of waste combusted. Due to emission factors are IPCC default values, *Tier 1* method was used.

$$CO_2 \text{ emissions, Gg/year} = \sum_i (SW_i \bullet dm_i \bullet CF_i \bullet FCF_i \bullet OF_i) \bullet 44/12 \qquad (8.11)$$[194]

CO_2 emissions - CO_2 emissions in inventory year ,Gg/year;
SW_i – total amount of solid waste of type *i* (wet weight) incinerated, Gg/year;
dm_i – dry matter content in waste (wet weight) incinerated, (fraction);
CF_i – fraction of carbon in the dry matter (total carbon content), (fraction);
FCF_i – fraction of fossil carbon in the total carbon, (fraction);
OF_i – oxidation factor (fraction);
type of waste incinerated specified as follows:
    MSW: municipal solid waste
    ISW: industrial solid waste

[193] IPCC 2006 Guidelines was used instead of IPCC 1996 and 2000, as more detailed emission factors were available according to waste types.
[194] IPCC 2006, Waste. Chapter 5, pp. 5.7, equation 5.1.

SS: sewage sludge
HW: hazardous waste
CW: clinical waste

Emission factors

Emission factors (EFs) used in calculations of emissions from waste incineration are default emission factors from *IPCC 2006 Guidelines for National Greenhouse Gas Inventories* (Table 8.23).

Table 8.23. Default dry matter content, total carbon content and fossil carbon content of different waste components[195],[196],[197]

Waste component	Dry matter content in % of wet weight	Total carbon content in % of dry matter	Fossil carbon fraction in % of total carbon
Municipal waste			
Paper/cardboard	90	46	1
Textiles	80	50	20
Food waste	40	38	-
Wood	85	50	-
Garden and park waste	40	49	0
Rubber and Leather	84	67	20
Plastics	100	75	100
Other, inert waste	90	3	100
Industrial waste			
Food, beverages and tobacco	40	15	-
Textile	80	40	16
Wood and wood products	85	43	-
Pulp and paper	90	41	1
Petroleum products, Solvents	0	80	80
Plastics	0	80	80
Rubber	84	56	17
Hazardous waste	10-90	NA	5-50
Clinical waste	65	40	25

In order to estimate N_2O emissions from solid waste burnt in controlled facilities *Tier 1* approach was employed (IPCC, 2006)[198]. N_2O emission estimate bases on the waste input to the incineration. Due to emission factors are IPCC default values, *Tier 1* method was used.

[195] Table 2.4 of the 2006 IPCC Guidelines, pp. 2.14.
[196] Table 2.5 of the 2006 IPCC Guidelines, pp. 2.16.
[197] Table 2.6 of the 2006 IPCC Guidelines, pp. 2.16.
[198] IPCC 2006 Guidelines was used instead of IPCC 1996 and 2000, as more detailed emission factors were available according to waste types

N_2O emissions, Gg/year = $\sum_i (IW_i \bullet EF_i) \bullet 10^{-6}$	(8.12)[199]

N_2O emissions - N_2O emissions in inventory year, Gg/year;
IW_i – amount of incinerated waste of type *i*, Gg/year;
EF_i – N_2O emission factor for waste of type *i*, kg N_2O/Gg of waste;
10^{-6} – conversion to gigagram;
i – category or type of waste incinerated specified as follows:

MSW: municipal solid waste
ISW: industrial solid waste
SS: sewage sludge
HW: hazardous waste
CW: clinical waste, others (that must be specified)

Emission factors

Emission factors (EFs) used in calculations of emissions from waste incineration are default emission factors from *IPCC 2000 Good Practice Guidance* and *IPCC 2006 Guidelines for National Greenhouse Gas Inventories* (Table 8.24).

Table 8.24. N_2O emission factors used in calculations of 'Waste Incineration'[200]

Waste category	Emission factor g N_2O/t waste incinerated	Weight basis
MSW	8[201]	Wet basis
Industrial waste	100	Wet basis
Sludge (except sewage sludge)	450	Wet basis
Sewage sludge	900	Wet basis

8.5.3. Quantitative overview - CO_2 and N_2O emissions from solid waste incineration

In 2011 no CO_2 and N_2O emissions emitted from solid waste incineration without energy recovery, as all wastes were burnt with a purpose to generate energy, emissions from waste incineration with energy recovery are reported under energy sector (Figure 8.13).

CO_2 emissions from combustion of biomass materials (e.g., paper, food waste, wood) contained in the waste are biogenic emissions and should not be included in national total emission estimates, but reported as an informational item under Waste Sector. CO_2 emissions from oxidation during incineration of carbon in waste of fossil origin (e.g., plastics, rubber, liquid solvents, waste oils) are considered net emissions and are reported under Waste sector (Figure 8.13)[202]. As seen from the figure below CO_2 emissions from non-biogenic origin have been larger than emissions derived from biomass materials since 1990 to 2001 and been highest in 1998 and 2000. The rise in the emissions in these years is caused by incineration of plastic, rubber and inert wastes. Since 2001 the proportion of non-biogenic emissions has decreased because wastes are rather incinerated to generate energy. CO_2 emissions from biogenic origin are fluctuating during the whole period, the rise in the emissions in 1995 is due to combustion of textile wastes, the minor emissions in 1998–2001 are related to the very

[199] IPCC 2006, Chapter 5, pp. 5.14, equation 5.5.
[200] Table 5.5 and 5.6 of the 2006 IPCC Guidelines, Chapter 5, pp. 5.21, 5.22.
[201] An experience of Germany.
[202] 2006 IPCC, Chapter 5, Waste, pp 5.5.

small quantities of paper combustion. Since 2002 biogenic emissions have increased as considerable amounts of textile wastes were incinerated. Since 2007 no non-biogenic waste have been burned, so no CO_2 emissions occurred, also emissions form biogenic materials have been negligible in last years (Figure 8.13).

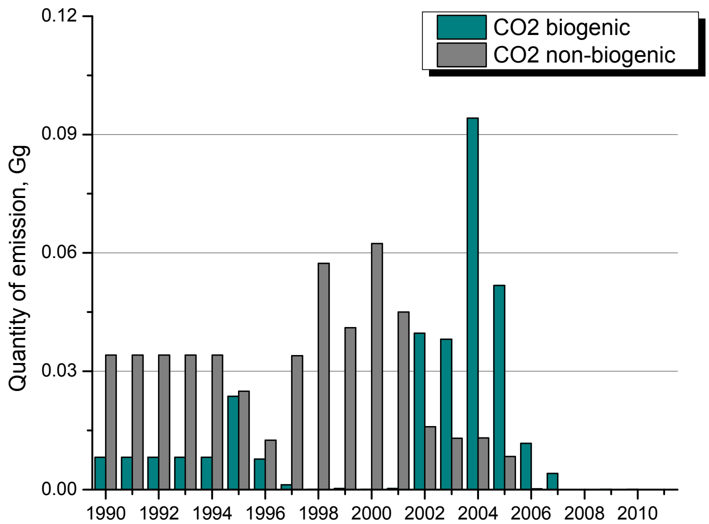

Figure 8.13. CO_2 emissions from waste incineration without energy recovery in Estonia in 1990–2011, Gg

N_2O emissions from waste combustion have been minor in 1990–1998. Considerable rises in the emissions from non-biogenic wastes have occurred in 1999–2001, when clinical, plastic and inert wastes were incinerated. Since 2001 the proportion of non-biogenic emissions has decreased because wastes are rather incinerated to generate energy. N_2O emissions from biogenic materials have been marginal in 1996–1998, but then in 1999–2001 remarkable amounts of wood and organic wastes were incinerated. Since 2002 to 2005 emissions from incineration of organic materials have decreased, some emissions occurred from incineration of textile, organic and paper wastes. After 2006 biogenic N_2O emissions are negligible and only minor amounts of paper, wood or textile waste have been burned as mostly it is focused to burn wastes with energy recovery (Figure 8.14).

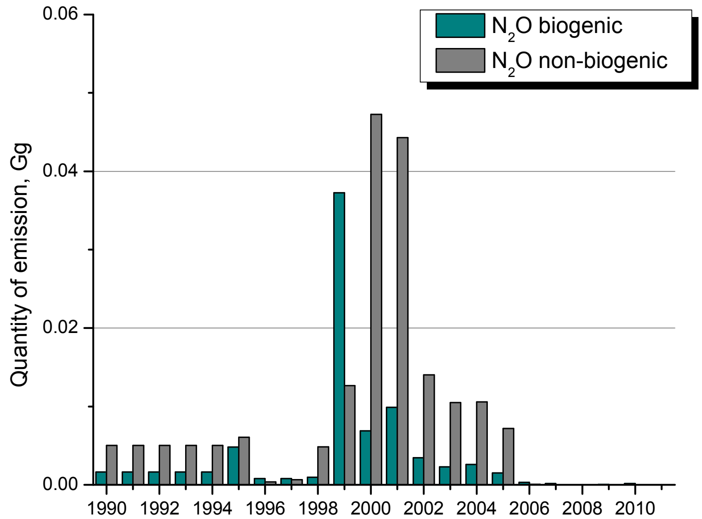

Figure 8.14. N_2O emissions from waste incineration without energy recovery in Estonia in 1990–2011, Gg

8.5.4. Uncertainties and time series consistency

The estimation of GHG emissions from waste incineration is carried out taking into account the activity data (amount of waste burnt) and emission factors. Uncertainties of default emission factors and activity data used in the estimations are derived accordingly to methodology from 2006 IPCC Guidelines. Values employed in the estimates are presented in Table 8.25.

The combined uncertainty rates related to waste incineration sub-category are reported in Chapter 8.1.4.

Table 8.25. Default uncertainty ranges for 'Waste Incineration'

Input	Uncertainties	Reference
Activity data		
Amounts of waste incinerated	±5%	IPCC 2006, Waste, pp. 5.24
Emission Factors		
Total carbon content		
Paper/cardboard	±9%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Textiles	-50%…0%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Food waste	-47%…+32%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Wood	±8%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Garden and park waste	-8%…+8%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Plastics	-11%…+13%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Other, inert waste	-100%…+30%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Hazardous waste	±82%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Fossil carbon fraction		
Paper/cardboard	-100%…+400%	IPCC 2006, Waste, Table 2.4, pp. 2.14

Textiles	-100%…+150%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Plastics	-5%…0%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Other, inert waste	-50%…0%	IPCC 2006, Waste, Table 2.4, pp. 2.14
Hazardous waste	±82%	IPCC 2006, Waste, Table 2.4, pp. 2.14

8.5.5. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Waste sector according to IPCC *Tier 1* method. The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.

8.5.6. Source-specific recalculations

In earlier submissions CO_2 emissions derived from waste incineration without energy recovery were reported as biogenic (derived from biomass materials, e.g., paper and food) and therefore were not counted in total GHG net emissions from waste sector, but added in the inventory as an informational item. During the in-country review in 2012 in Estonia it was clarified that part of these emissions are actually non-biogenic (derived from incineration of plastic, rubber, clinical waste etc) and should be reported separately and considered as net emissions. CO_2 emissions from incineration of non-biogenic materials were separated from the emissions derived from total amount of waste incinerated and reported as apart. The same was done with N_2O emissions, only without any changes in net emissions. No method or activity data was changed, CO_2 and N_2O emissions were separated based on biogenic or non-biogenic origin according to the activity data used in the estimations (Table 8.26)[203].

Table 8.26. CO_2 and N_2O emissions from waste incineration in 1990–2010

	In 2012 Submission		In 2013 Submission		In 2013 Submission	
	Considered as biogenic	Considered as biogenic	Considered as biogenic	Considered as non-biogenic	Considered as biogenic	Considered as non-biogenic
Year	CO_2, Gg	N_2O, Gg	CO_2, Gg	CO_2, Gg	N_2O, Gg	N_2O, Gg
1990	0.0423	0.0066	0.0082	0.03412	0.0016	0.0050
1991	0.0423	0.0066	0.0082	0.03412	0.0016	0.0050
1992	0.0423	0.0066	0.0082	0.03412	0.0016	0.0050
1993	0.0423	0.0066	0.0082	0.03412	0.0016	0.0050
1994	0.0423	0.0066	0.0082	0.03412	0.0016	0.0050
1995	0.0486	0.0109	0.0237	0.02492	0.0048	0.0061
1996	0.0203	0.0012	0.0078	0.01255	0.0008	0.0004
1997	0.0352	0.0014	0.0012	0.03398	0.0008	0.0007
1998	0.0574	0.0058	0.0001	0.05732	0.0009	0.0048
1999	0.0413	0.0499	0.0002	0.04104	0.0373	0.0126
2000	0.0624	0.0541	0.00004	0.06241	0.0069	0.0473
2001	0.0453	0.0542	0.0003	0.045	0.0099	0.0443
2002	0.0556	0.0175	0.0396	0.01596	0.0035	0.0140
2003	0.0511	0.0128	0.0381	0.01303	0.0023	0.0105
2004	0.1072	0.0132	0.0942	0.01309	0.0026	0.0106

[203] CO_2 emissions were recalculated as the recommendation by the ERT 2012.

2005	0.0601	0.0087	0.0517	0.00838	0.0015	0.0072
2006	0.0119	0.0004	0.0117	0.00019	0.0003	0.0001
2007	0.0041	0.0002	0.0041	NO	0.0002	NO
2008	NO	NO	NO	NO	NO	NO
2009	0.00004	0.0000	0.00004	NO	0.00002	NO
2010	0.00005	0.0002	0.00005	NO	0.0002	NO

8.5.7. Source-specific planned improvements

The activity data is kept under consideration and will be updated necessarily.

8.6. Biological Treatment (Composting) (CRF 6.D)

8.6.1. Source category description

Many advantages apply to biological treatment, like reduced volume in the waste material, stabilization of the waste, destruction of waste material and production of biogas for energy use. Composting of solid organic wastes, such as food waste, garden and park waste and sludge is an aerobic process with bacteria, where the large fraction of degradable organic carbon (DOC) in the waste material is converted into carbon dioxide. As CO_2 is formed during the aerobic conditions of composting with an inflow of oxygen, the emissions are not calculated because of originating from a biogenic source. CH_4 is formed in anaerobic sections of compost, but it is also oxidized to a large extent in the aerobic sections of the compost. The process of composting can also produce emissions of N_2O. In the current chapter the emissions of CH_4 and N_2O are covered.

8.6.2. Methodological issues

Activity data

The quantities of waste composted in 2011 are used as activity data. The data is provided by EEIC. In 2011 542 693 tonnes of wastes were treated biologically (composted) in Estonia; it made up 5.8% of the total amount of waste disposed. Compared to the year 2010 the amount of wastes composted has significantly decreased, as there is a sharp downfall in amounts of organic and sludge waste composted. According to the 2011 database of EEIC fluctuation in quantities of organic waste is related to minor generation of animal tissues that were landfilled instead of biological recycling and secondly, waste from dairy product industries (whey) was not generated and therefore biologically recycled (Table 8.27)[204]. Quantities of sludge in 2011 were affected by the recovery activities of municipal sludge: in 2010 the proportion of sludge composted and sludge used on agricultural soils was accordingly 77% and 23%, in 2011 sludge used in composting made up 50%, sludge used in agricultural soils 43% and 7% of the total amount of sludge recovered comprised recovering under R5 activity (recycling inorganic substances).

Inert and petroleum product wastes consist of oils and stone, waste from the oil shale industry, and plastic waste were not taken into account in the estimates of emissions from waste composting processes.

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[204] Changes in legislation – animal by-products are regulated since 2011 with EC Regulation 1069/2009 and collected by the VTA (Vetenary and Food Board).

Table 8.27. Amounts of waste used for composting in Estonia in 1990–2011, tonnes[205]

Year	Leather and Rubber	Municipal Waste	Organic Waste	Paper	Sludge	Textiles	Wood	Total
1990	n.d.[206]	n.d.	3 751	364	127	144	2 753	7 139
1991	n.d.	n.d.	3 948	383	127	144	2 898	7 501
1992	n.d.	n.d.	4 156	404	127	144	3 050	7 881
1993	n.d.	n.d.	4 375	425	127	144	3 211	8 282
1994	n.d.	n.d.	4 605	447	127	144	3 380	8 703
1995	1	1	4 847	471	127	366	3 558	9 371
1996	3		30 481	846		59	133	31 523
1997	11		62 341	890	102	72	1 993	65 409
1998	61		4 340	565	78	80	1 494	6 618
1999			6 226	600	220	319	3 480	10 845
2000			22 073	830	120	419	3 277	26 719
2001			20 241	775	12 168		2 498	35 682
2002			20 992	694	6 104	54	71 109	98 952
2003		84	130 504	2 988	35 904	83	128 339	297 903
2004		3 752	110 599	3 657	55 062	344	229 993	403 407
2005		1 210	184 907	5 032	68 527	52	220 197	479 924
2006		54	176 229	6 564	84 575	109	402 866	670 398
2007			141 036	5 882	157 522	29	465 184	769 653
2008		2 207	222 052	4 950	131 472	12	324 598	685 291
2009		10 172	206 961	2 226	144 666		303 696	667 721
2010		10 141	180 855	3 917	146 718		454 174	795 806
2011		25 180	35 882	6 120	94 834		380 677	542 693

[205] The data of 1990–1995 were interpolated based on rough assumptions made.
[206] n.d not determined.

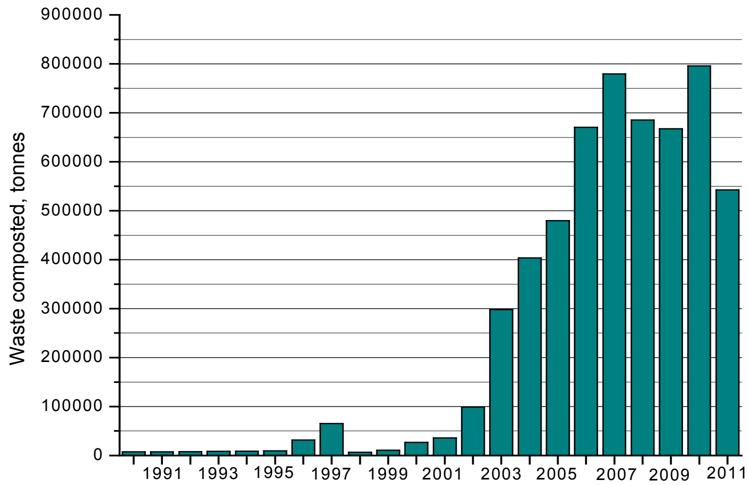

Figure 8.15. Amounts of organic waste used in biological treatment in Estonia in 1990–2011, tonnes

As seen from the previous figure (Figure 8.15) the amounts of organic waste used in biological treatment have been marginal in the first decade of the period and started to grow rapidly since 2000 and have increased about hundred fold – from 7 139 tonnes in 1990 to 542 693 tonnes in 2011. The increase in 1996–1997 is caused by large quantities of wastes from manures reported under composting activities. The volume of wastes for composting have enlarged significantly in recent years due to obligations stated with Waste Act in 2004[207], where percentage limitation of quantities of organic wastes disposed in landfills is enacted by time periods.

Methods

In order to estimate emissions from biological treatment of solid waste *Tier 1* approach was used (IPCC, 2006)[208], due to emission factors are IPCC default values.

$$CH_4, Gg = \sum_i (M_i \bullet EF_i) \bullet 10^{-3} - R \qquad (8.13)$$ [209]

CH_4 emissions – total CH_4 emissions in inventory year, Gg CH_4;
M_i – mass of organic waste treated by biological treatment type *i*, Gg;
EF – emission factor for treatment *i*, g CH_4/kg waste treated;
R – total amount of CH_4 recovered in inventory year, Gg CH_4;
i – composting or anaerobic digestion.

$$N_2O, Gg = \sum_i (M_i \bullet EF_i) \bullet 10^{-3} \qquad (8.14)$$ [210]

N_2O emissions – total N_2O emissions in inventory year, Gg N_2O;
M_i – mass of organic waste treated by biological treatment type *i*, Gg;
EF – emission factor for treatment i, g N_2O/kg waste treated;
i– composting or anaerobic digestion.

207 Estonian Waste Act.
208 IPCC 2006 Guidelines is used, as no method available in earlier guidelines.
209 IPCC 2006, Chapter 4, equation 4.1, pp. 4.5.
210 IPCC 2006, Chapter 4, equation 4.2, pp. 4.5.

Emission factors

Emission factors (EFs) used in calculations of emissions from biological treatment of wastes are default emission factors from *IPCC 2006 Guidelines for National Greenhouse Gas Inventories* (Table 8.28).

Table 8.28. Default emission factors from 'Biological treatment'[211]

Type of biological treatment	CH_4 emission factor (g CH_4/kg waste treated)	N_2O emission factor (g N_2O/kg waste treated)
Composting	4	0.3

8.6.3. Quantitative overview - CH_4 and N_2O emissions from biological treatment of waste

In 2011 the total N_2O emission from biological treatment of waste was 0.16 Gg and CH_4 emission 2.17 Gg. (Figure 8.16). As seen from the figure the emissions of CH_4 and N_2O follow the same trend as the amount of waste biologically treated changes. The sharp upturns in the quantities of CH_4 emissions since 2002 are related to the large amounts of wood, sludge and organic waste composting in these years. In 2008 and 2009 CH_4 and N_2O emissions have decreased due to reduction in consumption. The emissions have been highest in 2010 affected by the amount of wood waste treated biologically, sharp downfall in 2011 is related to the total amount of waste biologically recycled which has significantly decreased compared to previous years.

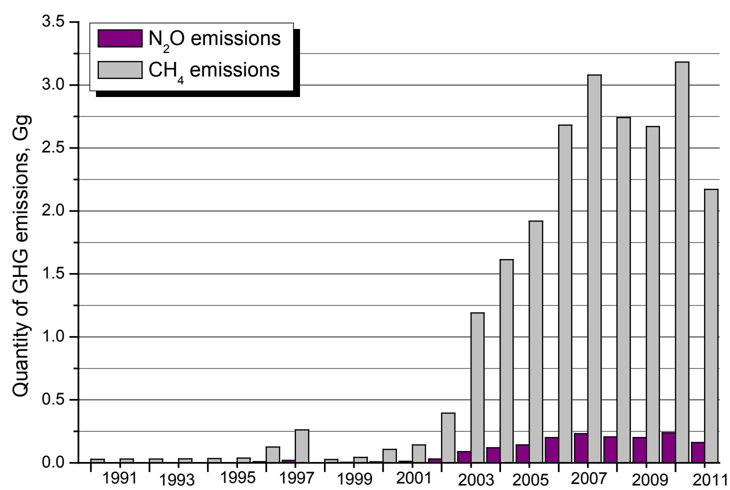

Figure 8.16. CH_4 and N_2O emissions from biological treatment in Estonia in 1990–2011, Gg

[211] IPCC 2006, Chapter 4, Table 4.1, pp. 4.6, on a wet basis.

8.6.4. Uncertainties and time series consistency

The estimation of GHG emissions from biological waste treatment is carried out taking into account activity data (quantities of waste composted) and emission factors. Uncertainties of default emission factors and activity data used in the estimations are derived accordingly to methodology from 2006 IPCC Guidelines. Values employed in the estimates are presented in Table 8.29.

The combined uncertainty rates related to biological treatment sub-category are reported in Chapter 8.1.4.

Table 8.29. Default uncertainty ranges for 'Biological Treatment'

Input	**Value**	**Reference**
Activity data		
Managed waste disposal	±10%	2006 IPCC, Waste, Table 3.5 pp. 3.27
Emission Factor		
CH_4	-99%...+100%	2006 IPCC, Waste, Chapter 4, pp. 4.6
N_2O	-80%...+100%	2006 IPCC, Waste, Chapter 4, pp. 4.6

8.6.5. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Waste sector according to IPCC *Tier 1* method. The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.

8.6.6. Source-specific recalculations

CH_4 and N_2O emissions from biological treatment category were recalculated for years 2007–2010 due to update in amounts of biological waste recovered under R3 recovery activity.

Table 8.30. CH_4 and N_2O emissions from biological treatment of waste in 2007–2010, Gg

Year	**Amounts of waste composted in 2012 Submission**	**Emissions reported in 2012 Submission, Gg**		**Amounts of waste composted in 2013 Submission**	**Emissions reported in 2013 Submission, Gg**	
	tonnes	CH_4	N_2O	tonnes	CH_4	N_2O
2007	779 813	3.12	0.234	769 653	3.08	0.231
2008	685 707	2.74	0.206	685 291	2.74	0.206
2009	663 626	2.65	0.199	667 721	2.67	0.200
2010	783 038	3.13	0.235	795 806	3.18	0.239

8.6.7. Source-specific planned improvements

The activity data is kept under consideration and will be updated necessarily. For the next Submission amounts of animal by-products (animal tissues, whey from dairy production) that were regulated so far with the Waste act, reported under R3 activity and were used under

'Biological Treatment', will be revised due to change in legislation. According to the new system, animal by-products are since 2011 regulated with the European Commission regulation 1069/2009 and collected by the VTA (Veterinary and Food Board[212]).

8.7. Biogas Burnt in a Flare (CRF 6.D)

8.7.1. Source category description

There are 2 landfills in Estonia where biogas is collected but instead of energy recovery it is burnt in a flare. The total amount of biogas burnt in a flare is also taken into account under 6.A category in methane recovery calculations, but CH_4 and N_2O emissions derived from flaring are reported apart under category Waste Other (6.D).[213]

8.7.2. Methodological issues

Activity data

Calculating emissions from biogas burnt in a flare the quantities of biogas burnt are used as activity data. The data is derived from EEIC Air bureau.

As seen from the Table 8.31, time series begin in 2009 when Väätsa landfill started to collect landfill gas. Additionally, in 2010 Paikre landfill started to collect and flare biogas as well (Table 8.31).

Table 8.31. Amount of biogas burned in a flare in 2009–2011

Company	2009	2010	2011
Väätsa Prügila AS	5 500 000	5 500 000	5 500 000
Paikre OÜ		17 130	97 520
Total (m^3)	5 500 000	5 517 130	5 597 520
Total (TJ)	0.11000	0.11034	0.11164

Methodology

Estimating GHG emissions the *Tier 1* method from IPCC 1996 Guidelines was applied by multiplying the amount of flared gas and energy stationary combustion default emission factors of CH_4 and N_2O.

$$N_2O, CH_4 = EF \bullet Activity \quad (8.15)$$ [214]

EF = emission factor (kg/TJ)
Activity = energy input (TJ)

Emission factors and parameters

Emission factors (EFs) used in calculations of emissions from biogas burnt in a flare are default emission factors from *IPCC 1996 Revised Guidelines*. Other parameters from Table 8.32 are plant specific.

[212] http://www.vet.agri.ee/
[213] Recommendation by ERT 2012.
[214] IPCC 1996, Energy, pp 1.35, pp 1.36.

Table 8.32. Emission factors and parameters used in calculations of biogas burnt in a flare

NCV[215] (MJ/Nm³) of biogas			
Company	2009	2010	2011
Väätsa Prügila AS	20	20	20
Paikre OÜ		20	16.8
Emission factors (kg/TJ)[216]			
N_2O	CH_4		
0.1	5		

8.7.3. Quantitative overview – CH_4 and N_2O emissions from biogas burnt in a flare

The total amount of CH_4 emission in 2011 was 0.000558 Gg and N_2O emission 0.000011 Gg. As seen from the table below (Table 8.33), the emissions are marginal compared to other greenhouse gas emissions from Waste Sector.

Table 8.33. CH_4 and N_2O emissions from biogas burnt in a flare, Gg

Emission	2009	2010	2011
CH_4	0.000550	0.000552	0.000558
N_2O	0.000011	0.000011	0.000011

8.7.4. Uncertainties and time series consistency

The estimation of GHG emissions from biogas burnt in a flare is carried out taking into account activity data (quantities of biogas burnt) and emission factors. Uncertainties of default emission factors and activity data used in the estimations are derived from IPCC GPG 2000 under Energy Sector, pp. 2.92. Accordingly, uncertainty for activity data is noted as 5% and uncertainty for emission factor 25%.

8.7.5. Source-specific QA/QC and verification

A complete Quality Assurance (QA) and Quality Control (QC) was carried out for Waste sector according to IPCC *Tier 1* method. The quality objectives and the QA/QC plan for Estonian GHG inventory at the national level are presented in Section 1.6.

8.7.6. Source-specific recalculations

No recalculations were made under specific category.

8.7.7. Source-specific planned improvements

The activity data is kept under consideration and will be updated necessarily.

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215 Net Calorific Value

216 IPCC 1996, Energy, pp 1.35, pp 1.36.

9. OTHER

Estonia does not report any emissions under the Other sector.

10. RECALCULATIONS AND IMPROVEMENTS

10.1. Explanations and justifications for recalculations

10.1.1. GHG inventory

Explanations and justifications for the recalculations performed for this submission are given in Table 10.1.

Table 10.1. Recalculations made for the 2013 inventory submission by the CRF category and their implications

SECTOR	SOURCE	RECALCULATION
ENERGY	Energy Industries (CRF 1.A.1)	In the 2012 submission, CEF of Jet Kerosene used was 19.6 tC/TJ. In current submission, the CEF of Jet Kerosene used is 19.5. Activity data on Biomass usage has been revised: in 2002 – 87 TJ (was 112 TJ); in 2004 – 94 TJ (was 84 TJ); in 2006 – 174 TJ (was 154 TJ); in 2008 – 119 TJ (was 82 TJ); in 2009 – 105 TJ (was 117 TJ); in 2010 – 155 TJ (was 179 TJ). Activity data on Oil Shale semi-coke gas has been corrected. Oil shale semi-coke gas in Narva changed in the years 1991 – 385 TJ (was 371 TJ); 1992 – 620 TJ (was 540 TJ); 1993 – 1059 TJ (was 700 TJ). Oil shale semi-coke gas in VKG changed in 2010 – 343 TJ (was 3 310 TJ). Oil shale semi-coke gas in Kiviõli changed in 2010 – 32 TJ (was 198 TJ). In previous submission there were wrong values used in calculations. In current submission, there has been made a new (more precise) carbon balance. New carbon balance also takes into account gas gasoline (part of oil shale gas). Therefore, more carbon is directed to burning and less carbon is stored with black ash in landfills. In the CRF source category 1.A.1.a the country specific carbon emission factor of gasoline has been implemented.
	Manufacturing Industries and Construction (CRF 1.A.2)	Activity data on Coke and Coal has been revised for the year 2007 in sub-sector Iron and Steel (CRF 1.A.2.a): Coke – 10 TJ (was 0 TJ) and Coal – 1 TJ (was 19 TJ). In previous submission there was a mistake in oxidation factor of coal (oxidation factor used was 0.99). In current submission, the oxidation factor of coal has been corrected to 0.98. Activity data has been revised in sub-sector Other (CRF 1.A.2.f) for the years 2003, 2007 and 2009. In 2003: Light Fuel Oil – 573 TJ (was 574 TJ); Gasoline – 161 TJ (was 212 TJ). In 2007: Solid Biomass – 434 TJ (was 442 TJ). In 2009: Peat – 0 TJ (was 105 TJ). CEF of waste oils (other fuels) has been changed from 20.182 to 20.1818 in current submission compared to previous submission. Activity data on oil shale consumption for shale oil production has been revised for year 2010 due to new information obtained from shale oil production companies – 17 155 TJ (was 18 245 TJ). In all sub-categories the country specific carbon emission factor for gasoline has been implemented.

SECTOR	SOURCE	RECALCULATION
	Transport (CRF 1.A.3)	In the CRF source category 1.A.3.b – Road transportation, the country specific carbon emission factors has been implemented for gasoline, diesel and LPG.
	Other Sectors (CRF 1.A.4)	In 2012 submission N_2O emission factor of Sod Peat in Commercial/Institutional (CRF 1.A.4.a) 50 kg/TJ was used. This has been corrected to 4 kg/TJ in current submission. Activity data on Natural Gas has been revised for the year 2006 in Commercial/Institutional (CRF 1.A.4.a) from 605.405 TJ in previous submission to 605.4 TJ in current submission. In all sub-sectors (CRFs 1.A.4.a; 1.A.4.b and 1.A.4.c) oxidation factor of Biomass has been corrected from 0.97 (in previous submission) to 0.98 (in current submission). In the CRF source categories 1.A.4.b and 1.A.4.c the country specific carbon emission factor for gasoline has been implemented.
	Feedstocks and non-energy use of fuels (CRF 1.AD)	Activity data on Lubricants (CRF 1.AD.2) consumption and Bitumen (1.AD.3) consumption has been revised for the whole time-series (1990–2010). Activity data on Natural Gas (CRF 1.AD.5) consumption has been revised for the years 1999, 2002, 2003, 2005 and 2007. Due to new carbon balance carbon stored with semi-coke and black ash (CRF 1.AD.10) has been recalculated for the whole time-series (1990–2010).
	Fugitive Emissions from Fuels (CRF 1.B)	In the CRF source category 1.B.2.B.5 – “Other Leakage” the notation key “IE” used in previous submission has been corrected to “NO” since no natural gas transmission occurs in Estonia.
	Memo Items (CRF 1.C)	In Aviation Bunkering (CRF 1.C.1.A) the activity data on Jet Kerosene has been revised for the years: 1993 – 735.3 TJ (was 747.7 TJ) and 1996 – 653.6 TJ (was 647.9 TJ).
INDUSTRIAL PROCESSES	Soda Ash Use (CRF 2.A.4.2)	Activity data in 1990–2010 was recalculated due to data about soda ash use was included by one plant.
	Food and Drink (CRF 2.D.2)	NMVOC emissions from food and drink were corrected for the years 1990 and 2010. The recalculations in 1990 and 2010 were due to corrections in food and drink production data. Every year Statistics Estonia gives out initial data and they have a practice to correct statistical data for previous years.
	Refrigerated Vehicles (sub sector under CRF 2.A.F.1.3 Transport Refrigeration)	Decommissioning emissions were recalculated in 2003–2010. According to product lifetime of 10 years for refrigerated vehicles, first decommissioning emissions occured in 2003.
	Stationary Air-Conditioning (CRF 2.A.F.1.5)	Activity data on split systems was corrected for years 1998–2010. Recalculation was made due to corrections in split systems data provided by Estonian Refrigeration Association.
	Mobile Air-Conditioning (CRF 2.A.F.1.6)	Activity data in years 2008–2010 were recalculated due to more data about ship air-conditioning was available from Estonian ferryboat companies.
	One Component PU Foam (sub sector under 2.IIA.F.2.1 Hard Foam)	In the 2013 Submission, HFC-152a emissions from one component PU foam were corrected for year 2010. Recalculation was made due to mistake in manufacturing loss data of one company. HFC-134a emissions from one component PU foam were corrected for year 2010. Recalculation was made due to entry mistake in manufacturing emissions.
	Fire Extinguishers (CRF 2.F.3)	Activity data in years 2007–2010 were recalculated due to more data from companies dealing with fire protecting systems was available.
	Car Tyres (CRF 2.F.9.C.S.4)	The investigation over time series was made and amount of SF_6 in car tyres (stock) was estimated for years 1992–1994. Decommissioning emissions were recalculated for years 1993–2003. According to product lifetime of one year after importation, first decommissioning emissions occurred in 1993. Actual emissions from stocks were corrected for years 1995–

SECTOR	SOURCE	RECALCULATION
		2003. Recalculation was made due to only decommissioning emissions occurred in Estonia from car tyres and operating emissions during the use of car tyres are not considered.
	Sport shoes (CRF 2.F.9)	The investigation over time series was made and amount of SF_6 in sport shoes (stock) was estimated for years 1991–1994. According to product lifetime of 3 years, first decommissioning emissions occurred in 1994.
SOLVENT AND OTHER PRODUCT USE	Paint Application (CRF 3.A), Degreasing and Dry Cleaning (CRF 3.B), Chemical Products, Manufacture and Processing (CRF 3.C), Printing Industry (CRF 3.D.5), Other Product Use (CRF 3.D.5)	NMVOC and indirect CO_2 emissions from paint application, chemical products, manufacture and processing, printing industry and other product use were corrected for the years 2006–2010 and from degreasing and dry cleaning for the years 2006–2008, 2010. Recalculations were due to updates in activity data in databases of Statistics Estonia and corrections in SNAP (Selected Nomenclature of sources of Air Pollution) codes in OSIS.
	Use of N_2O for Anaesthesia (CRF 3.D.1)	N_2O emissions from N_2O used for Anaesthesia (CRF 3.D.1) were recalculated for years 1990–1991. Activity data on N_2O sold to Estonian market was available from companies importing N_2O for medical use and other applications to Estonia since 1992. N_2O emissions in 1990–1991 were reported as not occurring (NO). As there have been most probably import and usage of N_2O also in 1990 and 1991, emissions were estimated based on the surrogate data method.
	N_2O from Aerosol Cans (CRF 3.D.3)	N_2O emissions from Aerosol Cans (CRF 3.D.3) were recalculated for year 2010. Recalculation was made due to corrections in data received from company selling N_2O containing aerosols to Estonian market.
AGRICULTURE	Enteric Fermentation (CRF 4.A, CH_4)	*Cattle enteric fermentation*: There are several recalculations 1 - data on weight of dairy cattle were updated; 2 - emissions from enteric fermentation were estimated separately for calves (0–6 months) and calves (6–12 months) (a recommendation of the ERT, see ARR2011 para 70). For this purpose, the total population of calves (less than 1 year old), data are collected by the SE, was split into two groups; 3 - data on weight of bovine cattle (aged between 1 and 2 years) was updated, country-specific values were used; 4 - reporting way of emissions in the CRF reporter was changed: emissions from enteric fermentation of bovine animals (aged between 1 and 2 years) were excluded from 'Manure non-dairy cattle' category (Option B) and reported under 'Young Cattle' category in the 2013 submission. *Sheep and goat enteric fermentation:* There is one recalculation performed to estimate CH_4 emissions from enteric fermentation of sheep and goats: data on livestock population were updated for 1990–1992 and for 1995 due to omission made in the previous submissions.
	Manure Management (CRF 4.B, CH_4, N_2O)	There are several recalculations carried out in the 2013 submission: Activity data on livestock population: 1 - activity data on sheep and goat population in 1990–1992 and in 1995 were updated because of the omission made in the previous submissions; Initial parameters used to estimate gross energy intake were recalculated (for cattle): 2 - data on weight of dairy cattle were updated; 3 - data on weight of bovine cattle (aged between 1 and 2 years) was updated, country-specific values were used; 4 - emissions from enteric fermentation were separately estimated for calves (0-6 months) and calves (6-12 months). For this purpose, the total population of calves, which is collected by the SE and represents the population of calves, which are less than 1 year old, was split into two groups; Nitrogen excretion rates were recalculated: 5 - data on protein content in milk were updated: county-

SECTOR	SOURCE	RECALCULATION
		specific protein content of milk was applied in the estimation for the entire period; 6 - nitrogen excretion rates of all categories of young cattle were calculated based on the updated data; The module on MMS usage was changed: 7 - Estonian country-specific MMSs were developed for cattle, swine and poultry based on data of 1990, 2001 and 2010. 8 - reporting way of emissions in the CRF reporter was changed: emissions from enteric fermentation of bovine animals (aged between 1 and 2 years) were excluded from 'Manure non-dairy cattle' category (Option B) and reported under 'Young Cattle' category in the 2013 submission;
	Direct emissions from agricultural soils (CRF 4.D.1, N_2O)	There are several recalculations carried out in the 2013 submission: 1- Animal manure applied on agricultural soils (CRF 4.D.1.2) – amounts of manure applied on soils were recalculated due to the changes employed in the estimations of nitrogen excretion rates and because of the development of Estonian module on MMS; 2- Cultivation of organic soils (CRF 4.D.1.5) – data on areas of organic soils cultivated were updated in the framework of the NFI; 3- Sewage sludge applied on agricultural lands (CRF 4.D.1.5) – nitrogen content in sewage sludge was updated; country-specific value was used in the estimations.
	Indirect emissions from agricultural soils (CRF 4.D.3, N_2O)	The recalculations in 'Indirect N_2O emissions from agricultural soils' category were performed due to the changes employed in the 'Manure management', 'Animal manure applied on agricultural soils' and 'Sewage sludge applied on agricultural soils' categories.
LULUCF	Forest Land (CRF 5.A)	$BCEF_S$ and R values from the IPCC 2006 were implemented. In case of missing country-specific emission factors, EFs from Sweden annual submission 2012 were applied. More appropriate dead wood densities from Sandström ***et al.*** (2007) were used in current submission. Mistake in applying the stock-change method was corrected.
	Cropland (CRF 5.B)	*Tier 1* method was applied for the first time for estimating emissions from Cropland remaining Cropland and Grassland conversion to Cropland on mineral soils. IPCC 2006 EF value was implemented for estimating organic soil emissions. N_2O emissions related to land conversion to Cropland were estimated for the first time.
	Grassland (CRF 5.C)	$BCEF_S$ and R values from the IPCC 2006 were implemented. In case of missing country-specific emission factors, EFs from Sweden annual submission 2012 were applied. *Tier 1* method was implemented to estimate emissions from Cropland conversion to Grassland on mineral soils. More appropriate dead wood densities from Sandström ***et al.*** (2007) were used in current submission. Mistake in applying the stock-change method was corrected.
	Wetlands (CRF 5.D)	Country-specific emission factors (CO2, CH4, N2O) from Salm ***et al.*** 2012 were applied for the first time.
	Settlements (CRF 5.E)	Updated emission factors from Sweden 2012 annual submission were implemented. Emissions from all pools realated to land conversion to Settlements were estimated.
	Other land (CRF 5.F)	Updated emission factors from Sweden 2012 annual submission were implemented. Emissions from all pools realated to land conversion to Other land were estimated.
WASTE	Solid Waste Disposal on Land (CRF 6.A)	During the UNFCCC in-country review in 2012 activity data under 6.A Solid Waste Disposal on Land category was revised due to underestimation of CH_4 emissions in period 1990–2010. In 2012 Submission landfills where municipal solid waste were disposed were classified since 1990-2008 as *uncategorized* and in 2009-2010 as *managed* disposal sites. As one landfill in Estonia (Pääsküla) started to collect and recover methane in 1995, the reclassification of landfills was needed, as landfill,

SECTOR	SOURCE	RECALCULATION
		which recovers methane, should be classified/reported as *managed* instead of *uncategorized*. Distribution of waste disposals (by mass) between site types (managed, uncategorized) was calculated based on the amounts of MSW disposed in Pääsküla and total amounts of MSW disposed in Estonia. During the UNFCCC in-country review in 2012 it was also recommended that amounts of flared biogas deducted from the total quantity of biogas collected in 2012 Submission should be still count in under CH_4 recovery, where the total gas collected is taken into account (incl. flared biogas). According to the ERT's recommendation, CH_4 recovery was recalculated for years 2009 and 2010. Thirdly during the compilation of 2013 Submission Estonia's GDP was updated according to the latest version of database available in Estonian Statistics.
	Wastewater Handling (CRF 6.B)	Under industrial wastewater hanfling (CRF 6.B.1.) CH_4 emission in 2010 was recalculated due to update in activity data of production output in databases of Estonian Statistics in 2012. Under domestic and commercial wastewater handling (CRF 6.B.2.1.) N_2O emissions were removed. During the in-country review in 2012 it was noted that at first it is not recommended to use 2006 IPCC Guidelines without reasonable explanation when there is method also available in 1996 Guidelines and secondly corresponding N_2O emissions are already reported under 6.B.2.2 Human sewage category (using 1996 Guidelines) which lead to double estimation of emissions. Thus, in order to be in accordance with IPCC Guidelines and to avoid double counting of emissions, N_2O emissions under domestic and commercial wastewater treatment were discounted from the inventory. N_2O emissions from human sewage (CRF 6.B.2.2.) were recalculated for whole time series due to change in methodology, quantity of N in sludge was deducted from total protein consumption referring to double counting, as N in sludge is already used in calculations under Agriculture sector. Also protein consumption from FAO databases was revised.
	Waste Incineration (CRF 6.C)	In earlier submissions CO_2 emissions derived from waste incineration without energy recovery were reported as biogenic (derived from biomass materials, e.g., paper and food) and therefore were not counted in total GHG net emissions from waste sector, but added in the inventory as information item. During the in-country review in 2012 in Estonia it was clarified that part of these emissions are actually non-biogenic (derived from incineration of plastic, rubber, clinical waste etc) and should be reported separately and considered as net emissions. CO_2 emissions from incineration of non-biogenic materials were separated from the emissions derived from total amount of waste incinerated and reported as apart (CRF 6.C.2.) The same was done with N_2O emissions, only without any changes in net emissions. No method or activity data was changed, CO_2 and N_2O emissions were separated based on biogenic or non-biogenic origin according to the activity data used in the estimations.
	Biological Treatment (CRF 6.D)	CH_4 and N_2O emissions from biological treatment category were recalculated for years 2007–2010 due to update in amounts of biological waste recovered under R3 recovery activity.

10.1.2. KP-LULUCF inventory

Entire time series of activity data was recalculated for ARD activities. In previous submissions, afforestation and reforestation areas were obtained from Statistics Estonia, that represents unequivocally "direct-human induced" afforestation and reforestation (only plantations are included), and these data represent about one third of the total area reported under land converted to forest. In current submission a new approach was implemented, NFI field data about land-use changes were used, assuming that cropland, wetlands and settlements conversion to forest land reported under the UNFCCC is direct human-induced land conversion, these areas were summed in order to get AR area. Grassland and other land conversion to forest land is considered not directly human induced. Grassland conversion to forest land is major land use change to forest that occurs mainly due to abandonment and lack of management of the land. With the new approach all AR areas are identified and georeferenced, detailed information about growing stock, mineral and organic soil distribution is obtained from NFI and cosistency between UNFCCC and KP-LULUCF reporting is assured. With the new approach, all activity data is obtained from one source, NFI, which increases transparency, consistency, accuracy and comparability of the report.

Areas subject to deforestation are updated annually, new data is integrated to overall activity data.

IPCC 2006 $BCEF_S$ and R values were applied for estimating emissions related to living biomass. Estimates for litter and mineral soils were provided for the first time implementing corresponding emission factors from Sweden 2012 annual inventory, whereas consistency between LULUCF (land converted to Forest Land) and AR soil EFs were assured. All organic soils under AR were assumed to be drained according to the ERT recommendation[217].
Emissions from litter, mineral and organic soils were recalculated applying EFs from Sweden 2012 annual submission. The mistake in applying the EFs was corrected[218].

Parameters used in KP-LULUCF recalculations are indicated in Table 11.8.

10.2. Implications for emission levels

10.2.1. GHG inventory

For the national total CO_2 equivalent emissions without Land-Use, Land-Use Change and Forestry, the general impact of the improvements and recalculations performed is small and the changes for the whole time-series are between -2.69% (2010) and -0.38% (1996/1997/2003). Therefore, the implications of the recalculations on the level and on the trend, 1990–2010, of this national total are small (Table 10.2).

For the national total CO_2 equivalent emissions with Land-Use, Land-Use Change and Forestry, the general impact of the recalculations is larger. The differences vary between -25.52% (2006) and 65.84% (2007), (Table 10.2).

[217] ARR2012, point 127.
[218] ARR2012, point 129.

Table 10.2. Recalculation performed in year 2013 for 1990–2010. Differences in % between this submission and the September 2012 submission for Estonia

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
Total CO_2 equivalent emissions with LULUCF	1.02	1.72	0.91	-2.66	-6.02	-10.63	-6.95	2.06	24.77	2.73	
Total CO_2 equivalent without LULUCF	-0.44	-0.49	-0.54	-0.51	-0.45	-0.41	-0.38	-0.38	-0.49	-0.54	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total CO_2 equivalent emissions with LULUCF	-14.60	0.39	1.88	2.80	11.82	41.62	-25.52	65.84	-15.45	-4.07	-16.31
Total CO_2 equivalent without LULUCF	-0.50	-0.53	-0.43	-0.38	-0.39	-0.55	-0.61	-0.51	-0.58	-0.99	-2.69

10.2.2. KP-LULUCF inventory

Quantitative changes due to recalculations under ARD are shown in Table 10.3 and Table 10.4.

See also Table 11.8.

Table 10.3. AR: Changes in emission estimates due to recalculations, Gg C

	2008	**2009**	**2010**
2012 resubmission			
Area, kha	22.67	22.84	22.98
Above-ground biomass	36.91	39.58	42.27
Below-ground biomass	16.43	17.61	18.81
Litter	NE	NE	NE
Mineral soils	-2.70	-2.72	-2.74
Organic soils	-2.90	-2.92	-2.94
2013 submission			
Area, kha	26.12	26.51	26.90
Above-ground biomass	19.63	24.27	26.27
Below-ground biomass	7.72	9.54	10.33
Litter	7.84	7.95	8.07
Mineral soils	-5.58	-5.59	-5.59
Organic soils	-2.90	-3.10	-3.33
TOTAL change % 2012/2013	**-79 %**	**-56%**	**-55%**

Table 10.4. D: Changes in emission estimates due to recalculations, Gg C

	2008	2009	2010
2012 resubmission			
Above-ground biomass	-172.90	-57.98	-59.30
Below-ground biomass	-50.70	-17.00	-17.39
Litter	-20.23	-21.30	-22.39
Dead wood	-5.78	-1.99	-2.06
Mineral soils	-12.82	-13.71	-14.63
Organic soils	-7.32	-7.32	-7.32
2013 submission			
Above-ground biomass	-133.30	-111.95	-74.16
Below-ground biomass	-31.38	-26.35	-17.46
Litter	-16.88	-18.94	-20.29
Dead wood	-0.32	-0.18	-0.01
Mineral soils	-10.67	-11.98	-12.92
Organic soils	-4.23	-4.71	-4.91
TOTAL change % 2012/2013	**-37%**	**31%**	**5%**

10.3. Implications for emission trends, including time series consistency

10.3.1. GHG inventory

It is a high general priority in the considerations leading to recalculations back to 1990 to have and preserve the consistency of the activity data and emissions time-series. As a consequence activity data, emissions factors and methodologies are carefully chosen to represent the emissions for the time-series correctly. Often considerations regarding the consistency of the time-series have led to recalculations for single years when activity data and/or emissions factors have been changed or corrected. Furthermore, when new source are considered, activity data and emissions are as far as possible introduced to the inventories for the whole time-series based on preferably the same methodology.

The implication of the recalculations is further shown in Table 10.5–Table 10.7.

Table 10.5. Recalculation for CO_2 performed in year 2013 for 1990–2010. Differences in CO_2 equivalent (Gg) between this and the September 2012 submission for Estonia

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total National Emissions and Removals		**514.16**	**681.17**	**338.14**	**-178.24**	**-618.74**	**-1 015.37**	**-666.80**	**316.69**	**2 313.84**	**425.99**	**-3 039.49**
1. Energy		**14.42**	**16.00**	**28.08**	**23.66**	**20.17**	**24.13**	**24.20**	**21.33**	**2.09**	**-8.14**	**-7.50**
1.A.	Fuel Combustion Activities	14.42	16.00	28.08	23.66	20.17	24.13	24.20	21.33	2.09	-8.14	-7.50
1.A.1.	Energy Industries	46.61	44.79	41.72	38.00	37.98	39.31	41.26	39.14	15.26	6.94	19.87
1.A.2.	Manufacturing Industries and Construction	-0.20	-0.13	-0.03	-0.02	-0.02	-0.02	-0.04	-0.04	-0.04	-0.03	-0.09
1.A.3.	Transport	-31.11	-28.03	-13.01	-13.98	-17.70	-15.05	-16.86	-17.61	-13.06	-14.96	-26.96
1.A.4.	Other Sectors	-0.82	-0.56	-0.59	-0.32	-0.09	-0.10	-0.15	-0.14	-0.08	-0.09	-0.31
1.A.5.	Other	-0.07	-0.07		-0.02	0.00	-0.01	-0.01	-0.01	0.00	-0.01	-0.01
2. Industrial Processes		**0.31**	**0.25**	**0.13**	**0.09**	**0.26**	**0.26**	**0.28**	**0.58**	**1.02**	**0.89**	**1.12**
2.A.	Mineral Products	0.31	0.25	0.13	0.09	0.26	0.26	0.28	0.58	1.02	0.89	1.12
3. Solvent and Other Product Use												
5. Land Use, Land-Use Change and Forestry		**499.40**	**664.88**	**309.89**	**-202.02**	**-639.20**	**-1 039.78**	**-691.30**	**294.75**	**2 310.68**	**433.20**	**-3 033.17**
5.A.	Forest Land	76.67	290.83	-19.44	-456.62	-862.13	-1 194.29	-836.04	171.75	2 240.55	447.07	-3 179.17
5.B.	Cropland	-16.73	-37.04	-53.52	-67.42	-93.36	-96.66	-103.46	-97.62	-82.71	-73.63	-65.73
5.C.	Grassland	322.43	301.20	279.23	225.92	219.89	197.98	147.81	118.00	64.44	-40.89	54.28
5.D.	Wetlands	117.03	109.89	103.60	90.40	90.40	90.40	90.40	90.40	90.40	90.40	90.40
5.E.	Settlements				5.69	6.00	-37.21	9.98	12.22	-2.00	10.25	67.06
5.F.	Other Land											
6. Waste		**0.03**	**0.03**	**0.03**	**0.03**	**0.03**	**0.02**	**0.01**	**0.03**	**0.06**	**0.04**	**0.06**
6.C.	Waste Incineration	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.03	0.06	0.04	0.06

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total National Emissions and Removals		**168.30**	**458.00**	**615.99**	**1 860.30**	**4 034.11**	**-3 664.32**	**5 216.81**	**-2 014.82**	**-247.85**	**-2 607.19**
1. Energy		**-9.64**	**11.18**	**13.29**	**11.15**	**-16.78**	**-21.93**	**-20.88**	**-24.33**	**-27.45**	**-417.01**
1.A.	Fuel Combustion Activities	-9.64	11.18	13.29	11.15	-16.78	-21.93	-20.88	-24.33	-27.45	-417.01
1.A.1.	Energy Industries	20.82	22.02	19.47	18.18	14.61	24.25	26.74	14.88	11.55	-405.23

1.A.2.	Manufacturing Industries and Construction	0.00	0.00	-0.04	0.02	-0.06	-0.05	-0.75	-0.02	-10.84	-0.02
1.A.3.	Transport	-30.11	-10.84	-6.25	-7.16	-31.05	-45.68	-46.41	-38.84	-27.92	-11.81
1.A.4.	Other Sectors	-0.32	0.00	0.10	0.10	-0.27	-0.44	-0.47	-0.35	-0.20	0.05
1.A.5.	Other	-0.03	0.00	0.01	0.01	-0.01	0.00	0.00	0.00	-0.04	
2. Industrial Processes		**0.97**	**0.94**	**0.41**	**0.52**	**0.30**	**0.58**	**0.38**	**0.19**	**0.06**	**0.06**
2.A.	Mineral Products	0.97	0.94	0.41	0.52	0.30	0.58	0.38	0.19	0.06	0.06
3. Solvent and Other Product Use							**-0.89**	**-2.03**	**-0.25**	**0.29**	**-0.26**
5. Land Use, Land-Use Change and Forestry		**176.93**	**445.86**	**602.28**	**1 848.61**	**4 050.58**	**-3 642.09**	**5 239.34**	**-1 990.43**	**-220.76**	**-2 189.98**
5.A.	Forest Land	-147.35	-183.08	-634.97	-162.62	3 690.96	-4 030.74	4 172.90	-3 210.65	-1 340.37	-2 837.53
5.B.	Cropland	-51.65	-34.34	-20.35	28.20	31.70	63.84	98.55	107.20	84.96	90.27
5.C.	Grassland	181.55	673.71	1 095.39	2 099.37	-112.05	173.06	1 593.48	981.38	490.07	321.32
5.D.	Wetlands	90.40	97.01	96.98	112.36	136.02	43.31	-12.85	164.77	151.67	141.48
5.E.	Settlements	103.97	-107.44	65.24	-245.76	205.40	135.33	-153.50	-27.63	256.83	25.49
5.F.	Other Land				17.06	98.56	-26.88	-459.35	-5.50	136.08	68.98
6. Waste		**0.04**	**0.02**	**0.01**	**0.01**	**0.01**	**0.00**				
6.C.	Waste Incineration	0.04	0.02	0.01	0.01	0.01	0.00				

Table 10.6. Recalculation for CH_4 performed year 2013 for 1990–2010. Differences in CO_2 equivalent (Gg) between this and the September 2012 submission for Estonia

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total National Emissions and Removals		**-182.87**	**-181.95**	**-155.20**	**-112.02**	**-99.49**	**-89.10**	**-84.21**	**-79.88**	**-76.56**	**-65.90**	**-63.25**
1. Energy		**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
1.A.	Fuel Combustion Activities	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.1.	Energy Industries		0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.	Manufacturing Industries and Construction			0.01			0.00					
1.A.3.	Transport	0.00	0.00	0.00								
1.A.4.	Other Sectors								0.00		0.00	
4. Agriculture		**-181.02**	**-180.36**	**-153.86**	**-110.84**	**-98.46**	**-88.20**	**-83.43**	**-79.19**	**-75.93**	**-65.34**	**-62.76**

4.A.	Enteric Fermentation	-137.04	-137.29	-114.23	-78.39	-70.07	-62.74	-58.29	-54.22	-51.44	-43.46	-41.73
4.B.	Manure Management	-43.98	-43.08	-39.63	-32.46	-28.39	-25.46	-25.14	-24.98	-24.49	-21.88	-21.03
5. Land Use, Land-Use Change and Forestry		**0.06**	**0.06**	**0.08**	**0.06**	**0.06**	**0.06**	**0.07**	**0.08**	**0.05**	**0.06**	**0.08**
5.A.	Forest Land	0.00	0.00	0.04	0.01	0.01	0.01	0.02	0.03	0.00	0.01	0.02
5.C.	Grassland	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00
5.D.	Wetlands	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
6. Waste		**-1.90**	**-1.64**	**-1.43**	**-1.24**	**-1.09**	**-0.96**	**-0.85**	**-0.76**	**-0.69**	**-0.62**	**-0.56**
6.A.	Solid Waste Disposal on Land	-1.90	-1.64	-1.43	-1.24	-1.09	-0.96	-0.85	-0.76	-0.69	-0.62	-0.56
6.B.	Waste-water Handling											
6.D.	Other											

		2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Total National Emissions and Removals		**-67.63**	**-67.05**	**-60.17**	**-57.70**	**-56.57**	**-54.43**	**-52.34**	**-56.47**	**-98.08**	**-93.91**
1. Energy		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-0.01**	**0.00**	**-0.07**	**-0.10**
1.A.	Fuel Combustion Activities	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.07	-0.10
1.A.1.	Energy Industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.10
1.A.2.	Manufacturing Industries and Construction			0.00				-0.01		-0.07	
1.A.3.	Transport					0.00	0.00				
1.A.4.	Other Sectors						0.00				
4. Agriculture		**-67.17**	**-66.66**	**-59.79**	**-57.35**	**-56.24**	**-54.25**	**-51.18**	**-48.94**	**-46.21**	**-43.59**
4.A.	Enteric Fermentation	-45.71	-46.90	-47.22	-44.59	-44.92	-44.24	-43.32	-42.36	-41.75	-41.32
4.B.	Manure Management	-21.46	-19.76	-12.57	-12.76	-11.32	-10.01	-7.87	-6.58	-4.47	-2.27
5. Land Use, Land-Use Change and Forestry		**0.06**	**0.09**	**0.06**	**0.07**	**0.06**	**0.19**	**0.05**	**0.03**	**0.06**	**0.06**
5.A.	Forest Land	0.00	0.05	0.01	0.02	0.00	0.15	0.00	0.02	0.00	0.00
5.C.	Grassland	0.00	-0.02	0.00	0.00	0.00	-0.02	-0.01	-0.05	0.00	0.00
5.D.	Wetlands	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06
6. Waste		**-0.52**	**-0.48**	**-0.44**	**-0.41**	**-0.39**	**-0.36**	**-1.20**	**-7.57**	**-51.86**	**-50.28**
6.A	Solid Waste Disposal on Land	-0.52	-0.48	-0.44	-0.41	-0.39	-0.36	-0.34	-7.53	-52.20	-51.35
6.B.	Waste-water Handling										-0.01

6.D.	Other							-0.85	-0.03	0.34	1.07

Table 10.7. Recalculation for N_2O performed year 2013 for 1990–2010. Differences in CO_2 equivalent (Gg) between this and the September 2012 submission for Estonia

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total National Emissions and Removals		**-10.20**	**-17.85**	**-20.27**	**-21.77**	**-22.06**	**-18.07**	**-18.01**	**-17.87**	**-17.52**	**-20.10**	**-15.65**
1. Energy		**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**-0.01**	**0.00**	**0.00**	**0.00**
1.A.	Fuel Combustion Activities	0.00	0.00	0.01	0.01	0.00	0.00	0.00	-0.01	0.00	0.00	0.00
1.A.1.	Energy Industries	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.A.2.	Manufacturing Industries and Construction			0.01			0.00					
1.A.3.	Transport											
1.A.4.	Other Sectors								-0.01	0.00	0.00	
3. Solvent and Other Product Use		**5.67**	**6.03**									
4. Agriculture		**18.88**	**10.82**	**14.14**	**14.50**	**13.44**	**14.82**	**14.78**	**17.31**	**17.43**	**14.30**	**15.00**
4.B.	Manure Management	43.72	40.85	38.50	31.89	28.70	26.78	26.57	26.69	26.17	22.30	22.30
4.D.	Agricultural Soils	-24.84	-30.02	-24.36	-17.39	-15.26	-11.96	-11.79	-9.38	-8.74	-8.01	-7.30
5. Land Use, Land-Use Change and Forestry		**0.68**	**0.68**	**0.68**	**0.68**	**0.68**	**0.68**	**0.68**	**0.68**	**0.68**	**0.67**	**0.68**
5.A.	Forest Land	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
5.B.	Cropland											
5.C.	Grassland	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00
5.D.	Wetlands	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
6. Waste		**-35.43**	**-35.37**	**-35.10**	**-36.97**	**-36.17**	**-33.57**	**-33.46**	**-35.85**	**-35.63**	**-35.07**	**-31.33**
6.B.	Waste-water Handling	-35.43	-35.37	-35.10	-36.97	-36.17	-33.57	-33.46	-35.85	-35.63	-35.07	-31.33
6.D.	Other											

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total National Emissions and Removals		**-15.32**	**-16.30**	**-24.34**	**-26.74**	**-26.74**	**-28.23**	**-28.65**	**-27.51**	**-31.23**	**-31.87**
1. Energy		**0.00**	**0.00**	**-0.01**	**0.00**	**0.00**	**0.00**	**-0.01**	**0.00**	**-0.13**	**-0.14**

1.A.	Fuel Combustion Activities	0.00	0.00	-0.01	0.00	0.00	0.00	-0.01	0.00	-0.13	-0.14
1.A.1.	Energy Industries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.14
1.A.2.	Manufacturing Industries and Construction		0.00	-0.01			0.00	-0.01		-0.13	
1.A.3.	Transport					0.00	0.00				
1.A.4.	Other Sectors			0.00	0.00	0.00	0.00				
3. Solvent and Other Product Use											**0.00**
4. Agriculture		**15.29**	**12.52**	**5.01**	**3.86**	**1.65**	**-0.43**	**-2.14**	**-3.25**	**-7.06**	**-8.58**
4.B.	Manure Management	23.19	21.68	15.45	14.15	12.40	10.68	9.05	7.11	5.09	3.11
4.D.	Agricultural Soils	-7.90	-9.16	-10.44	-10.29	-10.76	-11.11	-11.18	-10.35	-12.15	-11.69
5. Land Use, Land-Use Change and Forestry		**0.68**	**0.80**	**1.06**	**1.61**	**2.50**	**3.53**	**4.43**	**5.24**	**5.82**	**6.03**
5.A.	Forest Land	0.00	0.01	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
5.B.	Cropland		0.12	0.38	0.93	1.79	2.81	3.76	4.57	5.10	5.31
5.C.	Grassland	0.00	-0.01	0.00	0.00	0.00	-0.02	-0.01	-0.03	0.00	0.00
5.D.	Wetlands	0.68	0.68	0.68	0.69	0.72	0.70	0.68	0.70	0.72	0.72
6. Waste		**-31.28**	**-29.62**	**-30.39**	**-32.21**	**-30.88**	**-31.33**	**-30.93**	**-29.51**	**-29.85**	**-29.17**
6.B.	Waste-water Handling	-31.28	-29.62	-30.39	-32.21	-30.88	-31.33	-29.98	-29.47	-30.23	-30.36
6.D.	Other							-0.94	-0.04	0.38	1.19

10.3.2. KP-LULUCF inventory

See Chapter 10.1.2. KP–LULUCF inventory.

10.4. Recalculations, including in response to the review response, and planned improvements to the inventory

10.4.1. GHG inventory

Table 10.8 summarises the sectoral improvement needs for the forthcoming inventories recognised by the Estonian experts responsible for the calculations. More detailed information about planned improvements can be found under the sectoral chapters.

Table 10.8. Sector-specific improvement needs of Estonia's national greenhouse gas inventory

SECTOR	SOURCE	IMPROVEMENTS
ENERGY	CO_2, CH_4 and N_2O from 1.A.1, 1.A.2, 1.A.3, 1.A.4, 1.A.5	It is planned to evaluate and implement country specific emission factors for different fuels used in Estonia (e.g. fuels used in key categories, fuels produced in Estonia). Currently the process is underway, but it is not clear, to which fuels the country specific emission factors will be developed. Some of the emission factors are already developed and implemented (e.g. motor fuels in road transportation, oil shale gases).
	CH_4 from Natural Gas Distribution (CRF 1.B.2.b.4)	For the next inventory submission Estonia plannes to evaluate and implement country specific emission factor for fugitive methane emissions from natural gas distribution.
INDUSTRIAL PROCESSES	Glass Production (CRF 2.A.7.1)	Estonia investigates possibilities to develope country-specific EFs for Glass Production for future submissions as the encouragement of the UNFCCC review team.
SOLVENT AND OTHER PRODUCT USE		No source-specific improvements are under active consideration at the moment.
AGRICULTURE	N-fixing crops (4.D.1.3, N_2O), Crop residue (4.D.1.4, N_2O) and Field burning of agricultural residues (4.F, N_2O and CH_4)	Development of value of FracR (fraction of residues left on agricultural lands) and FracBurn (fraction of crop residues bunt) will be performed in the next submissions.
LULUCF	All land use categories	Areas of all land use and land-use change categories will be updated annually according to new data obtained from NFI fieldwork.
	Carbon stock change in forest mineral soils and litter pools (CRF 5.A)	Estonian Environment Information Centre has initialized in cooperation with the University of Tartu a pilot project aimed to obtain data about below-ground carbon fluxes in coniferous forest soils. Preliminary estimates are expected to be obtained by 2014
	Carbon stock change in cropland mineral and organic soils (CRF 5.B)	Ongoing negotiations with the Agricultural Research Centre of Estonia for conducting fieldwork and estimating carbon stock changes in cultivated mineral and organic soils. Project has not started yet due to lack of financial resources.
	Carbon stock change in grassland mineral and organic soils (CRF 5.C)	Estonia is making effort to develop country-specific emission factors for grassland mineral and organic soils.
WASTE	Solid Waste Disposal on Land (CRF 6.A)	Historical data on waste generation per capita and distribution of waste by waste management type will be kept under investigation and updated when data available.
	Wastewater Handling (CRF 6.B)	The activity data is kept under consideration and will be updated necessarily.
	Waste Incineration (CRF 6.C)	The activity data is kept under consideration and will be updated necessarily.
	Biological Treatment (CRF 6.D)	The activity data is kept under consideration and will be updated necessarily. For the next Submission amounts of animal by-products (animal tissues, whey from dairy production) that were regulated so far

SECTOR	SOURCE	IMPROVEMENTS
		with the Waste act, reported under R3 activity and were used under 'Biological Treatment' will be revised due to change in legislation. According to the new system, animal by-products are since 2011 regulated with the European Commission regulation 1069/2009 and collected by the VTA (Veterinary and Food Board.
	Biogas Burnt in a Flare (CRF 6.D)	The activity data is kept under consideration and will be updated necessarily.

Table 10.9 summarises Estonia's responses to the review of the initial report under the Kyoto Protocol.

Table 10.9. 2012 Estonia National GHG Inventory In-Country Review response

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Cross-cutting (Completeness)	The inventory is complete in terms of years and geographical coverage and covers all mandatory source and sink categories for the period 1990–2010 except for estimates of carbon stock changes and emissions and removals from mineral soils for all land uses (except forest land converted to settlements). In addition, the following non-mandatory categories have not been estimated: CH_4 from poultry due to lack of an emission factor (EF); biogenic CH_4 from waste incineration due to lack of activity data (AD); N_2O from wastewater due to lack of AD; and potential emissions of SF_6. The ERT recommends that Estonia estimate mandatory pools and related emissions and removals in its next annual submission. In addition, the ERT encourages Estonia to estimate emissions from non-mandatory categories in future submissions (e.g. by using methods/EFs used by other Parties which have similar conditions to those in Estonia).	In the 2013 annual submission, all estimates, including emissions and removals from mineral soils are provided. In case of missing or insufficient country-specific data, emission factors from Sweden 2012 submission were implemented with the agreement of ERT.	Chapters 7.2.2, 7.3.2, 7.4.2, 7.6.2, 7.7.2	
Cross-cutting (National system)	The ERT strongly recommends that Estonia allocate the necessary resources in order to ensure a smooth transition period, in particular ensuring that the TUT energy expert will allocate enough time to support the preparation and quality checking of the 2013 energy sector.	Quality assurance of energy sector was carried out by TUT expert in the 2013 inventory submission.	Section 1.6.1.2 QA procedures	
Cross-cutting (National system)	The ERT encourages Estonia to provide for adequate resources to the inventory team in order to make sure that appropriate back-up arrangements can be taken. The ERT also encourages Estonia to nominate further experts to the roster of experts for the review process, noting that participating in the review training and in the review process will strengthen the QA/QC capacity of its inventory team.	Agriculture expert Olga Gavrilova has passed the GHG review training course in 2010 and industrial processes expert Kaili Tuulik in 2011. Estonia plans to nominate further experts to the roster of expert in the future.		
Cross-cutting (National system)	The ERT recommends that Estonia explore the possibility of strengthening the links between the GHG inventory compilers and Statistics Estonia, which would facilitate the preparation of the inventory for the energy sector.	MoE and experts are working in close cooperation with Statistics Estonia. Quality control of activity data takes place on both side (e.g. energy expert highlights any error in energy balance and SE carries out QA of energy inventory). The need for futher cooperation with SE was discussed in annual meeting of GHG		

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
		inventory experts. Experts confirmed that there is no need for special agreement and that data needed for inventory preparation is available from electronical database of SE. Concrete steps for strengthening the links between the GHG inventory compilers and SE will be made if necessary.		
Cross-cutting (Key categories)	The ERT recommends that Estonia revise the uncertainty assessment and use the key category analysis to prioritize improvements of its inventory.	The results of the key category analysis are used to prioritize the development and improvement of the inventory. Estonia has launched a project in order to obtain country-specific EFs for energy sector. Estonian country-specific module on MMS was developed for cattle, swine and poultry.		
Cross-cutting (Uncertainties)	The ERT encourages Estonia to update the uncertainty estimates in order that they reflect the use of improved EFs/AD and in particular to revise the uncertainty estimates for solid fuels from public electricity and heat production.	Estonia plans to revise the uncertainty estimates for solid fuels from public electricity and heat production for the next submission.		
Cross-cutting (Uncertainties)	Estonia did not include explanations for the differences in the uncertainty estimates when the results are compared with previous annual submissions. In response to questions raised during the review Estonia provided detailed information on the changes of the uncertainty estimates. The ERT reiterates the recommendation of the previous review report that Estonia include explanations for such changes in the uncertainty estimates in its next annual submission.	Explanations for the differences in the uncertainty estimates when the results are compared with previous submission are included in the NIR 2013.	Chapter 4.5.1.6.5, 7.2.3, 7.4.3, 7.5.3, 7.6.3	
Cross-cutting (Uncertainties)	The ERT noted that the selected uncertainty values for each category are not always well explained or justified. The ERT reiterates the recommendation of the previous review report that, in its next annual submission, Estonia improve the justification of the uncertainty values used.	The justification of the uncertainty values used has been improved.	Sub-chapters "Uncertainty and time series consistency" under sectoral chapters	
Cross-cutting (Recalculations)	In general, the rationale for the recalculations is explained transparently in the NIR and in CRF table 8(b). However, the ERT noted that in the energy sector the explanations provided by the Party were not fully transparent. The ERT recommends that Estonia provide transparent explanations for all recalculations in its next annual submission.	Estonia has provided transparent explanations for all recalculations.	Sector specific chapters, Table 10.1 and CRF table 8(b)	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Cross-cutting (Verification and QA/QC approaches)	In response to a recommendation in the previous review report, Estonia implemented additional QA procedures for key categories before the 2012 annual submission. In addition, data from the EU ETS have been used for verification purposes of the 2012 inventory by MoE. The ERT recommends that the Party perform these checks on an annual basis.	EU ETS data has been used for verification purposes of the 2013 inventory. QA procedures will be revised and the focus on the key categories will be strengthened.	Chapter 1.6.2, 4.2.1.4 and 4.2.2.4	
Cross-cutting (Verification and QA/QC approaches)	During the review, Estonia provided the ERT with the QC reports prepared by the inventory compilers and with the QA reports prepared by the independent experts. The ERT found that, in general, the quality checks are documented very well. However, limited documentation is available for the overall checks made by the QA/QC coordinator and of cross-checks with the EU ETS data. Therefore, the ERT recommends that Estonia improve the documentation of these QA/QC checks.	The documentation of overall checks made by the QA/QC coordinator and of cross-checks with the EU ETS data was improved for the 2013 inventory submission.		
Cross-cutting (Verification and QA/QC approaches)	ERT encourages Estonia to strengthen its QA procedures, for example by: (a) being more proactive during the public review (e.g. by directly approaching relevant institutions such as business associations, university institutes, and so on); (b) involving Statistics Estonia in the QC of the inventory; (c) providing for peer reviews of the inventory.	Estonia improved its QA/QC plan for the 2013 inventory. The updated plan states that inventory will be annually sent to Statistics Estonia for quality checking. Energy chapter of the 2013 inventory was sent to Statistics Estonia for quality checking.	Chapter 1.6.1.2 QA procedures	
Cross-cutting (Archiving)	Estonia has a centralized archiving system, which includes the archiving of disaggregated EFs and AD, and documentation on how these factors and data have been generated and aggregated for the preparation of the inventory. The archived information also includes internal documentation on QA/QC procedures, external and internal reviews, and documentation on annual key categories and key category identification and planned inventory improvements. The archive is kept by EERC. However, the ERT noted that the archive does not include all information (e.g. XML files provided by the inventory compilers to the producers of the CRF tables. This information is stored on an electronic file transfer (ftp) site also managed by EERC and used to facilitate the exchange of data. The ERT recommends that Estonia make sure that all relevant materials (also relevant material from the ftp site) are stored in the archive.	Estonia improved its archiving system for the 2013 inventory. The archiving structure was modified the way that all relevant materials (e.g. XML files provided by the inventory compilers to the producers of the CRF tables, also relevant material from the ftp site) will be stored in the archive. Materials used in the 2013 inventory submission will be archived according to the improved archiving system.	Chapter 1.6.1.3 Archiving	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Energy (Consistency with IEA)	In response to questions raised during the review regarding some inconsistencies between national statistics and the International Energy Agency (IEA) statistics (most of them related to import/export of fuels), Estonia informed the ERT about its intention to review all export data of gas/diesel oil, other kerosene, gasoline and jet kerosene and make revisions if necessary in its next annual submission. The ERT recommends that Estonia improve the consistency between data reported to the IEA and data gathered at Statistics Estonia, and provide relevant information in the NIR to improve transparency in its next annual submission.	During the compilation of the NIR of 2013 submission, all relevant data was reviewed and corresponding recalculations were made.	In different chapters, where recalculations are made and explained.	
Energy (Transparency)	The NIR for the energy sector is generally transparent with a few exceptions, such as estimates of the CH4 EF for natural gas distribution, background information on CH4 and N2O emission estimates from road transportation using the COPERT IV model. The ERT recommends that Estonia improve the transparency of its reporting and provide more explanations on these matters in the NIR of the next annual submission.	In the 2012 submission, CH_4 EF for natural gas distribution was taken from Finland's NIR 2011 (EF from year 2009). Background information on CH_4 and N_2O emission estimates using COPERT IV model is added in the 2013 submission.	Chapter 3.2.6.3	Estonia is planning to develop country specific CH_4 emisison factor for natural gas distribution.
Energy (Accuracy)	Emissions from oil shale in the category public electricity and heat production, which accounts for 80.5 per cent of the total emissions of the sector, are estimated using detailed plantspecific information. A tier 3 approach based on the COPERT IV model is applied for emission estimates of CH4 and N2O from road transportation, which accounts for most of the emissions from transport. Such prioritizing is in accordance with the IPCC good practice guidance. Emissions from the remaining categories are estimated using tier 1 or tier 2 methods. During the review, Estonia informed the ERT that it has a plan for the improvement of the prioritization of key categories. The ERT encourages Estonia to continue its efforts towards the use of higher-tier methods and country-specific EFs for the key categories to improve accuracy.	Developing of country-specific EFs for the key categories are currently underway. In current submission, the country specific carbon emission factors for motor fuels used in road transportation are implemented.	Chapter 3.2.6.3	
Energy (Completeness)	The ERT noted that figures for apparent energy consumption (excluding non-energy use and feedstocks) were not provided in CRF table 1.A(c) and instead the notation key “not applicable” (“NA”) was used, which resulted in a 100 per cent difference for energy consumption data between the reference and sectoral approaches. The ERT recommends that Estonia improve the completeness of its reporting by providing the relevant figures in its next annual	The relevant data are provided in the 2013 submission.	Data are provided in CRF	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
	submission.			
Energy (Transparency - International bunker fuels)	Following the recommendation in the previous review report, Estonia provided the time series for the number of landing and take off cycles for both domestic and international flights, as well as additional information from Statistics Estonia on jet kerosene fuel consumption data for international and domestic aviation, and on residual fuel oil and diesel oil for marine bunkers. The ERT recommends that Estonia improve the transparency of its reporting by including in the next annual submission information on data sources and a description of the methodologies used.	The relevant information is provided in the 2013 submission.	Chapter 3.2.2 "International Bunker Fuels"	
Energy (Feedstocks and non-energy use of fuels)	AD on lubricants and bitumen consumption are based on IEA statistics, while data on natural gas use for non-energy use and oil shale semi-coke stored in the oil shale waste dumps are based on national energy statistics or plant-specific information. The ERT encourages Estonia to make further efforts in obtaining consumption data on lubricants and bitumen from national statistics authorities and to use these data in the next annual submission.	Statistics Estonia provides each year AD on lubricants and bitumen data on IEA. So the IEA data is based on the data received from Statistics Estonia. Compiling the NIR, Estonia uses data from IEA's "Joint Questionnaire" that is filled by Statistics Estonia. So, basically the source of the data is Statistics Estonia. This matter is clarified in the 2013 submission.	Chapter 3.2.3 "Feedstocks and Non-Energy Use of Fuels"	
Energy (Stationary combustion: solid fuels)	Oil shale is the dominant energy source in Estonia, and it accounted for 65 per cent of the national total primary energy supply in 2010. In response to a recommendation in the previous review report, Estonia provided an up-to-date carbon balance for all three individual shale oil production plants (Kiviõli Oil Shale Processing and Chemicals Plant Ltd, Viru Chemistry Group(VKG) Ltd and Narva Oil Plant AS at the Eesti Power Plant) based on each specific thermal processing operation. Additional information on an oil shale carbon balance check was provided as an annex to the NIR. Emission estimates for the current approach are based on oil shale carbon balance at the plant level, so the ERT recommends that Estonia continue to compare the carbon balance with emission estimates in future annual submissions.	Estonia will continue to compare the carbon balance with emission estimates in the future submissions.		Estonia will continue to compare the carbon balance with emission estimates in the future submissions.
Energy (Stationary combustion: solid fuels - CO_2)	Noting that the accuracy of the present emission estimates has been improved considerably by using plant-specific data in the carbon balance, and considering also the dominant role of this key category in the national total GHG emissions and overall outdated uncertainty estimates, the ERT encourages Estonia to update the uncertainty estimates for this category in future annual submissions.	Estonia will update the uncertainty estimates where possible in future years.		

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Energy (Stationary combustion: solid fuels - CO_2)	Recalculations have been conducted for the entire time series to reflect the updates in methodology and changes in AD and EFs, including the change in the use of the net calorific values for oil shale obtained from national statistical data to the use of plant-specific data. However, the reasons for the recalculations are not transparently explained in the NIR. The ERT recommends that Estonia provide relevant explanations in its next annual submission.	Explanations on the reasons of recalculations are brought out separately under each chapter and also in Table 10.1.	Chapters in Energy Sector "Source specific recalculations". Chapter 10 "Recalculations and Improvements"	
Energy (Stationary combustion: gaseous fuels - CO_2)	In response to the questions raised by the ERT during the review, Estonia explained that it calculated the CO_2 EF by using the carbon content of natural gas from the Russian Federation (15.07 t C/TJ) multiplied by the default oxidation rate value for natural gas (99.5 per cent) from the Revised 1996 IPCC Guidelines, which explains why the Estonian EF is lower than Russian EF (where oxidation rate of 100 per cent is applied). The ERT noted that Estonia incorrectly referenced the carbon content of natural gas to the Russian country-specific values (as contained in table 3.13 of the NIR of the Russian Federation). The ERT recommends that Estonia correct the source reference and provide the above explanations about the application of the carbon content and oxidation factor values in the NIR in its next annual submission.	References in table 3.13 of the NIR only apply to CEFs. They do not apply to other parameters.		Estonia will look over the possibilites of presenting table 3.13 more clear.
Energy (Road transportation: liquid fuels - CO_2)	Estonia applied the CO_2 EF for gasoline from Lithuania (72.97 t/TJ) without justification instead of developing its own country-specific EF. In response to a question raised by the ERT during the review Estonia explained that developing a country-specific CO_2 EF for gasoline is resource-intensive work and needs gasoline import data from countries that are not available in the electronic database of Statistics Estonia. During the review, Estonia informed the ERT that it calculated the country-specific EF of gasoline for one year (2009) and found it very close to the Lithuanian EF. However, because CO_2 emissions from gasoline is a key category, the ERT recommends that, to improve the accuracy of its reporting, Estonia extend this effort and develop a county-specific CO_2 EF for gasoline for the entire time series by using a weighted average of country-specific EFs from the main import countries.	The country-specific carbon emission factors for gasoline, diesel and LPG are implemented and used in the calculations. The CEFs are calculated using average weighted method. (See explanation on page 111).	Chapter 3.2.6.3 (Emission factors and other parameters)	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Energy (Road transportation: liquid fuels - CH_4, N_2O)	Estonia estimated CH_4 and N_2O emissions from road transportation based on a tier 3 approach (COPERT IV model). In response to recommendations in the previous review reports, Estonia provided a general description of the model and AD and EFs used as input to the model. During the review, in response to questions raised by the ERT, Estonia provided additional background information on the model framework, input/output data and QA/QC procedures such as common statistical quality checks related to the assessment of trends before using the AD. The ERT noted some large inter-annual fluctuations and noted that there are no explanations for the trends in the N_2O implied emission factor (IEF) for gasoline. The ERT recommends that Estonia strengthen its QA/QC procedures, for example by conducting model calibrations, and that Estonia provide the necessary explanations on emissions trends in the NIR to improve transparency.	Additional background information on the model framework, input/output data and QA/QC procedures is provided in the NIR 2013. Explanations on emissions trends are included in the NIR 2013.	Chapter 3.2.6.3	
Energy (Fugitive emissions: natural gas - CH_4)	Between the 2011 (266.09 t/PJ) and 2012 (165.02 t/PJ) annual submissions the CH_4 EF for natural gas distribution (category 1.B.2.b.iv) declined by 38.0 per cent for 2009. In the 2012 annual submission, Estonia reports a constant value of 165.02 t/PJ for the entire time series, referring to default EFs from the Revised 1996 IPCC Guidelines but without providing further explanations. The ERT noted that the CH_4 EF (266.09 kg/PJ) reported as leakage in the annual 2011 submission for 2009 is the mid-value in the range of weighted average of IPCC default EFs (mid-value of EFs for leakage at industrial plants and power stations (279.5 t/PJ) and mid-value of EFs for leakage in the residential and commercial sectors (139.5 t/PJ)). In response to questions raised by the ERT during the review, Estonia explained that it had decided to use the Finnish CH_4 EF for natural gas distribution (165.02 kg/PJ) for the whole time series, arguing that natural gas distribution networks in Estonia meet all the EU requirements. as do those in Finland. The ERT noted that the Finnish EF is based on measurements and varies from year to year, and therefore recommends that Estonia investigate the rationale of a constant EF and refer correctly to the source of the EF in the NIR for the next annual submission.	The process of developing country-specific CH_4 EF for natural gas distribution is underway.		Estonia plans to develop its own country specific CH_4 emission factor for natural gas distribution.

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Industrial processes and solvent and other product use (Limestone and dolomite use - CO_2)	The ERT encourages Estonia to cross-check limestone and dolomite use on an annual basis from the next annual submission (e.g. by comparing the sum of specific limestone and dolomite uses included in the inventory with apparent consumption obtained from statistical data on production, imports and exports). The ERT also encourages Estonia to document the results of such comparisons, including explanations for any discrepancies in the NIR of its next inventory submission.	The investigation over the possibilities to cross-check limestone and dolomite use on an annual basis was made. Statistics Estonia was contacted to get national data about limestone and dolomite use, production, imports and exports. The results of the investigation indicated that Statistics Estonia do not collect nor publish national data about limestone and dolomite use; Statistics Estonia have national data about production (limestone and dolomite mining - m^3); Statistics Estonia have national data about limestone and dolomite imports and exports. National data about limestone and dolomite mining can not be compared with data about limestone and dolomite use included in the inventory. The comparison will not be accuare due to only a small amount of the total mined limestone and dolomite are used under industrial processes. Most part of limestone and dolomite mined are used in road construction. Detailed data about quantities which are used under industrial processes and under road construction are not available from Statistics Estonia. Also, the comparison will not be accuare due to national data about limestone and dolomite mining on an annual basis is not equal to limestone and dolomite consumption (use) on an annual basis (not all limestone and dolomite mined are used same year).		
Industrial processes and solvent and other product use (Other (mineral products) - CO_2)	The ERT noted that the same raw materials as those used for cement and lime production are also used for glass production and ceramics productions (bricks and tiles and lightweight gravel) and these emissions are reported under other (mineral products) using IPCC default EFs. The ERT notes that, because the number of plants concerned is small, Estonia may wish to consider developing country-specific EFs and using tier 2 or higher methods to estimate emissions in order to increase accuracy of the estimates.	Estonia investigates possibilities to develope country-specific EFs for Glass Production (CRF 2.A.7.1) for future submissions.	Chapter 1.2.5 Glass Production	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Industrial processes and solvent and other product use (Soda ash use - CO_2)	The ERT encourages Estonia to enhance the accuracy of the inventory by monitoring and cross-checking the total soda ash use on an annual basis (e.g. by comparing the sum of specific soda ash uses included in the inventory with the apparent consumption estimated from national or international statistical data on production, imports and exports) and by documenting the results of such comparison in its next annual submission.	The investigation over the possibilities to cross-check soda ash use on an annual basis was made. Statistics Estonia was contacted to get national data about soda ash use, imports and exports (no production of soda ash in Estonia). The results of the investigation indicated that Statistics Estonia do not collect nor publish national data about soda ash use; Statistics Estonia have national data about soda ash imports and exports. A cross-check of soda ash for one year (2011) was made, based on total soda ash use included in the inventory against the total national soda ash imports obtained from Statistics Estonia. In 2011 total national soda ash imports were higher than soda ash use reported in the inventory. In 2008–2010, soda ash use reported in the inventory was significantly higher than national soda ash imports obtained from Statistics Estonia. Differences in soda ash use included in the inventory and soda ash imports obtained from Statistics Estonia are mainly due to not all imported soda ash are used same year. In addition, inventory take into consideration that CO_2 emissions do not occur from lead paste desulphurisation. Therefore, the amount of soda ash, which is used in lead paste desulphurisation, is subbtraced from total amount of soda ash use.	Chapter 4.2.3 Soda Ash Use	
Industrial processes and solvent and other product use (Consumption of halocarbons and SF_6 - HFCs, SF_6)	The ERT noted that many basic parameters elaborated for the 2006 reporting year are being used annually. In order to increase the accuracy of the estimates, the ERT encourages Estonia to continue its research efforts in order to revise and improve the basic parameters in the future and especially those which are very likely to evolve (e.g. replacement of F-gases due to legislation), which are based on assumptions or which were roughly estimated.	The basic parameters are kept under consideration and will be updated if necessary in future submissions.		

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Industrial processes and solvent and other product use (Consumption of halocarbons and SF_6 - HFCs, SF_6)	Estonia reported potential emissions of HFCs, PFCs and SF_6 as "NO" or "NE". In order to increase the transparency and comparability of the reporting, as well as to check actual estimates, the ERT reiterates the encouragement of the previous review report that Estonia provide estimates for the potential emissions of these gases.	Estonia has estimated actual emissions therefore we do not find it rational to estimate also potential emissions.		
Industrial processes and solvent and other product use (Consumption of halocarbons and SF_6 - HFCs, SF_6)	Emissions from the use of F-gases were calculated using tier 2a and tier 3 methods from the 2006 IPCC Guidelines and mainly country-specific EFs. Information on the comparison of the EFs used by the Party with the EFs recommended in the 2006 IPCC Guidelines was provided. Further, Estonia explained that the methodology of 2006 IPCC Guidelines has been chosen considering its suitability for the national circumstances and the possibilities to collect data. In order to enhance the transparency and comparability of the reporting, the ERT reiterates the recommendation of the previous review report that Estonia continue its efforts by providing, in its next annual submission, a more detail justification for the use of the methodologies described in the 2006 IPCC Guidelines.	Estonia has provided justification for the use of the methodologies described in the 2006 IPCC Guidelines under chapter 1.5 of the NIR.	Chapter 1.5 (Consumption of Halocarbons and SF_6)	
Agriculture (Transparency)	The ERT noted that not all CRF tables and data are fully explained and referred to in the NIR and recommends that Estonia include this information in its next annual submission to improve transparency.	Data on characteristics of livestock (e.g. weight of animals, feed digestibility, etc) were provided in the NIR (chapters 6.3 and 6.4). More detailed information was presented also in Annex 3.	NIR, chapters 6.3 and 6.4; Annex 3	
Agriculture (Enteric fermentation - CH_4)	For fur-bearing animals, Estonia has used an EF from Norway since no IPCC default value is available, but did not justify the use of the Norwegian factor in its NIR. The ERT encourages Estonia to examine the possibility of developing country-specific EFs for fur-bearing animals.	The EFs were received from a Finnish expert in the agriculture sector. The same factors are used in Finnish GHG emission inventory. Since, Estonian conditions are close to Finnish, it was decided to implement the EFs in the estimations of the emissions. However, due to a negligible contribution of emissions occurred due to fur-animals breading (less than 0.05% to the total CO_2eq emissions occurred in the agriculture sector) and due to the lack of resource, the encouragement given by the ERT was not implemented in the present submission.		Next submissions

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Agriculture (Enteric fermentation - CH_4)	The ERT noted that the NIR does not provide sufficient information on the characteristics of non-dairy cattle, such as animal weights, or on the CH_4 conversion factors and the data sources used for calculations of the CH_4 emission estimates. In response to questions raised by the ERT during the review, Estonia elaborated on these characteristics. The ERT recommends that Estonia increase the transparency of its reporting by including this information in its next annual submission.	The data on main characteristics of dairy- and non-dairy cattle are provided in the NIR and in Annex 3.	Chapter 6.3 (p.214-215); APPENDIX A.3.3_II; APPENDIX A.3.3_III.	
Agriculture (Enteric fermentation - CH_4)	Estonia reported calves under the subcategory young cattle and reported bovine cattle (aged 1 to 2 years) under the subcategory mature, which is not in accordance with the IPCC good practice guidance. The calves were not excluded from the enteric fermentation calculations for the period when they are milk-fed. The ERT considers that this may lead to an overestimate of CH4 emissions from enteric fermentation for the entire time series. The ERT reiterates the recommendations from the 2010 and 2011 review reports that Estonia report bovine cattle in the young cattle subcategory, because they are growing animals, and estimate CH_4 emissions from calves by applying a CH_4 conversion rate of zero for the period when they are milk-fed.	The recommendation was implemented in the 2013 submission; the recalculations were performed.	Chapter 6.3.2.1, 6.3.7	
LULUCF (Completeness)	The ERT noted that the LULUCF sector is not complete, because carbon stock changes in mineral soils and emission and removals from mineral soils are reported as "NE" for all land uses, except forest land converted to settlements. In the 2012 annual submission, Estonia provided for the first time estimates of the carbon stock changes in living biomass for cropland remaining cropland and for forests converted to settlements. Estonia did not report emissions and removals from forest land converted to wetlands, land converted to settlements (except forest land converted to settlements) and land converted to other land. The ERT commends the Party for the improvements made to the completeness of its inventory, but reiterates the recommendation of the previous review reports that Estonia further improve the completeness of the LULUCF estimates.	In the 2013 annual submission, all estimates, including emissions and removals from mineral soils are provided. In case of missing or insufficient country-specific data, emission factors from Sweden 2012 submission were implemented with the agreement of ERT.	Chapters 7.2.2, 7.3.2, 7.4.2, 7.6.2, 7.7.2	Estonia is making effort in order to develop country-specific emission factors.

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
LULUCF (Completeness)	Estonia reports planned improvements for estimating carbon stock changes in cultivated mineral soils, but at the same time highlights a lack of resources for conducting the work. The ERT notes that the IPCC tier 1 methodology provides a cost-effective approach for estimating emissions and removals in mineral soils in cropland, grassland and any land-use change. The ERT strongly recommends that Estonia begin to implement the IPCC tier 1 method for mineral soils, giving priority to emissions and removals from land-use changes.	In the 2013 submission IPCC tier 1 method was implemented for cropland mineral soils.	Chapter 7.3.2.2	Estonia is searching possibilities in order to carry out cropland soil studies.
LULUCF (Transparency)	The ERT reiterates a recommendation from the previous review report that the Party provide more information on the detailed methods used to identify the exact year when the landuse changes occurred on each sampling plot.	More information is provided in the NIR 2013.	Chapter 7.1.3	
LULUCF (Accuracy)	The tier 2 approach of the IPCC good practice guidance for LULUCF has been applied to estimate the carbon stock changes associated with aboveground biomass, dead wood and biomass burning for the whole time series, combined with specific tier 1 parameters (e.g. BEF, root–shoot ratio). Carbon stock changes in organic soils have been estimated using the IPCC default method. The ERT reiterates the recommendation of the previous review report that Estonia develop country-specific EFs and parameters where possible or, as an interim measure, use the EFs applied by the neighbouring countries with similar forest conditions. For consistency reasons, the ERT also recommends that Estonia revise the estimates of BEFs, EFs and area of drained organic soils, following the revisions made and reported under the KP-LULUCF activities in the submission of revised estimates made during the review week.	Estonia is making effort in order to develop country-specific parameters. During in-country review in 2012, it was agreed that Estonia implements emission factors from Sweden 2012 submission as an interim approach. The estimates of BEFs, EFs and area of drained organic soil have been revised and consistency between the Convention and KP reporting has been assured.	Chapters 7.2, 11.3	
LULUCF (Transparency)	The ERT considers that the reporting in the LULUCF sector is generally transparent. However, the ERT reiterates the recommendation from the previous review report that Estonia provide more detailed information on the methodology used to estimate the carbon stock changes in any land converted to other land in the NIR.	More information is provided in the NIR 2013.	Chapter 7	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
LULUCF (Forest land remaining forest land)	Estonia considers that all forest is managed forest and estimates annually the change in the carbon stock in living biomass by using the stock change method with default parameters (except wood density) from the IPCC good practice guidance for LULUCF. The ERT identified that the carbon stock change method has been incorrectly applied, because first the sum of the carbon stocks across all areas at times t1 and t2 was calculated and then the difference in carbon stocks was calculated. This resulted in errors when the area at times t1 and t2 was not the same. As set out in the IPCC good practice guidance for LULUCF (chapter 4.2.3.2), it is good practice to calculate the carbon stock change as follows: for each given area, the carbon stock change should first be calculated as a difference of carbon stocks between times t1 and t2 s and these stock changes should then be summed for all areas. The ERT recommends that Estonia apply the revised calculation for estimating the carbon stock changes in living biomass in the next annual submission.	The mistake in applying the stock change method has been corrected.	Chapter 7.2.2.1	
LULUCF (Forest land remaining forest land)	The carbon stock changes in living biomass fluctuate considerably between 1990 and 2010, from gains of –2,565.43 Gg C in 1994 to losses of 1,493.84 Gg C in 2001. In its NIR, Estonia reports that the significant change in the harvest volumes and the extensive impact of wildfires (e.g. in 2006) affect the emission estimates. However, the ERT noted that the level of harvest volumes and wildfires cannot explain the large inter-annual fluctuations in the most recent years and concluded that the relatively low NFI sampling frequency in each year is very likely to be the main reason for these fluctuations. The ERT reiterates the strong recommendation of the previous review reports that Estonia explore ways to reduce the inter-annual fluctuations, for example by using the NFI data set for a specific year and that for the five previous years to compare the data of the same sampling plots.	Due to the accounting rules, changes in biomass are very sensitive to the values of carbon stock per ha. For example, deviation of 0.5% produces remarkable annual fluctuations. The NFI determines carbon stock per ha with relative error up to 0.7%. Therefore, the smoothed data is used in this submission. Inter-annual variability is eliminated.	Chapter 7.2	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
LULUCF (Forest land remaining forest land)	A high level of removals was reported in recent years for carbon stock changes of dead organic matter (up to –1,163.05 Gg C in 2004), along with a high inter-annual variability. During the review, the Party explained that in 2001, 2002 and 2005 large scale storms damaged the forests, leading to large accumulations of dead wood. The ERT noted that the accumulation of dead wood due to the storms could not sufficiently explain the high inter-annual variability. Similarly to the carbon stock changes in living biomass, the ERT noted that the inter-annual variability of dead organic matter may be the result of the relatively low NFI sampling frequency in each year. The ERT therefore recommends that Estonia explore ways to reduce these interannual fluctuations and provide quantitative information on the impact of storms in its next annual submission.	Fluctuations in dead wood pool was reduced by implementing average NFI estimates. Additional information about storm damages in forest is provided in the NIR 2013.	Chapter 7.2	
LULUCF (Forest land remaining forest land)	Estonia applied the IPCC tier 1 approach for forest mineral soil, which assumes no change in carbon stock. Although this is a valid assumption in the absence of major changes in harvest intensity, in the last 20 years Estonia experienced significant variations in harvest, with the highest harvest levels corresponding to net emissions from living biomass. Therefore, the ERT considers that the tier 1 approach may not be fully appropriate for Estonia. During the review Estonia informed the ERT about planned improvements for estimating carbon stocks and turnover in forest soils through implementation of a project with the University of Tartu “Carbon stock and turnover in Estonian forest soils“. The ERT commends Estonia for these planned efforts and encourages Estonia to focus its efforts on the estimation of the impact of high harvest levels on forest soil emissions.	Estonia is making effort to improve forest soil emission estimates. As an interim approach, forest mineral soil EF from Sweden is implemented.	Chapter 7.2	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
LULUCF (Land converted to forest land)	Estonia reports removals of 640.19 Gg C for the living biomass of land converted to forest land, with input data using the carbon stock values reported by the NFI. During the review, the ERT noted that Estonia erroneously used the carbon stocks instead of the carbon stock changes to estimate removals, resulting in a significant overestimation of the removals. Also, the ERT noted that the correct use of the carbon stock changes from the NFI to estimate removals resulted in high and unexplainable inter-annual variations. The ERT considers that this variability is probably related to the limited number of plots which each year are classified as land converted to forest land, leading to high variability of total carbon stocks from one year to another. Therefore, the ERT recommends that, for the category land converted to forest land, Estonia use the same method applied for afforestation and reforestation (i.e. the biomass increment is estimated not as a difference in total carbon stocks between successive years, but rather using the mean increment per area unit of a certain age of the existing trees (as reported in table 11.2 of the NIR)).	In the 2013 submission, stock changes are correctly reported. Inter-annual variation was reduced by implementing average NFI estimates. Biomass increment as recommended by ERT was not implemented, instead the stock change method and weighted average BCEF values from IPCC 2006 were applied as also discussed during the in-country review in 2012. Consistency in applying parameters (BCEF, root-shoot ratio etc) was assured under the Convention and KP-LULUCF.	Chapters 7.2, 11.3	
LULUCF (Grassland remaining grassland)	The ERT noted that the removals for living biomass reported by Estonia for the category grassland remaining grassland are very high (reaching –3,351.11 Gg CO_2 eq in 2004) and vary considerably among years. The ERT considers that this is probably related to the method to estimate carbon stock changes in living biomass and recommends that Estonia revise the calculation method and estimate the biomass increment using the mean increment per area unit of certain age of the existing trees.	Revised NFI data and the correct implementation of stock change method gave new more reliable living biomass estimations under Grassland remaining grassland (max -1 394 Gg CO_2 eq. in 2005).	Chapter 7.4.2	
LULUCF (Cropland remaining cropland)	Estonia uses the default EF for cold temperate zone from the IPCC good practice guidance for LULUCF (1.0 t C/ha per year) for estimating emissions from cultivated organic soils. This value is much lower compared with that used by neighbouring countries with similar conditions which implemented tier 2 methods, and it is also considerably lower than the tier 1 value included in the 2006 IPCC Guidelines (5.0 t C/ha per year). The ERT reiterates the recommendation from the previous review report that Estonia develop a country-specific EF and parameters where possible. As an interim measure, the ERT recommends that Estonia use the EF for cultivated organic soil developed by neighbouring countries with similar	Sweden cropland organic soil emissions are highly dependent on the crop type. Since the data regarding crop type distribution and areas are not currently fully available in Estonia, IPCC 2006 default EF was implemented. Please note that IPCC 2006 default EF is 5 t C ha-1 yr-1 and EF used by Sweden is 3.73 t C ha-1 yr-1, therefore it is assumed that there is no underestimation of emissions from cropland organic soils in Estonia.	Chapter 7.3.2.3	Estonia is making effort to develop country-specific emission factors for cropland soils.

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
	conditions that use tier 2 methods, such as the EF used by Sweden.			
LULUCF (CO_2 emissions from agricultural lime application)	The ERT noted that emissions from liming vary considerably among years, and are nearly zero in some years. The ERT encourages Estonia to double-check the input data for estimating emissions for liming or to provide justifications for this variability in its next inventory.	Estonia recognizes the issue related to highly varying emissions from liming. Activity data about liming for the period 1990–2008 is acquired from the Estonian Ministry of Agriculture, according to whom no liming occurred in 2004 and 2008. It is more likely, that there is a gap in data, thus the average liming area and amount of lime of adjacent years were used as input data in order not to underestimate possible emissions. Liming data since 2009 is obtained from Statistics Estonia and is based on Agricultural Census.	Chapter 7.3.2.5	
Waste (Solid waste disposal on land - CH_4)	The ERT encourages Estonia to make further efforts to investigate the historical data of solid waste landfilled by collecting the data from solid waste disposal sites, instead of using expert judgement, to make the estimates more accurate.	Historical data on waste generation per capita and distribution of waste by waste management type will be kept under investigation and updated when data available.	Chapter 8.2.7	
Waste (QA/QC procedures)	Category-specific QA/QC procedures have been implemented in the waste sector. Nevertheless, the explanations for some of the notation keys used are not presented correctly in CRF table 9(a) (i.e. Estonia explained that “NE” is reported for CH_4 emissions from biogenic waste incineration due to lack of AD although, actually, the AD are available but the methodology for estimation of these emissions is not available in IPCC good practice guidance). In addition, the ERT identified discrepancies between the data in the CRF tables and the NIR (e.g. in solid waste disposal on land the amount of degradable organic carbon (DOC) and the fraction of DOC in municipal solid waste used were swapped). The ERT encourages Estonia to enhance QA/QC procedures for the preparation of its next annual submission.	Estonia made corrections in used notation keys in CRF Reporter. Correct explanation for notation key for CH_4 under waste incineration was added.	6.C Waste Incineration in CRF Reporter	Estonia will enhance QA/QC procedures for the preparation of its next annual submission.

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
Waste (Solid waste disposal on land - CH_4)	The IPCC first order decay method was used to estimate emissions of CH4 from this category. Estonia uses the default CH_4 generation rate constant (k) and a default DOC value for different waste types from the 2006 IPCC Guidelines without providing a justification that these parameters better suit the national circumstances of Estonia than those from the Revised 1996 IPCC Guidelines. Other parameters used, such as the methane correction factor, the fraction of DOC dissimilated, the oxidation factor and the fraction of CH_4 in landfill gas are the default values as in the IPCC good practice guidance. The ERT noted that information about the quantity of waste deposition on land for the entire time series is not presented in the NIR. The ERT recommends that Estonia improve the transparency of its reporting by providing more detailed information about the choice of waste deposition data, the CH_4 generation rate constant and the DOC content, and justify the use of parameters from the 2006 IPCC Guidelines in the next annual submission.	Estonia added detailed information about the waste deposition data in NIR (amounts of municipal and industrial wastes disposed in SWDS). In addition Estonia justified the use of parameters taken from 2006 IPCC Guidelines in NIR.	Chapter 8.2.2, Table 8.5, Table 8.6, Table 8.8	
Waste (Solid waste disposal on land - CH_4)	In 2010, 1.63 Gg CH_4 are reported as recovered and deducted from the total CH_4 emissions. However, CH_4 generated at solid waste disposal sites that is recovered and burned in a flare is not reported as recovery, which is not in line with the IPCC good practice guidance. The ERT recommends that Estonia report CH_4 recovered and burned in a flare properly, as CH_4 recovered, as required by the IPCC good practice guidance.	Estonia made recalculation for CH_4 recovery for years 2009 and 2010, as the quantities of biogas burnt in a flare should be count in under CH_4 recovery.	Chapter 8.2.1, 8.2.6	
Waste (Wastewater handling - N_2O)	The methodology from the 2006 IPCC Guidelines was used to estimate N_2O emissions from domestic and commercial wastewater (without human sewage) without an explanation of why this is better suited to the national conditions in Estonia than those in the Revised 1996 IPCC Guidelines. These estimates of N_2O emission (in accordance with 2006 IPCC Guidelines) include N_2O emissions from human sewage. The ERT noted that Estonia reported N_2O emissions from human sewage separately, in the subcategory N_2O emissions from human sewage, as required by the Revised 1996 IPCC guidelines, which leads to double counting of N_2O emissions from wastewater (as these emissions are reported under both, domestic and commercial (without human sewage) and under subcategory N_2O emissions from human sewage). The ERT therefore recommends that Estonia report N_2O emissions from human sewage separately from	In order to be in accordance with IPCC Guidelines and to avoid double counting of emissions, N_2O emissions under domestic and commercial wastewater treatment were discounted from the inventory and only N_2O emissions from human sewage using 1996 IPCC Guidelines were reported.	Chapter 8.3.6	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
	the subcategory domestic and commercial (without human sewage) to avoid double counting of emissions.			
Waste (Waste incineration - CO_2, N_2O)	Estonia has reported emissions from waste incineration with energy recovery under theenergy sector, which is in line with the IPCC good practice guidance. However, the ERT noted that the CO_2 and N_2O emissions from the incineration of biogenic and non-biogenic waste for nonenergy use are reported under biogenic waste incineration. Therefore CO_2 emissions from nonbiogenic waste incineration for the period 1990 to 2005 are not included in total GHG emission as all waste was considered as biogenic. In accordance with the Revised 1996 IPCC Guidelines the fossil based emissions should be considered as net carbon emissions. Therefore GHG emissions for 1990–2005 are underestimated. The ERT recommends that Estonia report emissions from biogenic and non-biogenic waste separately and include CO_2 from non-biogenic waste incineration in the total CO_2 emissions in its next annual submission.	Estonia reported emissions from biogenic and non-biogenic waste separately and included CO_2 from non-biogenic waste incineration in the total CO_2 emissions.	Chapter 8.5.6	
KP-LULUCF (Afforestation and reforestation)	The forest definition used by Statistics Estonia (minimum land area of 0.1 ha) is different from that used by the NFI (minimum land area of 0.5 ha). As also noted by previous review reports, this discrepancy suggests that the area of afforestation and reforestation may be overestimated. According to NFI estimates, the difference in area due to different forest definitions applied by Statistics Estonia and the NFI constitutes only 0.35 per cent of the total forest area of Estonia. The ERT considers that, since this figure has been obtained for the total forest area, the real difference related to different forest definitions during the detection of small and scattered events such as afforestation and reforestation may be higher. Therefore, the ERT recommends that, in its next annual submission, Estonia assess the impact of the application of different forest definitions specifically for afforested and reforested lands, and use the results to correct the areas of afforestation and reforestation obtained using the Statistics Estonia data.	Estonia takes into account the recommendations and will adjust the values of AR areas in the next submission. However, differences will be negligible because information of Statistics Estonia does not include information on very small afforestation areas.	Chapter 11	Estonia is planning to change accounting system of afforestation.

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
KP-LULUCF (Deforestation)	The ERT noted that the frequency of NFI sample plots does not allow for the detection of annual deforestation events (typically small and rare) with high statistical confidence (i.e. on average, every year only about 1–3 plots of new deforestation events are sampled over the whole country). The ERT considers that this may introduce a significant statistical inaccuracy in the annual estimates of emissions from deforestation. In order to increase the confidence that deforested areas during the commitment period are not underestimated, the ERT strongly recommends that Estonia analyse other possible sources of information (land-use statistics, harvesting permits, land cadastre) to complement the NFI data, and include the results of this analysis in the next annual submission.	Estonia agrees with note and recommendation. NFI is currently the only source of information. There is no land-use statistics usable for detection of deforestation areas, harvesting permits do not differentiate forest and other land, land cadastre data is static since 1991.	Chapter 11	Estonia is searching possibilities in order to collect additional data.
KP-LULUCF (Transparency)	Overall, the additional information on land identification provided by Estonia during the review increased the confidence of the ERT on the capacity of the Party to identify areas of land and areas of land-use change. However, the ERT strongly recommends that Estonia improve the transparency of information provided in the NIR specifically on: (i) how afforested and reforested areas are identified by Statistics Estonia; (ii) how deforestation areas are detected in practice (areas identified, year of change); and (iii) how each plot is classified as deforested and then translated into deforestation area.	More information is provided in the NIR 2013.	Chapter 11	
KP-LULUCF (Afforestation and reforestation)	The ERT commends recommends that Estonia develop country-specific EFs for all carbon pools (litter, dead wood and mineral soil) reported.	Estonia is making effort in order to develop country-specific emission factors for litter, dead wood and mineral soil on AR areas. As an interim approach, EF-s from Sweden are implemented.	Chapter 11	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
KP-LULUCF (Afforestation and reforestation)	For estimating the carbon stock changes in living biomass on afforestation and reforestation areas, Estonia used the values of biomass mean increment per unit area of a certain age of forest (derived from NFI data), combined with tier 1 parameters (BEF, root–shoot ratio, wood density). During the review, the ERT noted that the value of BEF was higher (2.5) compared with the default value (1.3). Estonia explained that this value was taken from the upper part of the range provided by the IPCC good practice guidance for LULUCF (BEF of 1.3 for temperate conifers, with a range of 1.15–4.2; whereas the higher values are typical for young forests). The ERT noted that the 2006 IPCC Guidelines (table 4.5 in Vol. 4) provide BEFs as a function of growing stock, climate and species. The 2006 IPCC Guidelines suggest that a BEF of 2.5 is applicable for very young forests only. The ERT recommends that Estonia use a lower BEF value which is more appropriate for the growing stocks of afforestation and reforestation areas in Estonia.	BCEF values from the IPCC 2006 are implemented in the 2013 submission.	Chapter 11	
KP-LULUCF (Afforestation and reforestation)	When estimating emissions from organic soils, Estonia used the NFI information on the share of drained organic soil area over the total area of forest organic soils. However, the ERT noted that this information is valid for forest remaining forest, while for land-use changes from/to forest it is more appropriate to assume (in the absence of more specific information) that all the area of organic soils is drained. Furthermore, the ERT noted that for calculating emissions from organic soils Estonia used the EF from the IPCC good practice guidance for LULUCF for afforestation and reforestation areas, whereas the EF from Sweden is used for deforestation areas. In order to ensure consistency throughout the KP-LULUCF sector, the ERT recommends that Estonia use the EFs from Sweden for afforestation and reforestation as well as for deforestation.	In the 2013 submission all soils under AR are considered drained. EFs from Sweden are used consistently throughout the LULUCF and KP-LULUCF sector, including ARD.	Chapters 7 and 11	
KP-LULUCF (Afforestation and reforestation)	The ERT recommends that Estonia in its next annual submission: (i) use the country-specific shares of different growing stocks and species to estimate more accurate BEFs; and (ii) develop species-specific values of biomass mean increment per unit area of a certain age of forest.	Weighted average BCEF (considering species, stand age and growing stock) from the IPCC 2006 is implemented.	Chapter 11	

Category	Comment	Estonia's response	Where in NIR 2013	Future plans
KP-LULUCF (Deforestation)	In its 2012 annual submission, Estonia estimated emissions from litter, mineral soils and organic soils in deforested areas using the EFs from Sweden. While the ERT recommends that Estonia develop country-specific EFs for key categories whenever possible, the use of EFs from Sweden may be considered acceptable as an interim solution. The ERT noted that EFs were erroneously applied as factors for carbon stock, instead of factors for carbon stock change, and recommends that Estonia correct this mistake in its next annual submission. Furthermore, the ERT recommends that Estonia, as an interim solution, use the weighted average value EFs from Sweden, according to area of land-use changes (forest land converted to other land uses) existing in Estonia.	The mistake in applying EFs has been corrected and the method recommended by the ERT has been implemented.	Chapters 7 and 11	
KP-LULUCF (Deforestation)	As part of the revised estimates made during the review, Estonia implemented the recommendations of the ERT regarding EFs of litter, mineral soils and organic soils in deforested areas. Overall, the revised estimates for deforestation provided during the review indicate total emissions for the period 2008–2010 equal to 1,877.81 Gg CO_2 eq, as compared with 1,462.13 Gg CO_2 eq reported in the original 2012 annual submission. The ERT commends Estonia for the improvements made in estimating emissions from deforestation and recommends that Estonia include all these emissions and removals in its next annual submission.	Emissions under deforestation have been calculated based on the recommendations made by the ERT.	Chapter 11	

10.4.2. KP-LULUCF inventory

Planned improvements in KP LULUCF sector include following:
- improving the accuracy of D areas using updated data from fieldwork;
- assessments of the AR sites in the framework of the NFI;
- estimation of omitted carbon pools (litter, mineral soil).

Estonian Environment Information Centre has initialized a project aimed to conduct fieldwork in order to obtain data about litter and mineral soil organic carbon stocks. Preliminary estimates are expected to be obtained by 2014.

PART II: SUPPLEMENTARY INFORMATION REQUIRED UNDER ARTICLE 7, PARAGRAPH 1

11. KP-LULUCF

11.1. General information

Under Article 3, paragraph 3, of the Kyoto Protocol (KP), Estonia reports emissions and removals from afforestation (A), reforestation (R) and deforestation (D). The estimates for emissions and removals are prepared and reported consistent with the IPCC GPG LULUCF 2003 and Decisions 15/CMP.1 and 16/CMP.1 of the KP.

Estimates of emissions and removals from Article 3.3 activities are presented in Table ES.3. In 2011, net emissions from Article 3.3 activities were 232.11 Gg CO_2 eq. Uptake from afforestation and reforestation activities including emissions from biomass burning was estimated at -145.01 Gg CO_2 eq., whereas deforestation resulted in a net emission of 377.12 Gg CO_2 eq. Areas subject to AR and D were 27 295 and 19 135 ha, respectively by the end of 2011. Annual rates of afforestation and deforestation have declined continuously from 0.6 kha to 0.4 kha per year for AR and from 2.2 kha to 0.8 kha per year for D during the period 2008–2011 (Table 11.10).

11.1.1. Definition of forest and any other criteria

Paragraph 1 of the definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the Kyoto Protocol, as contained in the Annex to decision 16/CMP.1 defines 'forest' as "a minimum area of land of 0.05–1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10–30 per cent with trees with the potential to reach a minimum height of 2–5 meters at maturity *in situ*. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high portion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10–30 per cent or tree height of 2–5 meters are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest."

The definition of forest established by FAO (GFRA 2005) fits within the Kyoto's – 'land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use'.

The Estonian Forest Act and the consequent definition of forest has been amended several times during the last 20 years. The last one stipulates forest land as land which meets at least one of the following requirements:

i) forest land use is included in land cadastre;

ii) has an area of 0.1 hectares of land, growing woody plants with a minimum height of 1.3 meters and the tree crown cover at least 30 percent.

This approach is possible if there is the case of a specific part of the forest. However, it is practically very difficult to follow the requirement of forest use in cadastre in statistics for the whole country. Should also be noted that up to 13% of forest land has not yet been registered in the cadastre. Also, there is no international definition of forest based on registering forest land in the cadastre.

In addition, as the criterion of 1.3 m has caused some confusion in earlier reports, it should be noted that it is not 'the minimum tree height' in context of forest land definition. Actually, 1.3 m is criteria for counting unstocked forest area to stocked forest. The minimum potential tree height *in situ* by meaning of the Forest Act is defined by tree species, stand's age and site index. Thus, there is not constant criteria for tree height in national definition.

For consistent statistical reasons, Estonian National Forest Inventory (NFI) has complied in general with the definition of forest, which was sustained in 1999. According to that, forest land is 'a land spanning 0.1 ha or more with tree crown cover (equivalent stocking level) of 30% or more with trees with the potential to reach a minimum height depending on the function of tree species, stand's age and site index. The latter criterion can be interpreted as stand productivity at least in 'Va yield class'. Forest area includes temporary unstocked forest land (clear-cut areas, young regeneration areas, failed stands etc) that has enough potential to be a forest. It does not include land that is predominantly under agricultural or urban land use. According to the NFI's definition of forest, estimates reported in national statistics and also in the UN/FAO Forest Resources Assessment (2005, 2010) procedure.

Starting from 2005, FRA 2005 forest criteria and OWL criteria were used in parallel with the national forest definition in the framework of the NFI. The aim was to present more precise and internationally comparable assessments in the future. Despite the fact the NFI could publish nowadays statistics in accordance with the forest definition of FRA, appropriate assessments are not published until now in international reports. Compared to the national definition, area of forest land is about 2% higher according to the FRA forest definition.

Due to the differences between definitions and that given in the decision 16/CMP.1, under the KP Estonia has defined forest as a land with the main parameters of forest definition reported in Table 11.1. These criteria are also used under UNFCCC reporting for the LULUCF sector.

Table 11.1. Elected parameters for forest definition

Minimum tree crown cover	30%
Minimum land area	0.5 ha
Minimum tree height	2 m

Compared to national definitions, the minimum tree crown cover (equivalent stocking level) criterion corresponds to the national definition of forest.

Since the NFI has been recording information on forests, which remain in their surface area per hectare between 0.1 and 0.5 (due to the fact that criterion of 0.5 ha has been a minimum forest area in one of the earlier redaction of the Forest Act), there is information available that is used to exclude these areas (sample-plots) from LULUCF statistics. The proportion of sample plots under 0.5 ha in forests is 0.35%. The same information is used for estimating forest area according to the FRA definition.

As mentioned above, there is no strict definition of the criterion of minimum tree height in the national definition of forest. For estimating forest area according to the FRA definition, the criterion 5 m of minimum tree height is used. As there is no forest-tree species that could reach the height of 2 m and not 5 m in the age of maturity in Estonia, the criterion and data same as for counting forests according to the FRA definition can be used.

The total forest land in Estonia is or has been covered with forest management plans. In addition, protected forests are covered with the protection scheme. Thus, the total forest land in Estonia is managed forest – managed in one way or another.

11.1.2. Elected activities under Article 3, paragraph 4, of the Kyoto Protocol

Estonia has elected to account the activities under article 3.3 (afforestation, reforestation and deforestation) for the first commitment period stated in the report “Report to facilitate the estimation of Estonia’s assigned amount under the Kyoto Protocol, 2007”.

Estonia has not elected to account the activities under article 3.4 for the first commitment period.

11.1.3. Description of how the definitions of each activity under Article 3.3 and each elected activity under Article 3.4 have been implemented and applied consistently over time

Estonia started to make efforts to monitor, estimate and to report carbon flows related to afforestation (A), reforestation (R) and deforestation (D) activities for the first time in the 2010 submission. All forests fulfilling the definition of forest, as given above, are considered as managed forests.

In previous submissions, afforestation and reforestation areas were obtained from Statistics Estonia, that represents unequivocally “direct-human induced” afforestation and reforestation (only plantations are included), and these data represent about one third of the total area reported under land converted to forest. In current submission a new approach is implemented, NFI field data about land-use changes were used, assuming that cropland, wetlands and settlements conversion to forest land reported under the UNFCCC is direct human-induced land conversion, these areas were summed in order to get AR area (Table 11.10). Grassland and other land conversion to forest land is considered not directly human induced. Grassland conversion to forest land is major land use change to forest that occurs mainly due to abandonment and lack of management of the land, therefore these areas were not taken into account for afforestation reporting. With the new approach all AR areas are identified and georeferenced, detailed information about growing stock, mineral and organic soil distribution is obtained from NFI and consistency between UNFCCC and KP-LULUCF reporting is assured.

Data about deforestation areas has been acquired from NFI database. This database contains sample plot data, stand-level and tree data. To collect specific land use change data, additional field study started in 2009 in the framework of the NFI. In this submission new datasets are used for land use change, including deforestation activities. The land use at the end of 1989 for each sample plot has been derived from the information of land use and land-use changes assessed in the field using aerial photographs as supporting material if necessary. The time series for D activities were established from data using the same principles and definitions for forest and D activities. NFI will continue to monitor forest and other land-use categories during the first commitment period (or as long as needed).

The forests, other land use and land-use changes are monitored every year in the whole country. Sampling design of the Estonian NFI and the method for estimating land use changes is described in Subchapter 7.1.3. More detailed information about sampling scheme, design and density is described in National Forest Inventories (2010)[219].

With the new approach, all activity data (AR & D) is obtained from one source, NFI, which increases transparency, consistency, accuracy and comparability of the report.

11.1.4. Description of precedence conditions and/or hierarchy among Article 3.4 activities, and how they have been consistently applied in determining how land was classified.

Not applicable.

11.2. Land-related information

Estonia implements the *Reporting Method 1* for lands subject to Article 3.3 activities. The area of Estonia is not divided into regions because it is relatively small and homogeneous in terms of ecological conditions. *Approach 2* is used for determining the land areas and land-use changes related to afforestation/reforestation and deforestation. Data for land-use changes is obtained by the National Forest Inventory. NFI is a sampling based inventory system that covers all land-use categories. Sampling unit for area estimation is a point. Plots that contain different land categories or stands of distinctly different parameters are divided into sections accordingly to the detailed regulation. The latter ones counted in estimations with its area weighted to full-size sample plot. More information can be found in Chapter 7.1.3.

11.2.1. Spatial assessment unit used for determining the area of the units of land under Article 3.3

The spatial assessment unit to determine the area of units of land under Article 3.3 is 0.5 ha, which is the same as the minimum area of forest.

11.2.2. Methodology used to develop the land transition matrix

Approach 2 is employed to estimate areas of land use change in the LULUCF sector inventory. In order to collect data about land-use transitions, additional field studies started in 2009 in the framework of the NFI. This method follows the example of Finnish NFI. The fieldwork is ongoing (until 2014 or as long as needed). Collected data provides information on different land use classes (origins retrospectively 20 years), the year of changes and also soil type. During land category registration, “LULUCF former land category” is registered on every sample plot if land category has changed after base point (31.12.1989). The year of change is being estimated first directly in the field. Older maps and aerial photographs are used afterwards as supporting material to determine the exact year more accurately. Since 1999 there is information available on permanent sample plots. The annual land-use change areas were calculated for 1990–2011. Land transition matrix was developed by adding and subtracting land under conversion to and from land-use category areas.

[219] p.177-183; *http://www.springer.com/life+sciences/forestry/book/978-90-481-3232-4.*

11.2.3. Maps and/or database to identify the geographical locations, and the system of identification codes for the geographical locations

The area of Estonia is not divided into geographical regions. Since the spatial assessment unit defined is Estonia's national territory, the geographical location of the boundaries of the areas that encompass units of land subject to ARD is that of the entire country.

11.3. Activity-specific information

11.3.1. Methods for carbon stock change and GHG emission and removal estimates

The same methodology, emission factors and data sources is used for reporting LULUCF under the KP as for reporting under UNFCCC.

11.3.1.1. Description of the methodologies and the underlying assumptions used

Carbon stock changes in living biomass

Carbon stock changes in living biomass on AR areas have been estimated following the same method as under the UNFCCC reporting land converted to Forest land subcategory. Growing stocks are obtained from NFI.

Above-ground living biomass is calculated as follows, taking into account an average tree species distribution on AR areas (by the NFI), average growing stock level by stand age (NFI) and default BCEFs for boreal forests (IPCC 2006, Table 4.5, p 4.50):

$$\mathrm{AG}_t = \frac{c}{2}\left(\sum_{i=1}^{3}\alpha_i\beta_{ij(u)}\right)\left(\sum_{k=1990}^{t}s_k(t-k)(t+1-k)\right)$$

where

AG_t − above-ground living biomass, tonnes in year t

c − average change of growing stock per year in young stands, $m^3\ ha^{-1}$

s_k − AR area in year k

t, k − year

α_i − share of tree species (Table 11.3)

$\beta_{ij(u)}$ − $BCEF_S$ of tree species, tonnes m^{-3} (Table 11.2)

i − index of tree species (Table 11.2, Table 11.3)

$$j(u) = \begin{cases} 1, \textbf{\textit{if}}\ 0 \le u < 10 \\ 2, \textbf{\textit{if}}\ 11 \le u \le 16 \\ 3, \quad \textbf{\textit{if}}\ u > 16 \end{cases}$$

where

$j(u)$ − index of growing stock level by stand age (Table 11.4)

$$u = \sum_{k=1990}^{t}(t-k)$$

Table 11.2. $BCEF_S$ [t biomass/m³ wood volume]

Species	Growing stock level [m³/ha]		
	< 20	21–50	51–100
pine	1.20	0.68	0.57
spruce	1.16	0.66	0.58
hardwoods	0.90	0.70	0.62

Table 11.3. Distribution of main tree species and applied R ratio on AR areas

Main tree species		Root-shoot ratio[220]
Pine	0.4268	0.390
Spruce	0.5276	0.390
Others (mainly birch)	0.0457	0.460
Weighted average		0.393

Table 11.4. Input $BCEF_S$[221] for above-ground AR biomass calculations

Age of AR	Growing stock m³/ha	$BCEF_S$ weighted average
1...6	< 20	1.1652
7...13	21-50	0.6704
14...22	51-100	0.5776

Equation 7.2 and same parameters as undel Forest Land conversion to other land uses are applied to estimate carbon stock changes in living biomass above- and below-ground pools and dead wood pools for D areas.

Carbon stock changes in mineral and organic soils

Emissions from mineral and organic forest soils were calculated similarly as those under the Convention reporting (chapters 7.2.2.5 & 7.2.2.6), only weighted average emission factors seen in tables Table 11.5 & Table 11.6 were applied.

Table 11.5. EF used for AR mineral and organic soil and litter emission estimations

LUC	kha (2011)	%	EF min soil	EF org soil	EF litter
CL→FL	17.1	63%	-0.85	-0.57	0.3
WL→FL	5.3	20%	0.17	-0.57	0.3
SL→FL	4.8	18%	0.17	-0.57	0.3
TOTAL	27.3	weighted average	**-0.266**	**-0.57**	**0.3**

[220] IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
[221] IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50

Table 11.6. EF used for D mineral and organic soil and litter emission estimations

LUC	kha (2011)	%	EF litter	EF mineral soil	EF organic soil
FL→GL	5.4	28%	-0.75	0.225	-1.6
FL→WL	2.4	13%	-1.25	-1.30	-1.741[222]
FL→SL	8.9	47%	-1.25	-1.30	-1.30
FL→OL	2.4	12%	-1.25	-1.30	-1.30
TOTAL	19.14	weighted average	**-1.108**	**-0.867**	**-1.441**

Carbon stock changes in litter and dead wood

According to Estonian national forest inventory conducted on permanent sample plots, there is no significant dead wood present on AR areas, thus NO is reported for changes in dead wood pool on AR. For changes in the litter pool, the same approach as under land converted to Forest land subcategory was implemented (chapter 7.2.2.4 and Table 11.5).

Emissions related to dead wood after deforestation were calculated following the same approach as under the Convention reporting (chapter 7.2.2.3), assuming that all dead wood will be lost. Losses from litter under D were estimated based on the weighted average value of litter emission factors (Table 11.6) obtained from the Swedish submission 2012[223].

Biomass burning

Non-CO_2 emissions from biomass burning were provided for AR areas only. The same methodology was implemented as described under the Convention reporting Section 7.8. Equation 7.13 and parameters indicated in Table 11.7 were used. Data regarding forest growing stock (biomass burnt) was obtained from NFI. For combustion efficiency, a higher value than the one used under Forest Land (CRF 5.A) was chosen based on expert opinion, since compared to mature forests young trees are more affected by forest fires.

Table 11.7. Parameters used for biomass burning estimation on AR areas

	Combustion efficiency [224]	CH_4 emission factor [225]	N_2O emission factor [226]
AR	0.76	9	0.11

[222] CO_2-C country-specific emission factor of peatland, Table 7.27.
[223] National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84.
[224] GPG-LULUCF 2003, Table 3A.1.12, p. 3.179, upper limit of All Boreal Forest, NFI expert opinion, EEIC.
[225] GPG-LULUCF 2003, Table 3A.1.16, p. 3.185, Forest fires (Delmas *et al.* (1995)).
[226] GPG-LULUCF 2003, Table 3A.1.16, p. 3.185, Forest fires (Delmas *et al.* (1995)).

Instant oxidation is assumed for all living biomass under deforestation, therefore its is reported that burning does not occur under D areas.

Other GHG emissions

Emissions from N fertilization and from lime applications are not estimated, since they do not occur.

11.3.1.2. Justification when omitting any carbon pool or GHG emissions/removals from activities under Article 3.3 and elected activities under Article 3.4

No pools have been omitted in the 2013 submission. Missing country-specific data is replaced with emission factors obtained from the Sweden 2012 submission and the approach has been approved by the in-country review in 2012.

11.3.1.3. Information on whether or not indirect and natural GHG emissions and removals have been factored out

Indirect and natural GHG emissions/removals have not been factored out.

11.3.1.4. Changes in data and methods since the previous submission (recalculations)

Several suggestions and recommendations were made by the in-country UNFCCC review in 2012. All the recommendations have been followed and improved estimates are provided in the 2013 submission.

In current submission a new approach was implemented for obtaining areas subject to afforestation and reforestation. NFI field data about land-use changes were used, assuming that cropland, wetlands and settlements conversion to forest land reported under the UNFCCC is direct human-induced land conversion, these areas were summed in order to get AR area (more information in Chapter 10.1.2).

For living biomass estimations, up-to-date root-shoot (R) and $BCEF_S$ values (Table 11.8) from the IPCC 2006 guidelines were applied. The mistake in applying the stock-change method has been corrected (see chapter 7.2.2.1).

Weighted average emission factors from Sweden were applied to obtain carbon stock changes in mineral and organic soils, also for the litter pool under deforestation.

More appropriate dead wood densities were used in current submission.

See also Chapter 10.1.2 and 10.2.2.

Table 11.8. Parameters used in ARD recalculations

	2012 submission			2013 submission		
Afforestation /reforestation	parameter	value	source	parameter	value	source
Living biomass	BEF upper limit of the range for boreal young forests	2.5	Table 3A.1.10, LULUCF GPG 2003, p. 3.178	$BCEF_S$ weighted average for each stand age depending on tree species distribution	Age 1...6 1.1652 7...13 0.6704 14...22 0.5776	IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50
	R average	0.445	Table 3A.1.8, LULUCF GPG 2003, p. 3.168	R tree species and above-ground dependent weighted average	0.39	IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
Mineral soil	EF	NE	NA	EF mineral LUC weighted average	-0.266	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84
Organic soil	EF	-0.16	Table 3.2.3, LULUCF GPG 2003, p. 3.42	EF organic LUC weighted average	-0.57	
Litter	EF	NE	NA	EF litter	0.3	
Deforestation						
Living biomass	BEF weighted average	1.33	Table 3A.1.10, LULUCF GPG 2003, p. 3.178	$BCEF_S$ weighted average	0.58	IPCC 2006, Vol 4 (AFOLU), Table 4.5, p. 4.50
	R weighted average	0.29	Table 3A.1.8, LULUCF GPG 2003, p. 3.168	R weighted average	0.235	IPCC 2006, Vol 4 (AFOLU), Table 4.4, p. 4.49
Mineral soil	IEF	-1.204	2008 & 2009 average IEF GL to FL, from Sweden CRF 2011 submission	EF mineral LUC weighted average	-0.867	Kõlli *et al*. 2004. Organic Carbon pools in Estonian Forest Soils; Kõlli *et al*. 2009. Stocks of organic carbon in Estonian soils National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84
Organic soil	EF	-0.25	Table 3.4.6, LULUCF GPG 2003, p 3.118	EF organic LUC weighted average	-1.441	National Inventory Report, Sweden 2012, Annexes, Table A 3:2.9, p. 84

Litter	IEF	-1.243	2008 & 2009 average IEF GL to FL, from Sweden CRF 2011 submission	EF litter LUC weighted average	-1.108	
Dead wood	Dead wood density [t m^{-3}] All tree species	0.266	Merganičová, K., Merganič, J. 2010. Coarse woody dbris carbon stocks in natural spruce forests of Babia hora	Average dead wood density [t m^{-3}] of pine, spruce and birch	0.2465	Sandström *et al*, 2007. Biomass conversion factors (density and carbon concentration) by decay classes for dead wood of Pinus sylvestris, Picea abies and Betula spp. in boreal forests of Sweden

11.3.1.5. Uncertainty estimates

Tier 1 was implemented for estimating uncertainty rates related to activity data and emission factors employed in the estimates under Article 3.3. activities. The methodology for uncertainty estimation will be further developed.

Table 11.9. Uncertainties of ARD activities.

IPCC Source Category		Uncertainties ±%		EF References
		Activity data[227]	Emission factors	
KP.A.1.1	Afforestation and Reforestation - living biomass	26.04	46.95	IPCC 2003 & 2006
KP.A.1.1	Afforestation and Reforestation - litter	22.09	50.00	Sweden NIR 2012, Table 7.5, p. 291
KP.A.1.1	Afforestation and Reforestation - mineral soil	25.32	35.00	Sweden NIR 2012, Table 7.5, p. 291
KP.A.1.1	Afforestation and Reforestation - organic soil	45.42	35.00	Sweden NIR 2012, Table 7.5, p. 291
KP.A.1.1	Afforestation and Reforestation - biomass burning	22.09	70.00	LULUCF, 2003, p. 3.50
KP.A.1.1	Afforestation and Reforestation - biomass burning	22.09	70.00	LULUCF, 2003, p. 3.50
KP.A.2	Deforestation - living biomass	26.53	46.95	IPCC 2003 & 2006
KP.A.2	Deforestation - litter	25.69	50.00	Sweden NIR 2012, Table 7.5, p. 291
KP.A.2	Deforestation - dead wood	28.74	12.89	Sandström *et al.* 2007
KP.A.2	Deforestation - mineral soil	28.59	35.00	Sweden NIR 2012, Table 7.5, p. 291
KP.A.2	Deforestation - organic soil	58.83	35.00	Sweden NIR 2012, Table 7.5, p. 291

11.3.1.6. Information on other methodological issues

The NFI measures one fifth of the sample plots of one inventory cycle during one year. When describing rare events, NFI estimates have the disadvantage fluctuations from year to year when using the data from one year. In current submission, NFI field data from 2009 - 2011 was used to assess the changes in land-use data in 1990s. To improve the accuracy of the estimates, several years data should be used.

More accurate assessment of AR sites is under development in the framework of the NFI. The argument for applying NFI data is that it is the only continuous inventory and monitoring system in Estonia that covers all land uses and gives reliable estimates for the land use areas and tree growth.

11.3.1.7. The year of the onset of an activity, if after 2008

The year of the onset of an activity is 2008.

[227] All activity data uncertainty estimates are obtained from NFI.

11.4. Article 3.3

Estonia reports all emissions by sources and removals by sinks from AR activities under Category A.1.1 Afforestation/Reforestation: units of land not harvested. Forests afforested or reforested since 1990 have not reached the regeneration age by the first commitment period. According to guidance for good silviculture, the rotation time varies from 30 to 120 years depending on the tree species and site index of a forest.

The areas of Article 3.3 activities are estimated as described in Section 11.2.2. – the cumulative sum of areas afforested/reforested and deforested since 1990.

11.4.1. Information that demonstrates that activities under Article 3.3 began on or after 1 January 1990 and before 31 December 2012 and are direct human-induced

The activity data subject to afforestation/reforestation and deforestation areas is presented in Table 11.10. The reported AR activities are directly human induced since those activities are based on decisions not to continue the previous activities but the forest management activities. Planting of new forest is the main human-induced reforestation activity directed towards increasing of forest area in Estonia. Afforestation activities have been implemented on agricultural lands and exhausted quarries.

Changes in deforested areas were detected on NFI sample plots. The land-use category in the end of 1989 was assessed during field measurements, in addition aerial photos were used where necessary. Since the land-use category just before 1 January 1990 was fixed, the reported land-use changes have occurred after that. Occurrence of not directly human-induced changes resulting in deforestation are practically non-existent in Estonia.

Table 11.10. Areas subject to afforestation/reforestation (AR) and deforestation (D) activities, ha (NFI)

Year	Afforestation/ Reforestation	Deforestation
1990	1 860.5	177.0
1991	1 883.1	211.0
1992	1 869.1	182.4
1993	2 132.6	281.7
1994	2 100.7	346.5
1995	2 089.1	347.2
1996	2 058.6	282.2
1997	1 943.3	282.2
1998	1 635.6	259.9
1999	1 417.6	259.6
2000	1 185.1	392.8
2001	863.4	518.3
2002	761.5	813.2
2003	639.4	946.9
2004	783.1	1 260.5
2005	774.5	1 896.3
2006	839.4	2 323.5
2007	706.0	2 225.3
2008	574.3	2 230.7
2009	395.3	1 852.7
2010	391.3	1 216.4
2011	391.9	829.1

Year	Afforestation/ Reforestation	Deforestation
Total	27 295	19 135

11.4.2. Information on how harvesting or forest disturbance that is followed by the re-establishment of forest is distinguished from deforestation

According to Estonian legislation land category change by human is allowed only with orders from local authorities and/or environmental minister. This must be preceded by the reassignment of the land (eg commercial, residential or transport land), which is reflected both in the Land Cadastre and Land Registry. When a NFI sample plot is located in a clear-cut area, the surveyor assesses whether the cutting has been done for regeneration purpose or for land-use change. Clear signs of a land-use change can be seen in the surrounding and location of the area; also the data from Land Cadastre and Land Registry is checked.

According to the Forest Act, forest owner is obliged to implement reforestation techniques to the extent that within five years after logging or forest death ensures a renewed forest. Re-establishment of a forest usually starts within 2 years after the harvesting.

11.4.3. Information on the size and geographical location of forest areas that have lost forest cover but which are not yet classified as deforested

Clear-cut forest areas, which have not classified as deforestation, were classified as temporarily unstocked forest.

11.5. Article 3.4

Not applicable.

11.6. Other information

Estonian Forestry Development Plan up to 2020 was approved by the Parliament on 15 February 2011. The main aim of the Forestry Development Plan is to ensure sustainable forest management.

At present, land reform in Estonia is coming the end and no special measures regarding afforestation, reforestation and deforestations are foreseen. Therefore current trends are expected to continue and activities under Article 3.3 are expected to be a source during the first commitment period.

11.6.1. Key category analysis for Article 3.3 activities and any elected activities under Article 3.4

The basis for assessment of key categories under Article 3.3 of the KP is the same as the assessment made for the UNFCCC inventory. Key category analysis for KP-LULUCF was performed according to Chapter 5.4.4 of the IPCC Good Practice Guidance for LULUCF (IPCC 2003).

According to the IPCC GPG for LULUCF the key categories for Kyoto Protocol activities can be derived from the identified key categories in the UNFCCC inventory as follows: Whenever a category is identified as key in the UNFCCC inventory, the associated activity under the Kyoto Protocol can be considered as key in reporting under the Kyoto Protocol. According to this approach, all of the categories under Articles 3.3 of the Kyoto Protocol (afforestation and reforestation, deforestation) can be regarded as key categories.

11.7. Information relating to Article 6

No projects in this sector under Article 6 are implemented in Estonia.

12. INFORMATION ON ACCOUNTING OF KYOTO UNITS

12.1. Background information

Standard Electronic Format report (hereinafter as SEF) information corresponds to the requirements of decisions 14/CMP.1 and 15/CMP.1. Information required under Decision 15/CMP.1 paragraph 11 is displayed as required by UNFCCC ITL Administrators' "Standard Independent Assessment Report. Reporting Requirements and Guidance for Registries v4.7" in SEF_EE_2013_1_17-20-44 10-4-2013.xls.

The SEF report for 2012 has been submitted to the UNFCCC Secretariat electronically and the contents of the report can also be found as Annex 6 of this document. The SEF tables include information about AAU, ERU, CER, t-CER, l-CER and RMU in Estonian National Registry (hereinafter as NR) standing 31st of December 2012. Also the SEF includes information on transfers of the units during the year 2012.

12.2. Summary of information reported in the SEF tables

The total number of units in the NR at the beginning of the year 2012 was: 144 277 134 AAU, 13 448 ERU and 957 CER. In the end of the year the total balance of units was: 131 081 678 AAU (53 085 500 in retirement and 210 000 in cancellation accounts), 3 758 479 ERU (141 034 in retirement account) and 29 551 CER (16 555 in retirement account).

Estonian NR did not contain any RMUs, t-CERs or l-CERs nor any units were on the Article 3.3/3.4 Net-Source Cancellation accounts and in t-CER and l-CER Replacement accounts. SEF report will be also included in Estonian Standard Independent Assessment Report (hereinafter as SIAR) 2012 report as Appendix 1 (as SIAR Report R-1).

12.3. Discrepancies and notifications

Information about discrepant transactions is included in SIAR report Appendixes 2 and 3. No discrepancies and no notifications occurred in 2012.

12.4. Publicly accessible information

Due to the updates on the publicly available information web page in year 2011, information referred in Decision 13/CMP.1; II Registry requirements; E. Publicly accessible information in paragraphs 45-48 are as following via user interface of the MoE www.envir.ee/ 1170489:

- account information (information on paragraph 45 of annex to the decision 13/CMP.1);
- JI projects in Estonia (information on paragraph 46 of annex to the decision 13/CMP.1);
- information about unit holdings and transactions (information on paragraph 47 of annex to the decision 13/CMP.1);

- information about Entities Authorized to Hold Units (information on paragraph 48 of annex to the decision 13/CMP.1).

Information regarding the NR is publicly available to users via MoE web page http://www.envir.ee/register.

This information is currently available at:

1) Paragraph 45 of annex to the decision 13/CMP.1 (account information). This information is available to users via user interface of the MoE http://www.envir.ee/1170489 and via CITL http://ec.europa.eu/environment/ets/. Selecting from left hand menu "Accounts" - "Search" - selecting Estonia;

2) Paragraph 46 of annex to the decision 13/CMP.1 (information of JI projects in Estonia). This information is available to users via user interface of the web page of the Ministry of the Environment http://www.envir.ee/1155464;

3) Paragraph 47 of annex to the decision 13/CMP.1 (information about unit holdings and transactions). Following information is publicly accessible via user interface of the CITL http://ec.europa.eu/environment/ets. Selecting from left hand menu "Transactions" - "Search" - selecting Estonia and other relevant parameters displayed in the search field. In accordance with the annex XVI of the EC regulation (No 2216/2004 of 21 Dec. 2004) "the information for each completed transaction relevant for the registries system for year X shall be displayed from 15 January onwards of year X+5".

4) Paragraph 48 of annex to the decision 13/CMP.1 (information about Entities Authorized to hold units under its responsibility). The Decision 280/2004/EC of the European Parliament and of the Council requires EU Member States to provide information on the legal entities authorized to participate in the mechanism under Articles 6, 12 and 17 of the Kyoto Protocol in the NIR. According to the Estonian national legislation (The Ambient Air Protection Act) §117) the Ministry of the Environment as competent authority is authorized to trade with AAUs, RMUs, ERUs and CERs. This information is available at http://www.envir.ee/1170489. Installations falling under the scope of the Directive 2003/87/EC are authorized to use ERUs and CERs for compliance according to the percentage set out in National Allocation Plan for 2008-2012. This information is available to users via user interface of the web page of the Ministry of the Environment http://www.envir.ee/1173994.

Public information required by Commission regulation (EC) No 920/2010 (in addition to the above-mentioned public information):

1) Installation and permit details - information about installations and permit details is available to users via user interface of MoE

http://www.envir.ee/orb.aw/class=file/action=preview/id=1172349/KP+2008-2012+ja+aastad_alloc+ja+VE.pdf and CITL http://ec.europa.eu/environment/ets/ selecting from left hand menu "Operator Holding Accounts" - "Search" - selecting Estonia;

2) Information about verified emissions, surrenders and compliance status of installations - information about verified emissions, surrenders and compliance status of installations is available to users via user interface of the MoE web page at http://www.envir.ee/cp1 (selecting „Ülevaade kauplemisperioodil 2008-2012 eraldatud LHÜ-de, tõendatud KHG heitkoguste ja tagastatatud LHÜ-de kohta on leitav siit„) and from the interface of the CITL http://ec.europa.eu/environment/ets/ selecting from left hand menu "Allocation/Compliance" - "Search" - selecting Estonia;

3) National allocation plan for Estonia - information on national allocation plan for Estonia is available via user interface of the MoE web page at http://www.envir.ee/cp1 (selecting from headline „*Eesti riiklik kasvuhoonegaaside lubatud heitkoguse jaotuskava aastatel 2008-2012*" last three headings in English and via CITL web page http://ec.europa.eu/environment/ets/ selecting from left hand menu "NAP-info" - "Search" - selecting Estonia. NIMs list is available at http://www.envir.ee/orb.aw/class=file/action=preview/id=1181767/NIMs List+EE_v3_avalikustamine.pdf.

12.5. Calculation of the commitment period reserve (CPR)

The commitment period reserve can be calculated in accordance with decision 11/CMP.1 as 90% of the proposed assigned amount or 100% of its most recently reviewed inventory times five, whichever is lowest.

Estonia has interpreted the "most recently reviewed inventory" the inventory for the year 2011. This would mean that five times the emissions from the total inventory of 2011 will be lower, than 90% of the assigned amount. This would give an estimated commitment period reserve of **104 777 884 tonnes CO_2 equivalents.**

20 955 576.877 x 5 = 104 777 884 t $CO_{2\ eq}$.

12.6. KP-LULUCF accounting

The results of accounting procedure for the activities under Articles 3.3 of the Kyoto Protocol are presented in Table 12.1.

Net emissions from Article 3.3 activities were 232.11 Gg CO_2 eq. in 2011.

Table 12.1. Calculation of accounting quantities for activities under Article 3, paragraphs 3 and 4

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	BY(5)	Net emissions/removals(1)					Accounting Parameters[7]	Accounting Quantity [8]
		2008	2009	2010	2011	Total[6]		
	(Gg CO_2 equivalent)							
A. Article 3.3 activities								
A.1. Afforestation and Reforestation								-495,23
A.1.1. Units of land not harvested since the beginning of the commitment period[2]		-97,88	-121,26	-131,07	-145,01	-495,23		-495,23
A.1.2. Units of land harvested since the beginning of the commitment period[2]								NA,NO
Total Estonia		NA,NO	NA,NO	NA,NO	NA,NO	NA,NO		NA,NO
A.2. Deforestation		721,53	638,44	475,74	377,12	2 212,82		2 212,82

B. Article 3.4 activities								
B.1. Forest Management (if elected)		NA	NA	NA	NA	NA		NA
3.3 offset(3)							1 717,59	NA
FM cap(4)							1 833,33	NA
B.2. Cropland Management (if elected)	0,00	NA	NA	NA	NA	NA	0,00	0,00
B.3. Grazing Land Management (if elected)	0,00	NA	NA	NA	NA	NA	0,00	0,00
B.4. Revegetation (if elected)	0,00	NA	NA	NA	NA	NA	0,00	0,00

13. INFORMATION ON CHANGES IN NATIONAL SYSTEM

The following changes in Estonia's national system have been implemented during 2012:

- MoE did not renew the contract with TUT for the estimation of the emissions from Energy and Agriculture sector in 2012. Contract agreement with EERC for inventory preparation in Energy and Agriculture sector was concluded for the first time in 2012 and was done for 1 year. EERC signed a contract agreement with the Department of Chemistry at TUT for preparation of Agriculture sector estimates in 2013 submission.

The overview of the allocation of responsibilities is shown in Figure 1.1.

14. INFORMATION ON CHANGES IN NATIONAL REGISTRY

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

(1) Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

(2) Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

(3) Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

(4) Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

(5) The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

(6) The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

(7) All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

(a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);

(b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;

(c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;

(d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;

(e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry of Estonia have therefore occurred in 2012, as a consequence of the transition to the CSEUR platform:

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	National administrator is: Mr Mihkel Visnapuu khgregister@envir.ee tel. +372 6262 829

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: • **Readiness questionnaire** • **Application logging** • **Change management procedure** • **Disaster recovery** • **Manual Intervention** • **Operational Plan** • **Roles and responsibilities** • **Security Plan** • **Time Validation Plan** • **Version change Management** The documents above are provided as an appendix to this document. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to **successful certification on 1 June 2012.**
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012,
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and **the operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry EU and all consolidating national registries. The documentation is annexed to this submission..

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	The new internet address of the Estonian registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/EE/index.xhtml
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan.** The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.
The previous Annual Review recommendations	There were no recommendations proposed in previous Annual Review Report.

15. INFORMATION ON MINIMIZATION OF ADVERSE IMPACTS IN ACCORDANCE WITH ARTICLE 3, PARAGRAPH 14

Estonia has provided information on minimization of adverse impacts in accordance with Article 3, paragraph 14 in its previous national inventory reports under the Kyoto Protocol. The information is provided in accordance with the guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol (Decision 15/CMP.1, Section H.).

The changes since previous inventory submission include following:

- update of information regarding fast start financing,
- update of information regarding inclusion of aviation,
- update of information regarding co-operation projects with developing countries.

15.1. Information on how Estonia is striving, under Article 3, paragraph 14, of the Kyoto Protocol, to implement the commitments mentioned in Article 3, paragraph 1, of the Kyoto Protocol in such a way as to minimize adverse social, environmental and economic impacts on developing country Parties, particularly those identified in Article 4, paragraphs 8 and 9, of the Convention

European Union (EU) has agreed a forward-looking political agenda to achieve its core energy objectives of sustainability, competitiveness and security of supply, by reducing greenhouse gas emissions by 20%, increasing the share of renewables in the energy consumption to 20% and improving energy efficiency by 20%, all of it by 2020.

Two major EU Directives, the Directive on the promotion of the use of renewable energy (Directive 2009/28/EC) and as well as the extension of the EU emission trading scheme to the aviation sector (Directive 2008/101/EC) are more related with potential impacts on third countries.

Inclusion of aviation in the EU Emission Trading Scheme

Aviation contributes to global climate change, and its contribution is increasing. Even though there has been significant improvement in aircraft technology and operational efficiency this has not been enough to neutralise the effect of increased traffic, and the growth in emissions is likely to continue in the decades to come. Aircraft operators from developing countries will be affected to the extent they operate on routes covered by the EU Emissions Trading Scheme. On the 12.11.2013 the European Commission proposed a draft legislation "stop the clock" in the form of a Decision. It proposes a derogation from Article 16 of the EU ETS Directive so that action will not be taken against aircraft operators that do not meet the Directive's reporting and compliance obligations arising before the ICAO Assembly for non-European flights. As such it would cover obligations arising in respect of emissions in 2010, 2011 and 2012. At the International Civil Aviation Organisation (ICAO) Council meeting of 9 November 2012, significant progress was made in view of agreeing global action on aviation and climate change. In particular through recognising that a global market-based measure (MBM) is technically feasible and commitments made to adopt a framework for market based measures applicable to international aviation emissions. It was agreed to set up a high-level group which will take forward this policy area as a matter of urgency. The EU considers that an agreement on a global market-based measure for addressing international aviation emissions is within reach at the ICAO Assembly scheduled for September 2013. This proposal is being made by the European Commission in order to provide time for the 2013 ICAO Assembly to agree on a global market-based measure with a realistic timetable for further development and implementation, and the adoption of a framework for facilitating States' application of MBMs to international aviation pending the global measure's application. This proposal to "stop the clock" for flights to and from Europe demonstrates goodwill towards the successful conclusion of these ICAO processes.

At the moment Estonia is Administrative Member State for one aircraft operator from developing country – Zambezi Airlines of Zimbabwe. They did not have any EU related flights in the year 2012. In terms of the economic impacts, aircraft operators with higher market share on the routes covered will have to pay larger proportion of the compliance costs.

Promotion of renewable energy

The Directive on renewable energy (Directive 2009/28/EC), a part of the EU's climate and energy package, sets ambitious targets for all Member States including Estonia. In November 2010, the Government approved the National Renewable Energy Action Plan up to 2020. One of the objectives of the plan is to increase the share of renewable energy to at least 25% in gross final consumption of energy.

According to the plan, the share of electricity produced from renewable sources must grow to over 15% of consumption in ten years. Inland transport, the aim is to achieve that 10% of the used energy sources would be renewable energy.

Estonia supports regional and international development measures, encourages the exchange of best practices in production of energy from renewable sources between regional and international development initiatives and promotes the use of structural funding. For promoting the use of biomass and bio-energy, the Government approved in January 2007 the Development Plan 2007−2013 for Enhancing the Use of Biomass and Bioenergy. The objective of the plan is to create favorable conditions for the development of biomass and bio-energy production.

Co-operation projects with developing countries

One of the priorities of developing co-operation in Estonia as stated in the Development Plan for Estonian Development co-operation and humanitarian aid 2011–2015 is supporting sustainable development and achieving internationally set environmental standards in developing countries.

Under this priority Estonia funds and implements bilateral development co-operation projects for supporting the development of environmental protection institutions, in particular in the field of water resource management and energy efficiency.

Other method of supporting developing countries is through support of international environmental organisations - European and Mediterranean Plant Protection Organisation, International Atomic Energy Agency, International Plant Genetic Resources Institute, International Seed Testing Association, World Meteorological Organisation, Multilateral Fund for the Implementation of the Montreal Protocol, United Nations Framework Convention on Climate Change, Desert Convention, International Union for Conservation of

Nature, Food and Agriculture Organisation of the United Nations – in their activities in supporting environmentally friendly development in developing countries.

Fast start finance projects

The Copenhagen Accord notes developed countries' commitment to providing developing countries with fast start finance approaching USD 30 billion for the 2010-2012 period, for enhanced action on mitigation (including Reducing Emissions from Deforestation and Forest Degradation, REDD), adaptation, technology development and transfer and capacity building. Fast start finance will support immediate action on climate change and kick start mitigation and adaptation efforts in developing countries.

<u>Climate change mainstreaming in Bhutan</u>

In 2011 Estonia contributed 796972 EUR to the co-financing action in Bhutan named "Global Climate Change Alliance- Climate Change Adaptation in the Renwable Natural Resources Sector". Co-financing is in cooperation with European Commission and total cost of the project is 4 396 972 EUR. The overall objective of the GCCA programme is to enhance resilience of Bhutan´s rural households to the effects of climate change. The specific objectibe is to ensure climate change readiness of the Renewable Natural Resources sector in Bhutan by mainstreaming climate change into the sector and ensuring steps are taken towards increasingly addressing climate change adaptation at multi-sectoral level. The expected results of the proposed programme are the development of a Renewable Natural Resources- Climate Change Adaptation Action Plan as well as the establishment of an institutional framework allowing a mutli-sectoral approch to climate change adaptation. Required activities to achieve the expected results and objectives cover among others a thorough and consultative planning exercise, a realistic budgeting exercise for all planned actions, an assessment and determination of the responsibility of each stakeholder and the establishment of a formal coordination mechanism for the planning and implementation of climate change adaptation measures.

The Global Climate Change Alliance (GCCA) is an initiative set up by the European Commission to strengthen dialogue and cooperation on climate change between the European Union and the developing countries that are most vulnerable, in particular the least developed countries (LDCs) and small island developing states (SIDS). It was launched in 2007. Through the GCCA the EU provides technical and financial support in five priority areas: mainstreaming climate change into poverty reduction strategies; adaptation; reducing emissions from deforestation and forest degradation (REDD+); enhancing participation in the Clean Development Mechanism; and disaster risk reduction.

<u>Let's do it! – World Cleanup 2012</u>

In 2012 Estonian Ministry of the Environment supported one of the fastest-expanding civic movement- Let's Do It! The movement was born in 2008 in Estonia when 50.000 people came together to get rid of 10.000 tons of illegal garbage from roadsides, forests and towns, cleaning the entire country in 5 hours. Let's Do It! prepared the programme for activities in 2012 called World Cleanup 2012 where hundreds of volunteers, NGOs and many other groups and organizations came together to initiate the ambitious global volunteer action to start cleaning the world. Series of local, national and regional cleanup events took place from 24th of March 2012 until the end of 2012. More than 3 million volunteers participated in the cleanup actions in more than 65 different countries, picking up together over 100 000 tons of waste. Alongside regional gatherings took place to share existing experiences and plan next steps together. Let's Do It! local teams gather in four different regions in November 2012 European countries met in Russia, St Petersburg, Asian countries met in Nepal, North-, Central- and South-American countries met in El Salvador and African countries in Benin. Many communication documents and papers, also different audiomaterial were prepared to support World Cleanup activities and to support capacity building. During the programme the easy-to-use free online tool the World Waste Map was created. Everyone can use it to map the illegal garbage in any area in the world. By using free applications for iPhone and Android phones, it's possible to send the data and locations of the most troubling dumping areas to an open virtual world waste map, which is visible to everyone online.

Strengthening Climate Change Adaptation in Rural Communities, for Agriculture and Environmental Management in Afghanistan

Ministry of the Environment of Estonia made a contribution of 1,605,008 to the United Nations Environment Programme for "Strengthening Climate Change Adaptation in Rural Communities, for Agriculture and Environmental Management in Afghanistan" within UNEP project "Environmental Cooperation for Peacebuilding-Phase III" in 2012-2015. The project will build national capacity to plan for community resilience to climate change based threats in Afghanistan. Focus will be on sustainable water, pasture and environmental management in pilot sites and strengthening communities in Kabul province, the North and Central Highlands of Afghanistan. Core activities involve working with national government planners, advisors and decision makers to strengthen planning and action for community resilience in vulnerable areas of the country where high potential exists for productive, financially sustainable, ecologically sound agricultural development.

15.2. Information on how Estonia gives priority, in implementing the commitments under Article 3, paragraph 14, to specific actions

Estonia reports activities that are related to the actions specified in the subparagraphs (a) to (f) of paragraph 24 of the reporting requirements in the Annex to decision 15/CMP.1.

a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities

Several fiscal measures have been introduced in Estonia to support sustainable energy consumption and reduce GHG emissions. For example excise duties on fuels and pollution charges. Current tax rates are stipulated in the *Alcohol, Tobacco, Fuel and Electricity Excise Duty Act*. The Environmental Charges Act (enforced in 2006) obliges the owners of combustion equipment to pay pollution charges for several pollutant emissions (e.g. sulphur dioxide, nitrogen oxides, etc.). At present, the CO_2 charge has to be paid by all enterprises producing heat in the scope of *District Heating Act* (includes distribution and sales of heat) excluding the ones firing biomass, peat or waste.

Estonia as a Member State of the EU has to comply with the EU requirements (Directive 2003/96/EC) for the taxation of fuels and energy. Estonia has been granted some transitional time for the introduction of relevant taxes. Regarding shale oil (oil produced from oil shale), Estonia was eligible to apply a transitional period until 1 January 2010 for adjusting the national level of taxation on shale oil used for district heating purposes to the EU minimum level of taxation. Nevertheless, Estonia had already introduced the tax on shale oil. The tax exemption for natural gas (methane) is permitted by Directive 2003/96/EC, which allows an exemption on natural gas in those Member States where the share of natural gas in energy end-use was less than 15% in 2000. The exemption applies for a maximum of ten years after the directive's entry into force or until the national share of natural gas in energy end-use reaches 25%, whichever comes first. Actually, Estonia imposed excise duty on natural gas on 1 January 2008 already.

More information about tax system and fiscal measures is presented in Estonia's Fifth National Communication under the UNFCCC and Kyoto Protocol.

b) Removing subsidies associated with the use of environmentally unsound and unsafe Technologies

No subsidies for environmentally unsound and unsafe technologies have been implemented. Estonia's tax system is presented shortly above (Paragraph 24a) and through this tax system Estonia promotes sustainable production and technologies. For instance according to the Environmental Charges Act (enforced in 2006) the CO_2/t pollution charge doubled between 2006 and 2009.

c) Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end

Estonia does not have any support activities in this field.

d) Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non- Annex I Parties in this effort

Estonia has done research for enhancing technologies that emit less GHGs but at the moment there is no cooperation with developing countries in this field.

e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities

Estonia's development policy supports low carbon and sustainable development but at the moment there is no cooperation with developing countries in this field.

f) Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies

Estonia contributes since 2008 annually to the Neighbourhood Investment Facility Trust Fund. Trust Fund supports strengthening of infrastructure interconnections between the EU and its neighbours in the areas of transport and energy, addressing common environmental concerns and supports other relevant activities. Estonia earmarked its contribution to the Eastern region of European Neighbourhood and Partnership Instrument (including Georgia and Republic of Moldova). Estonia is planning to contribute at least 1,000,000 EUR over the years 2011-2013 to the Neighbourhood Investment Facility Trust Fund and as for the previous period, the contribution will be earmarked to the Eastern region of European Neighbourhood and Partnership Instrument.

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ANNEXES TO THE NATIONAL INVENTORY REPORT

Annex 1. Key categories

This annex contains the detailed information on key categories.

The following tables are provided:

- Tier 2 level assessment year 1990 excluding LULUCF
- Tier 2 level assessment year 1990 including LULUCF
- Tier 2 level assessment year 2011 excluding LULUCF
- Tier 2 level assessment year 2011 including LULUCF
- Tier 2 trend assessment excluding LULUCF
- Tier 2 trend assessment including LULUCF

The tables follow the format and methodology (Tier 2) suggested in IPCC guidelines (2000, 2003). Uncertainty estimates used in the analysis can be found in Annex 6 of the present report.

Table A.1.1. Tier 2 level assessment year 1990 excluding LULUCF

	IPCC Source Category	Gas	Emissions 1990	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column H
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	21 889.13	0.540	39.04%	0.211	0.597	0.597
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	478.96	0.012	415.98%	0.049	0.139	0.736
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	394.80	0.010	85.59%	0.008	0.024	0.759
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	303.38	0.007	103.56%	0.008	0.022	0.781
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO_2	792.78	0.020	39.04%	0.008	0.022	0.803
4.A	Enteric Fermentation - Dairy Cattle	CH_4	583.68	0.014	50.99%	0.007	0.021	0.824
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO_2	669.20	0.017	39.04%	0.006	0.018	0.842
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO_2	620.79	0.015	39.04%	0.006	0.017	0.859
4.D.2	Pasture, Range and Paddock Manure	N_2O	202.30	0.005	103.56%	0.005	0.015	0.873
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	389.02	0.010	50.99%	0.005	0.014	0.887
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	247.95	0.006	80.00%	0.005	0.014	0.901

Table A.1.2. Tier 2 level assessment year 1990 including LULUCF

	IPCC Source Category	Gas	Emissions 1990	Absolute value	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column I
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	21 889.13	21 889.13	0.422	39.04%	0.165	0.435	0.435
5.A.1	Forest Land remaining Forest Land – living biomass	CO_2	-8 492.18	8 492.18	0.164	46.98%	0.077	0.203	0.639
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	478.96	478.96	0.009	415.98%	0.038	0.102	0.740
5.B.1	Cropland remaining Cropland - organic soils	CO_2	418.34	418.34	0.008	93.63%	0.008	0.020	0.760
5.A.1	Forest Land remaining Forest Land - mineral soils	CO_2	-1 016.79	1 016.79	0.020	35.07%	0.007	0.018	0.778
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	394.80	394.80	0.008	85.59%	0.007	0.017	0.796
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	303.38	303.38	0.006	103.56%	0.006	0.016	0.812
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO_2	792.78	792.78	0.015	39.04%	0.006	0.016	0.827
4.A	Enteric Fermentation - Dairy Cattle	CH_4	583.68	583.68	0.011	50.99%	0.006	0.015	0.843
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO_2	669.20	669.20	0.013	39.04%	0.005	0.013	0.856
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid	CO_2	620.79	620.79	0.012	39.04%	0.005	0.012	0.868

	IPCC Source Category	Gas	Emissions 1990	Absolute value	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column I
	Fuels								
4.D.2	Pasture, Range and Paddock Manure	N_2O	202.30	202.30	0.004	103.56%	0.004	0.011	0.879
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	389.02	389.02	0.008	50.99%	0.004	0.010	0.889
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	247.95	247.95	0.005	80.00%	0.004	0.010	0.899

Table A.1.3. Tier 2 level assessment year 2011 excluding LULUCF

	IPCC Source Category	Gas	Emissions 2011	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column H
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	13 162.32	0.628	39.04%	0.245	0.648	0.648
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	196.93	0.009	415.98%	0.039	0.103	0.751
6.A	Solid Waste Disposal on Land	CH_4	254.31	0.012	83.67%	0.010	0.027	0.778
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO_2	448.98	0.021	39.04%	0.008	0.022	0.800
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO_2	413.74	0.020	39.04%	0.008	0.020	0.820
1.A.4.b	Other Sectors/Residential - Biomass	CH_4	96.16	0.005	150.33%	0.007	0.018	0.839
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	163.33	0.008	85.59%	0.007	0.018	0.856
4.A	Enteric Fermentation - Dairy Cattle	CH_4	259.14	0.012	50.99%	0.006	0.017	0.873
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	96.13	0.005	103.56%	0.005	0.013	0.885
4.D.2	Pasture, Range and Paddock Manure	N_2O	74.45	0.004	103.56%	0.004	0.010	0.895
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N_2O	79.37	0.004	93.41%	0.004	0.009	0.904

Table A.1.4. Tier 2 level assessment year 2011 including LULUCF

	IPCC Source Category	Gas	Emissions 2011	Absolute value	Lxt	Uxt	Tier 2 level assessment	Normalised Tier 2 level assessment	Cumulative total of column I
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	13 162.32	13 162.32	0.453	39.04%	0.177	0.442	0.442
5.A.1	Forest Land remaining Forest Land - living biomass	CO_2	-3 921.22	3 921.22	0.135	46.98%	0.063	0.159	0.601
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	196.93	196.93	0.007	415.98%	0.028	0.070	0.671
5.A.1	Forest Land remaining Forest Land - mineral soils	CO_2	-1 009.78	1 009.78	0.035	35.07%	0.012	0.030	0.702
5.B.1	Cropland remaining Cropland - organic soils	CO_2	375.41	375.41	0.013	93.63%	0.012	0.030	0.732
6.A	Solid Waste Disposal on Land	CH_4	254.31	254.31	0.009	83.67%	0.007	0.018	0.750
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO_2	448.98	448.98	0.015	39.04%	0.006	0.015	0.765
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO_2	413.74	413.74	0.014	39.04%	0.006	0.014	0.779
5.A.1	Forest Land remaining Forest Land - organic soils	CO_2	455.02	455.02	0.016	35.35%	0.006	0.014	0.793
5.B.1	Cropland remaining Cropland - mineral soils	CO_2	-302.68	302.68	0.010	50.10%	0.005	0.013	0.806
1.A.4.b	Other Sectors/Residential - Biomass	CH_4	96.16	96.16	0.003	150.33%	0.005	0.012	0.818
5.C.1	Grassland remaining Grassland - living biomass	CO_2	291.84	291.84	0.010	48.13%	0.005	0.012	0.831
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	163.33	163.33	0.006	85.59%	0.005	0.012	0.843
4.A	Enteric Fermentation - Dairy Cattle	CH_4	259.14	259.14	0.009	50.99%	0.005	0.011	0.854
5.E.2	Land converted to Settlements - living biomass	CO_2	115.54	115.54	0.004	86.58%	0.003	0.009	0.863
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	96.13	96.13	0.003	103.56%	0.003	0.009	0.871
5.A.1	Forest Land remaining Forest Land - dead wood	CO_2	-685.76	685.76	0.024	13.07%	0.003	0.008	0.879
4.D.2	Pasture, Range and Paddock Manure	N_2O	74.45	74.45	0.003	103.56%	0.003	0.007	0.885
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N_2O	79.37	79.37	0.003	93.41%	0.003	0.006	0.892
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N_2O	82.89	82.89	0.003	80.00%	0.002	0.006	0.898
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	126.82	126.82	0.004	50.99%	0.002	0.006	0.903

Table A.1.5. Tier 2 trend assessment excluding LULUCF

	IPCC Source Category	Gas	Emissions 1990	Emissions 2011	Txt	Uxt	Tier 2 trend assessment	Normalised Tier 2 trend assessment	Cumulative total of column I
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	21 889.13	13 162.32	0.171	39.04%	0.067	0.301	0.301
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	478.96	196.93	0.005	415.98%	0.019	0.088	0.389
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO_2	65.20	413.74	0.035	39.04%	0.014	0.062	0.451
6.A	Solid Waste Disposal on Land	CH_4	179.67	254.31	0.015	83.67%	0.012	0.056	0.507
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO_2	620.79	0.00	0.030	39.04%	0.012	0.052	0.560
1.A.4.b	Other Sectors/Residential - Biomass	CH_4	33.67	96.16	0.007	150.33%	0.011	0.049	0.609
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO_2	669.20	44.11	0.028	39.04%	0.011	0.049	0.658
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	247.95	47.75	0.007	80.00%	0.006	0.027	0.685
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	303.38	96.13	0.006	103.56%	0.006	0.026	0.711
6.B.1	Industrial Wastewater	CH_4	106.73	5.21	0.005	107.35%	0.005	0.022	0.734
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO_2	4 825.04	339.05	0.199	2.48%	0.005	0.022	0.756
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CO_2	0.00	88.51	0.008	60.21%	0.005	0.022	0.778
6.D	Biological Treatment	N_2O	0.66	50.47	0.005	100.50%	0.005	0.021	0.799
6.D	Biological Treatment	CH_4	0.60	45.59	0.004	100.50%	0.004	0.019	0.818
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	389.02	126.82	0.007	50.99%	0.003	0.016	0.834
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	394.80	163.33	0.004	85.59%	0.003	0.015	0.848
4.D.2	Pasture, Range and Paddock Manure	N_2O	202.30	74.45	0.003	103.56%	0.003	0.013	0.861
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N_2O	88.93	82.89	0.003	80.00%	0.003	0.012	0.874
2.B.1	Ammonia Production	CO_2	420.05	0.00	0.020	11.18%	0.002	0.010	0.884
1.A.3.B	Road Transport - Liquid Fuels	CO_2	2 236.11	2 113.72	0.088	2.48%	0.002	0.010	0.894
1.A.4.b	Other Sectors/Residential - Biomass	N_2O	6.63	18.93	0.001	150.33%	0.002	0.010	0.904

Table A.1.6. Tier 2 trend assessment including LULUCF

	IPCC Source Category	Gas	Emissions 1990	Emissions 2011	Absolute value (2011)	Txt	Uxt	Tier 2 trend assessment	Normalised Tier 2 trend assessment	Cumulative total of column I
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO_2	21 889.13	13 162.32	13 162.32	0.186	39.04%	0.073	0.167	0.167
5.A.1	Forest Land remaining Forest Land - living biomass	CO_2	-8 492.18	-3 921.22	3 921.22	0.063	46.98%	0.029	0.068	0.235
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N_2O	478.96	196.93	196.93	0.006	415.98%	0.026	0.060	0.296
5.A.1	Forest Land remaining Forest Land - mineral soils	CO_2	-1 016.79	-1 009.78	1009.78	0.054	35.07%	0.019	0.044	0.339
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO_2	65.20	413.74	413.74	0.043	39.04%	0.017	0.039	0.378
5.C.1	Grassland remaining Grassland - living biomass	CO_2	-25.36	291.84	291.84	0.035	48.13%	0.017	0.039	0.417
5.B.1	Cropland remaining Cropland - organic soils	CO_2	418.34	375.41	375.41	0.018	93.63%	0.017	0.038	0.455
6.A	Solid Waste Disposal on Land	CH_4	179.67	254.31	254.31	0.018	83.67%	0.015	0.035	0.490
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO_2	620.79	0.00	0.00	0.037	39.04%	0.015	0.033	0.523
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO_2	669.20	44.11	44.11	0.035	39.04%	0.014	0.032	0.555
1.A.4.b	Other Sectors/Residential - Biomass	CH_4	33.67	96.16	96.16	0.009	150.33%	0.013	0.031	0.586
5.E.2	Land converted to Settlements - living biomass	CO_2	0.00	115.58	115.58	0.013	86.58%	0.011	0.026	0.612
5.A.1	Forest Land remaining Forest Land - dead wood	CO_2	-152.51	-685.76	685.76	0.069	13.07%	0.009	0.021	0.633
5.A.1	Forest Land remaining Forest Land - organic soils	CO_2	458.05	455.02	455.02	0.024	35.35%	0.009	0.020	0.652
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N_2O	247.95	47.75	47.75	0.009	80.00%	0.008	0.017	0.670
4.B	Manure Management - Solid Storage and Dry Lot	N_2O	303.38	96.13	96.13	0.007	103.56%	0.007	0.017	0.687
5.B.1	Cropland remaining Cropland - mineral soils	CO_2	-355.97	-302.68	302.68	0.013	50.10%	0.007	0.015	0.702
6.B.1	Industrial Wastewater	CH_4	106.73	5.21	5.21	0.006	107.35%	0.006	0.014	0.717
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO_2	4 825.04	339.06	339.06	0.250	2.48%	0.006	0.014	0.731
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CO_2	0.00	88.51	88.51	0.010	60.21%	0.006	0.014	0.745
5.C.2	Land converted to Grassland - mineral soils	CO_2	-2.60	-138.63	138.63	0.016	38.80%	0.006	0.014	0.759
6.D	Biological Treatment	N_2O	0.66	50.47	50.47	0.006	100.50%	0.006	0.013	0.772
5.E.2	Land converted to Settlements - soils	CO_2	0.00	102.42	102.42	0.012	45.29%	0.005	0.012	0.784
6.D	Biological Treatment	CH_4	0.60	45.59	45.59	0.005	100.50%	0.005	0.012	0.796
4.A	Enteric Fermentation - Non-Dairy Cattle	CH_4	389.02	126.82	126.82	0.009	50.99%	0.005	0.010	0.807
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N_2O	394.80	163.33	163.33	0.005	85.59%	0.004	0.010	0.817

	IPCC Source Category	Gas	Emissions 1990	Emissions 2011	Absolute value (2011)	Txt	Uxt	Tier 2 trend assessment	Normalised Tier 2 trend assessment	Cumulative total of column I
4.D.2	Pasture, Range and Paddock Manure	N_2O	202.30	74.45	74.45	0.004	103.56%	0.004	0.009	0.825
5.F.2	Land converted to Other Land - living biomass	CO_2	0.00	34.23	34.23	0.004	86.58%	0.003	0.008	0.833
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N_2O	88.93	82.89	82.89	0.004	80.00%	0.003	0.008	0.841
5.D.1	Wetlands remaining Wetlands/Peatland - organic soils managed for peat extraction	CO_2	102.60	102.60	102.60	0.006	56.51	0.003	0.007	0.848
2.B.1	Ammonia Production	CO_2	420.05	0.00	0.00	0.025	11.18%	0.003	0.006	0.854
4.A	Enteric Fermentation - Dairy Cattle	CH_4	583.68	259.14	259.14	0.005	50.99%	0.003	0.006	0.861
5.B.2.2	Grassland converted to Cropland - organic soils	CO_2	0.00	14.51	14.51	0.002	165.24%	0.003	0.006	0.867
5.B.2.2	Grassland converted to Cropland - mineral soils	CO_2	0.00	48.41	48.41	0.006	48.33%	0.003	0.006	0.873
1.A.4.b	Other Sectors/Residential - Biomass	N_2O	6.63	18.93	18.93	0.002	150.33%	0.003	0.006	0.879
1.A.3.B	Road Transport - Liquid Fuels	CO_2	2 236.11	2 113.72	2 113.72	0.106	2.48%	0.003	0.006	0.885
5.A.2.1	Cropland converted to Forest Land - mineral soil	CO_2	3.51	50.02	50 02	0.005	44.93%	0.002	0.006	0.891
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N_2O	186.36	79.37	79 37	0.002	93.41%	0.002	0.005	0.896
5.C.1	Grassland remaining Grassland - organic soils	CO_2	119.16	106.54	106.54	0.005	39.91%	0.002	0.005	0.900
5.A.2.2	Grassland converted to Forest Land - living biomass	CO_2	-8.33	-30.30	30.30	0.003	60.46%	0.002	0.004	0.904

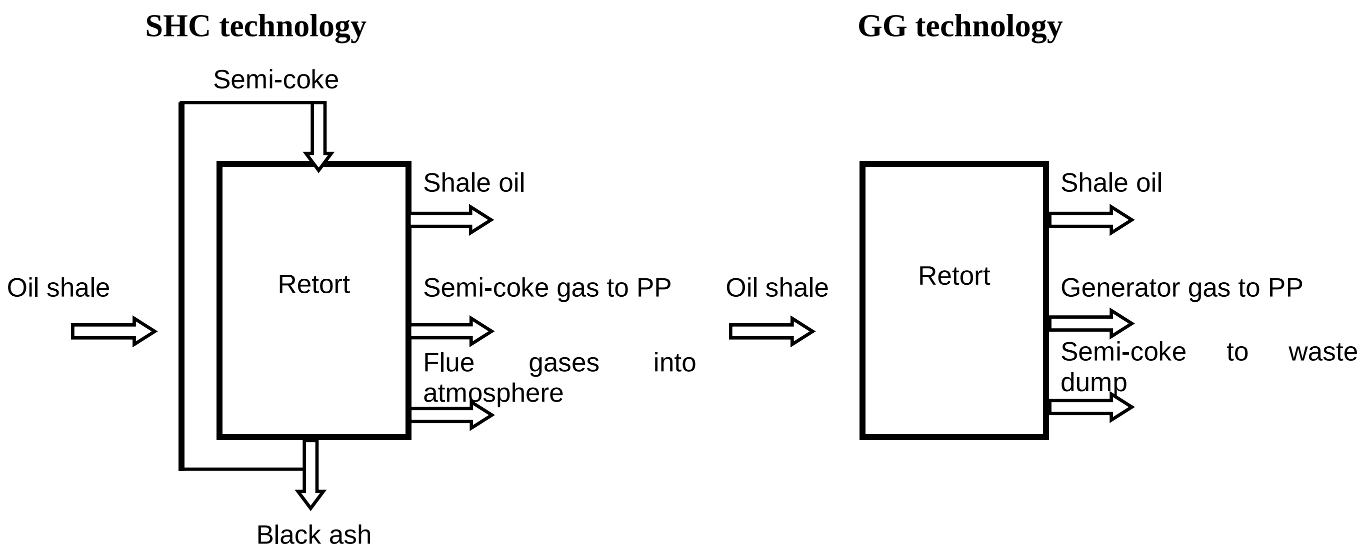
Annex 2. Detailed discussion of methodology and data for estimating CO_2 emissions from fossil fuel combustion

Description of shale oil production technologies and detailed methodology for estimation of carbon emission factors of oil shale gases

There are two different technologies for shale oil production in Estonia: oil shale thermal processing with solid heat carrier (SHC technology) and oil shale thermal processing with gaseous heat carrier in gas generators (GG technology). In 2011 three oil production companies and 5 oil plants were in operation:

1. AS Eesti Energia Narva Oil Plant – SHC technology plant;
2. Viru Chemistry Group AS (VKG) Oil Plant – SHC technology plant (since 2010) and GG technology plant;
3. Kiviõli Oil Plant – SHC technology plant (since 2010) and GG technology plant.

The following simplified schemes describe the output products and waste by different oil shale thermal processing technologies.



During oil shale thermal processing in retort shale oil (a liquid fuel) and semi-coke or generator gas will by formed (depending of technology used). Oil shale gases are usually delivered to power plants nearby for combustion and no GHG or other emissions will be emitted at oil plant. The waste product of the oil shale processing is semi-coke. Using GG technology formed semi-coke will be delivered to waste dump and the small amount of carbon in semi-coke will be stored. Using SHC technology formed semi-coke will be delivered for combustion in aerofountain chamber. The combustion product – flue gases have been used for oil shale draining and after that delivered into atmosphere. To find the amount of CO_2 emitted with flue gases into atmosphere a carbon balance method has been developed.

The idea of carbon balance method is very simple: from the carbon amount delivered with oil shale into retorting process will be take off carbon amount of shale oil, semi coke gas and black ash. The rest of the carbon is the amount which will be emitted into atmosphere.

For generator gas technology the carbon balance method was used to estimate the amount of carbon delivered with semi-coke to waste dump.

Table A.2.1. Composition of semi-coke gas from the Narva Solid Heat Carrier-140 processes

Composition of semi-coke gas	**Content in volume %**	**Carbon mole ratio**	**Density (kg/Nm^3)**	**Density rate (kg/Nm^3)**	**Rate of C in gas volume, %**	**Rate of C in gas weight, %**	**Heat value of gas Q^r_{scg} (MJ/Nm^3)**	**Rate of Q^r_{scg} (MJ/Nm^3)**
1	2	3	4	5=2×4/100	6=2×3	7=6×4/ Σ5	8	9=2×8/100
CO_2	9.880	12/44	1.964	0.194	2.695	4.066		
H_2S	2.610		1.520	0.040			23.384	0.610
N_2	1.360		1.257	0.017				0.000
O_2	0.280		1.428	0.004				0.000
CO	9.430	12/28	1.250	0.118	4.041	3.882	12.636	1.192
H_2	16.990		0.090	0.015			10.798	1.835
CH_4	13.190	12/16	0.720	0.095	9.893	5.473	35.82	4.725
C_2H_6	9.520	24/30	1.340	0.128	7.616	7.842	63.751	6.069
C_2H_4	10.520	24/28	1.250	0.132	9.017	8.661	59.066	6.214
C_3H_8	3.710	36/44	1.970	0.073	3.035	4.595	91.256	3.386
C_3H_6	7.920	36/42	1.880	0.149	6.789	9.807	86.005	6.812
C_4H_{10}	1.860	48/58	2.590	0.048	1.539	3.063	118.651	2.207
C_4H_8+C_4H_6	3.950	48/56	2.500	0.099	4.091	7.859	113.514	4.484
C_5H_{12}	1.820	60/72	3.220	0.059	1.517	3.753	146.084	2.659
C_5H_{10}	0.000	60/70	3.120	0.000	0.000	0.000	140.78	0.000
C_4H_8	5.270	48/56	2.503	0.132			113.514	5.982
Total	**93.040**			**1.301**		**59.000**		**46.173**

The carbon emission factor from semi-coke gas combustion can be calculated by the following formula:

$$q_{c\ scg} = 10\,(12/16 \times CH_4 + 24/30 \times C_2H_6 + 24/28 \times C_2H_4 + 36/44 \times C_3H_8 + 36/42 \times C_3H_6 + 48/58 \times C_4H_{10} + 48/56 \times C_4H_8 + 60/72 \times C_5H_{12} + 60/70 \times C_5H_{10} + 72/82 \times C_6H_{10} + 12/44 \times CO_2 + 12/28 \times CO)/Q^{r'}_{scg},\ tC/TJ, \quad (1)$$

where

$q_{c\ scg}$ – carbon emission factor of semi-coke gas, tC/TJ,
C_Σ – total carbon content in semi-coke gas, % and
$Q^{r'}_{scg}$ – lower heating value of semi-coke gas, MJ/kg.

Q^r_{scg} – lower heating value of semi-coke gas: = **46.173 MJ/Nm^3**,
ρ_{scg} – density of semi-coke gas 1.301 kg/Nm^3 and
$Q^{r'}_{scg} = Q^r_{sg}/\rho_{sg}$ = 46.173/1.301 = **35.479 MJ/kg.**

The carbon emission factor of Narva semi-coke gas:

$$q_{c\ scg} = 10 \times C_\Sigma / Q^{r'}_{scg} = 10 \times 59.000/35.479 = \mathbf{16.63\ tC/TJ}$$

Table A.2.2. Composition of semi-coke gas from the VKG Solid Heat Carrier-140 (Petroter) processes

Composition of semi-coke gas	Content in volume %	Carbon mole ratio	Density (kg/Nm^3)	Density rate (kg/Nm^3)	Rate of C in gas volume, %	Rate of C in gas weight, %	Heat value of gas Q^r_{scg} (MJ/Nm^3)	Rate of Q^r_{scg} (MJ/Nm^3)
1	2	3	4	5=2×4/100	6=2×3	7=6×4/ Σ5	8	9=2×8/100
CO_2	9.350	12/44	1.964	0.184	2.550	3.759		
H_2S	2.200		1.520	0.033			23.384	0.514
N_2	11.320		1.257	0.142				0.000
O_2	0.190		1.428	0.003				0.000
CO	9.590	12/28	1.250	0.120	4.110	3.856	12.636	1.212
H_2	14.340		0.090	0.013			10.798	1.548
CH_4	14.520	12/16	0.720	0.105	10.890	5.885	35.82	5.201
C_2H_6	7.730	24/30	1.340	0.104	6.184	6.219	63.751	4.928
C_2H_4	10.490	24/28	1.250	0.131	8.991	8.436	59.066	6.196
C_3H_8	2.770	36/44	1.970	0.055	2.266	3.351	91.256	2.528
C_3H_6	6.740	36/42	1.880	0.127	5.777	8.152	86.005	5.797
C_4H_{10}	1.110	48/58	2.590	0.029	0.919	1.786	118.651	1.317
C_4H_8+ C_4H_6	2.640	48/56	2.500	0.066	2.734	5.131	113.514	2.997
C_5H_{12}	3.505	60/72	3.220	0.113	2.921	7.059	146.084	5.120
C_5H_{10}	3.505	60/70	3.120	0.109	3.004	7.035	140.78	4.934
C_6H_{10}		72/82	3.210				141.571	
Total	**100.000**			**1.332**		**60.668**		**42.293**

Using the formula 1,

where

$q_{c\ scg}$ – carbon emission factor of semi-coke gas, tC/TJ,
C_Σ – total carbon content in semi-coke gas, % and
$Q^{r'}_{scg}$ – lower heating value of semi-coke gas, MJ/kg.

Q^r_{scg} – lower heating value of semi-coke gas: = **42.293 MJ/Nm^3**,
ρ_{scg} – density of semi-coke gas 1.332kg/Nm^3 and
$Q^{r'}_{scg} = Q^r_{sg/}\ \rho_{sg}$ = 42.293/1.332 = **31.743 MJ/kg.**

The carbon emission factor of VKG semi-coke gas:

$$q_{c\ scg} = 10 \times C_\Sigma / Q^{r'}_{scg} = 10 \times 60.668/31.743 = \mathbf{19.112\ tC/TJ}$$

Table A.2.3. Composition of semi-coke gas from the Kiviõli Solid Heat Carrier-140 processes

Composition of semi-coke gas	Content in volume %	Carbon mole ratio	Density (kg/Nm^3)	Density rate (kg/Nm^3)	Rate of C in gas volume, %	Rate of C in gas weight, %	Heat value of gas Q^r_{scg} (MJ/Nm^3)	Rate of Q^r_{scg} (MJ/Nm^3)
1	2	3	4	5=2×4/100	6=2×3	7=6×4/ Σ5	8	9=2×8/100
CO_2	3.040	12/44	1.964	0.060	0.829	1.386		
H_2S	0.070		1.520	0.001			23.384	0.016
N_2	32.760		1.257	0.412				0.000
O_2	2.650		1.428	0.038				0.000
CO	8.610	12/28	1.250	0.108	3.690	3.927	12.636	1.088
H_2	12.230		0.090	0.011			10.798	1.321
CH_4	12.880	12/16	0.720	0.093	9.660	5.922	35.82	4.614
C_2H_6	6.780	24/30	1.340	0.091	5.424	6.188	63.751	4.322
C_2H_4	9.490	24/28	1.250	0.119	8.134	8.657	59.066	5.605
C_3H_8	2.470	36/44	1.970	0.049	2.021	3.390	91.256	2.254
C_3H_6	5.960	36/42	1.880	0.112	5.109	8.177	86.005	5.126
C_4H_{10}	0.950	48/58	2.590	0.025	0.786	1.734	118.651	1.127
C_4H_8+ C_4H_6	2.320	48/56	2.500	0.058	2.403	5.114	113.514	2.634
C_5H_{12}	0.000	60/72	3.220	0.000	0.000	0.000	146.084	0.000
C_5H_{10}	0.000	60/70	3.120	0.000	0.000	0.000	140.78	0.000
C_6H_{10}	0.000	72/82	3.210	0.000	0.000	0.000	141.571	0.000
Total	**100.210**			**1.175**		**44.494**		**28.107**

Using the formula 1,

where

$q_{c\ scg}$ – carbon emission factor of semi-coke gas, tC/TJ,
C_Σ – total carbon content in semi-coke gas, % and
$Q^{r'}_{scg}$ – lower heating value of semi-coke gas, MJ/kg.

Q^r_{scg} – lower heating value of semi-coke gas: = **28.107 MJ/Nm^3**,
ρ_{scg} – density of semi-coke gas 1.175 kg/Nm^3 and
$Q^{r'}_{scg} = Q^r_{sg/}\ \rho_{sg}$ = 28.107/1.175 = **23.930 MJ/kg.**

The carbon emission factor of Kiviõli semi-coke gas:

$$q_{c\ scg} = 10 \text{ x } C_{\Sigma\ /}\ Q^{r'}_{scg} = 10 \text{ x } 44.494/23.930 = \mathbf{18.594\ tC/TJ}$$

Table A.2.4. Composition of the VKG generator gas

Composition of generator gas	Content in volume %	Carbon mole ratio	Density (kg/Nm^3)	Density rate (kg/Nm^3)	Rate of C in gas volume, %	Rate of C in gas weight, %	Heat value of gas Q^r_{gg} (MJ/Nm^3)	Rate of Q^r_{gg} (MJ/Nm^3)
1	2	3	4	5=2×3/100	6=2×3	7=6×4/Σ5	8	9=2×8/100
CO_2	17.3	12/44	1.964	0.340	4.72	7.03		
H_2S	0.4		1.520	0.006	0.00	0.00	23.38	0.09
N_2	65.8		1.257	0.827	0.00	0.00		0.00
O_2	1.1		1.428	0.016	0.00	0.00		0.00
CO	7.3	12/28	1.250	0.091	3.13	2.96	12.64	0.92
H_2	5.4		0.090	0.005	0.00	0.00	10.80	0.58
C_mH_n (C_2H_4)	2.7	24/28	1.250	0.034	2.31	2.19	59.07	1.59
Total	**100.00**			**1.319**		**12.188**		**3.194**

Using the formula 1,

where

$q_{c\ gg}$ – carbon emission factor of generator gas, tC/TJ,
C_Σ – total carbon content in generator gas, % and
$Q^{r'}_{gg}$ – lower heating value of generator gas, MJ/kg.

Q^r_{gg} – lower heating value of generator gas: = **3.194 MJ/Nm^3**,
ρ_{gg} – density of generator gas 1.319 kg/Nm^3 and
$Q^{r'}_{gg} = Q^r_{sg}/\rho_{sg}$ = 3.194/1.319 = **2.422 MJ/kg.**

The carbon emission factor of VKG generator gas:

$q_{c\ gg}$ = 10 x $C_\Sigma / Q^{r'}_{scg}$ = 10 x 12.188/2.422 = **50.322 tC/TJ**

Table A.2.5. Composition of the Kiviõli generator gas

Composition of generator gas	Content in volume %	Carbon mole ratio	Density (kg/Nm^3)	Density rate (kg/Nm^3)	Rate of C in gas volume, %	Rate of C in gas weight, %	Heat value of gas Q^r_{gg} (MJ/Nm^3)	Rate of Q^r_{gg} (MJ/Nm^3)
1	2	3	4	5=2×4/100	6=2×3	7=6×4/ Σ5	8	9=2×8/100
CO_2	17.270	12/44	1.964	0.339	4.710	7.045		
H_2S	0.410		1.520	0.006			23.384	0.096
N_2	68.050		1.257	0.855				0.000
O_2	1.920		1.428	0.027				0.000
CO	3.970	12/28	1.250	0.050	1.701	1.620	12.636	0.502
H_2	5.500		0.090	0.005			10.798	0.594
CH_4	1.590	12/16	0.720	0.011	1.193	0.654	35.82	0.570
C_2H_6	0.280	24/30	1.340	0.004	0.224	0.229	63.751	0.179
C_2H_4	0.540	24/28	1.250	0.007	0.463	0.441	59.066	0.319
C_3H_8	0.100	36/44	1.970	0.002	0.082	0.123	91.256	0.091
C_3H_6	0.200	36/42	1.880	0.004	0.171	0.245	86.005	0.172
C_4H_{10}	0.050	48/58	2.590	0.001	0.041	0.082	118.651	0.059
C_4H_8+C_4H_6	0.050	48/56	2.500	0.001	0.052	0.099	113.514	0.057
C_5H_{12}	0.000	60/72	3.220	0.000	0.000	0.000	146.084	0.000
C_5H_{10}	0.000	60/70	3.120	0.000	0.000	0.000	140.78	0.000
C_6H_{10}	0.000	72/82	3.210	0.000	0.000	0.000	141.571	0.000
Total	**99.930**			**1.313**		**10.537**		**2.638**

Using the formula 1,

where

$q_{c\ gg}$ – carbon emission factor of generator gas, tC/TJ,
C_Σ – total carbon content in generator gas, % and
$Q^{r'}_{gg}$ – lower heating value of generator gas, MJ/kg.

Q^r_{gg} – lower heating value of generator gas: = **2.638 MJ/Nm^3**,
ρ_{gg} – density of generator gas 1.313 kg/Nm^3 and
$Q^{r'}_{gg} = Q^r_{sg/}\ \rho_{sg}$ = 2.638/1.313 = **2.009 MJ/kg.**

The carbon emission factor of Kiviõli generator gas:

$$q_{c\ gg} = 10 \times C_{\Sigma\ /}\ Q^{r'}_{gg} = 10 \times 10.537/2.009 = \mathbf{52.45\ tC/TJ}$$

Table A.2.6. Carbon Balances

Activity data used in calculations in carbon balances are collected from private companies and are therefore considered confidential. Activity data on oil shale, shale oil and oil shale gases production by oil companies and calculations of carbon balances are not part of the national inventory report and are allocated into archive. The data can be made available during the review process for the review team.

Table A.2.7. Carbon stored with semi-coke

Narva	**Unit**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Amount of black ash to landfill	TJ	84	46	70	114	128	116	124	138	115	110	155	167	181	208	218	238	224	220	297	351	395	379
Carbon stored with black ash	Gg	2.55	1.41	2.14	3.48	3.89	3.52	3.77	4.20	3.49	3.36	4.72	5.09	5.51	6.35	6.66	7.27	6.84	6.71	9.05	10.71	12.05	11.55

VKG GG Technology	**Unit**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Semi-coke to landfill	TJ	3 760	3 348	2 945	3 769	2 068	3 662	3 262	3 513	2 954	1 813	2 285	3 535	2 552	2 629	2 831	3 264	2 947	2 742	2 647	2 512	3 029	3 327
Carbon stored with semi-coke	Gg	114.64	102.06	89.78	114.91	63.06	111.65	99.46	107.09	90.07	55.27	69.66	107.77	77.81	80.16	86.30	99.51	89.85	83.59	80.71	76.60	92.35	101.43
VKG SHC																							
Semi-coke to landfill	TJ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59.56	153.40
Carbon stored with black ash	Gg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.82	4.68

Kiviõli GG Technology	**Unit**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Semi-coke to landfill	TJ	1 614	1 463	1 356	1 458	1 219	1 302	1 371	1 475	1 086	105	1 248	1 222	1 332	1 300	964	632	454	401	192	282	323	194
Carbon stored with semi-coke	Gg	49.20	44.61	41.35	44.45	37.15	39.69	41.79	44.97	33.10	3.19	38.06	37.26	40.62	39.64	29.39	19.27	13.83	12.23	5.85	8.61	9.84	5.92
Kiviõli SHC																							
Semi-coke to landfill	TJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.01	11.10
Carbon stored with black ash	Gg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.34

Total carbon stored with semi-coke

	Unit	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Oil Shale Total	TJ	5 458	4 857	4 371	5 341	3 415	5 080	4 757	5 125	4 155	2 028	3 688	4 924	4 065	4 138	4 013	4 134	3 625	3 363	3 136	3 146	3 812	4 064
Carbon stored with semi-coke and black ash	Gg	166.40	148.08	133.26	162.84	104.11	154.86	145.02	156.25	126.67	61.82	112.44	150.11	123.94	126.15	122.35	126.05	110.53	102.54	95.60	95.92	116.21	123.91

Table A.2.8. Fuel combustion by fuel types, PJ

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Solid Fuels	**238.51**	**215.90**	**174.04**	**133.30**	**138.75**	**127.96**	**131.94**	**129.02**	**114.72**	**107.96**	**108.66**	**106.82**	**103.70**	**122.05**	**122.14**	**116.06**	**109.36**	**135.78**	**125.51**	**106.87**	**143.19**	**155.97**
Oil Shale	215.38	195.44	158.51	121.33	128.04	115.20	118.47	116.97	106.76	101.54	100.49	97.13	94.99	113.56	113.37	107.38	99.57	123.70	113.06	95.38	130.90	143.49
Milled Peat	1.81	1.13	1.17	1.12	1.22	1.81	1.32	1.35	0.99	0.76	0.69	1.17	1.22	1.18	0.97	1.01	1.22	1.60	1.26	1.33	1.66	1.64
Sod Peat	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.85	0.87	0.68	0.69	0.60	0.75	0.76	0.79	0.59	0.57	0.61	0.59	0.57	0.50	0.21
Peat Briquette	3.59	3.34	2.61	2.03	1.58	2.16	2.00	1.10	0.55	0.51	0.47	0.27	0.30	0.33	0.24	0.21	0.19	0.21	0.27	0.16	0.18	0.20
Coal	9.29	9.00	5.69	2.93	2.19	2.50	2.80	2.41	1.83	1.95	2.29	2.96	1.61	1.19	1.56	1.50	1.89	3.52	3.48	2.35	1.62	1.88
Oil shale semi-coke gas	0.70	0.39	0.62	1.06	0.91	0.90	1.00	1.05	0.92	0.79	1.04	1.26	1.26	1.32	1.48	1.59	1.62	1.53	2.00	2.40	3.21	3.77
Oil shale generator gas	6.37	5.48	4.49	3.76	3.80	4.40	4.28	4.26	2.17	1.24	2.17	2.44	2.64	2.74	2.76	2.78	3.21	3.46	3.65	3.38	3.54	3.15
Gas gasoline	0.95	0.81	0.87	0.98	0.97	0.96	1.03	1.03	0.60	0.45	0.77	0.86	0.90	0.95	0.96	0.97	1.08	1.14	1.20	1.30	1.58	1.62
Coke	0.41	0.32	0.09	0.08	0.05	0.03	0.03	0.02	0.03	0.03	0.05	0.13	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Liquid Fuels	**121.83**	**110.96**	**61.64**	**59.84**	**58.33**	**46.82**	**49.90**	**48.49**	**48.33**	**43.73**	**36.13**	**42.18**	**43.30**	**42.19**	**42.33**	**42.67**	**42.73**	**44.76**	**41.89**	**38.91**	**41.19**	**41.58**
Heavy fuel oil	67.84	61.69	26.86	28.66	23.40	14.41	15.72	13.05	13.52	10.98	3.73	3.34	2.38	1.21	0.67	0.51	0.23	0.26	0.20	0.19	0.22	0.07
Light fuel oil	5.05	3.69	1.60	0.86	0.73	0.97	1.69	1.96	2.23	2.69	3.21	4.88	4.73	4.70	4.34	4.00	2.56	2.88	2.81	2.14	2.06	0.41
Motor gasoline	22.84	20.26	9.85	10.10	12.49	10.75	12.07	13.14	12.68	12.04	12.15	14.42	13.37	12.95	12.40	12.47	13.53	14.20	14.05	12.91	11.96	11.34
Diesel oil	24.44	23.77	14.40	13.26	14.31	12.98	14.18	14.11	15.12	12.65	12.43	14.18	17.70	18.23	19.50	20.62	22.18	24.04	21.45	20.63	23.40	24.06
LPG	1.58	1.47	0.54	0.33	0.47	0.32	0.33	0.35	0.38	0.32	0.33	0.36	0.27	0.29	0.29	0.31	0.27	0.35	0.36	0.28	0.36	0.34
Aviation Gasoline	0.08	0.08	0.03	0.05	0.04	0.05	0.04	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.04	0.02	0.02	0.02	0.03	0.02	0.02	0.04
Shale oil (heavy fraction)	0.00	0.00	8.37	6.57	6.90	7.35	5.86	5.83	4.37	5.01	4.25	4.97	4.83	4.78	5.09	4.73	3.95	3.02	3.00	2.74	3.16	2.54

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Shale oil (light fraction)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.78
Gaseous fuels	**43.46**	**44.21**	**26.41**	**13.41**	**16.53**	**19.37**	**21.93**	**21.23**	**19.88**	**19.45**	**23.58**	**25.35**	**23.81**	**25.10**	**27.93**	**28.55**	**28.98**	**29.00**	**27.43**	**21.40**	**23.55**	**21.24**
Natural Gas	43.46	44.21	26.41	13.41	16.53	19.37	21.93	21.23	19.88	19.45	23.58	25.35	23.81	25.10	27.93	28.55	28.98	29.00	27.43	21.40	23.55	21.24
Other Fuels	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.13**	**0.35**	**0.39**	**0.78**	**0.61**	**0.60**	**0.77**	**0.95**	**0.52**	**0.56**	**1.12**
Waste oils	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.13	0.33	0.34	0.73	0.60	0.57	0.65	0.59	0.25	0.17	0.19
Plastics	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00
Municipal Solid Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.06	0.05	0.01	0.03	0.11	0.35	0.24	0.38	0.93
Biomass	**8.63**	**8.47**	**8.11**	**7.73**	**12.54**	**20.35**	**24.28**	**24.78**	**21.12**	**21.27**	**21.43**	**22.56**	**22.86**	**24.10**	**25.00**	**24.51**	**22.07**	**24.92**	**26.89**	**29.41**	**34.99**	**33.71**
Solid biomass	8.63	8.47	8.11	7.73	12.52	20.26	24.22	24.72	21.05	21.16	21.35	22.47	22.78	23.98	24.91	24.36	21.85	24.73	26.59	29.23	34.51	33.38
Liquid biomass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.02	0.18	0.07	0.32	0.19
Gaseous biomass	0.00	0.00	0.00	0.00	0.02	0.09	0.06	0.06	0.07	0.11	0.08	0.08	0.09	0.11	0.09	0.15	0.17	0.18	0.12	0.11	0.16	0.14

**Biodiesel and Bioethanol*

Table A.2.9. CO_2 emissions from fuel combustion, Tg

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Solid Fuels	**24.080**	**21.871**	**17.513**	**13.211**	**13.754**	**12.768**	**13.108**	**12.777**	**11.255**	**10.531**	**10.554**	**10.337**	**10.014**	**11.793**	**11.703**	**10.990**	**10.356**	**13.056**	**11.808**	**9.789**	**13.100**	**14.071**
Oil Shale	21.295	19.418	15.642	11.769	12.424	11.177	11.468	11.274	10.320	9.830	9.616	9.232	8.986	10.782	10.669	9.967	9.190	11.643	10.357	8.471	11.719	12.747
Milled Peat	0.190	0.119	0.122	0.117	0.128	0.189	0.138	0.141	0.103	0.080	0.072	0.122	0.127	0.124	0.101	0.105	0.128	0.167	0.132	0.140	0.174	0.172
Sod Peat	0.000	0.000	0.000	0.000	0.000	0.000	0.101	0.086	0.088	0.069	0.069	0.061	0.076	0.076	0.079	0.060	0.057	0.062	0.059	0.058	0.050	0.021
Peat Briquette	0.338	0.315	0.245	0.192	0.149	0.203	0.188	0.104	0.052	0.048	0.045	0.026	0.028	0.031	0.022	0.020	0.018	0.020	0.026	0.015	0.017	0.019
Coal	0.895	0.867	0.548	0.282	0.211	0.241	0.270	0.232	0.176	0.187	0.221	0.285	0.155	0.114	0.150	0.145	0.182	0.339	0.336	0.226	0.156	0.181
Oil shale semi-coke gas	0.048	0.026	0.042	0.072	0.062	0.062	0.068	0.072	0.063	0.054	0.071	0.086	0.086	0.090	0.101	0.109	0.111	0.105	0.137	0.164	0.219	0.236
Oil shale generator gas	1.206	1.037	0.845	0.703	0.708	0.825	0.800	0.796	0.408	0.229	0.403	0.453	0.490	0.509	0.512	0.517	0.595	0.641	0.678	0.626	0.656	0.583
Gas gasoline	0.065	0.055	0.059	0.067	0.067	0.066	0.071	0.071	0.041	0.031	0.053	0.059	0.062	0.065	0.066	0.067	0.074	0.078	0.082	0.089	0.108	0.111
Coke	0.044	0.034	0.009	0.008	0.005	0.003	0.004	0.002	0.003	0.003	0.005	0.013	0.003	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000
Liquid Fuels	**9.096**	**8.285**	**4.611**	**4.481**	**4.349**	**3.482**	**3.704**	**3.591**	**3.580**	**3.236**	**2.639**	**3.080**	**3.180**	**3.099**	**3.108**	**3.106**	**3.093**	**3.237**	**3.034**	**2.827**	**3.011**	**3.039**
Heavy fuel oil	5.196	4.725	2.057	2.195	1.792	1.104	1.204	1.000	1.035	0.841	0.286	0.256	0.182	0.093	0.051	0.039	0.017	0.020	0.015	0.014	0.017	0.005
Light fuel oil	0.371	0.271	0.117	0.063	0.054	0.071	0.124	0.143	0.163	0.197	0.235	0.358	0.347	0.344	0.318	0.294	0.187	0.211	0.206	0.157	0.151	0.030
Motor gasoline	1.633	1.449	0.704	0.722	0.893	0.769	0.862	0.940	0.912	0.863	0.859	1.023	0.966	0.940	0.900	0.881	0.944	0.993	0.988	0.918	0.867	0.823
Diesel oil	1.792	1.743	1.056	0.973	1.049	0.952	1.041	1.035	1.109	0.928	0.911	1.038	1.296	1.335	1.428	1.509	1.623	1.759	1.570	1.508	1.710	1.759
LPG	0.099	0.092	0.034	0.021	0.030	0.020	0.021	0.022	0.024	0.020	0.020	0.023	0.017	0.018	0.018	0.019	0.017	0.022	0.022	0.018	0.022	0.021
Aviation Gasoline	0.006	0.006	0.002	0.004	0.003	0.004	0.003	0.004	0.003	0.003	0.003	0.002	0.003	0.002	0.003	0.002	0.001	0.001	0.002	0.002	0.002	0.003
Shale oil (heavy fraction)	0.000	0.000	0.641	0.503	0.528	0.563	0.449	0.446	0.335	0.384	0.325	0.380	0.370	0.366	0.390	0.362	0.302	0.231	0.230	0.209	0.242	0.195
Shale oil (light fraction)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.204
Natural Gas	**2.389**	**2.430**	**1.452**	**0.737**	**0.909**	**1.065**	**1.206**	**1.167**	**1.093**	**1.070**	**1.296**	**1.393**	**1.309**	**1.380**	**1.536**	**1.570**	**1.593**	**1.594**	**1.508**	**1.177**	**1.295**	**1.168**
Other Fuels	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.001**	**0.010**	**0.026**	**0.030**	**0.058**	**0.045**	**0.045**	**0.057**	**0.072**	**0.040**	**0.044**	**0.089**

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Waste oils	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.009	0.025	0.025	0.054	0.044	0.042	0.048	0.044	0.018	0.012	0.014
Plastics	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.001	0.000
Municipal Solid Waste	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.004	0.004	0.001	0.002	0.009	0.028	0.019	0.031	0.074

Table A.2.10. CH_4 emissions from fuel combustion, Gg CO_2 eq

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Solid Fuels	**30.463**	**31.100**	**13.215**	**7.549**	**4.167**	**8.268**	**11.361**	**10.534**	**8.012**	**8.324**	**7.120**	**6.711**	**7.322**	**5.372**	**7.633**	**6.970**	**6.108**	**5.240**	**4.464**	**3.728**	**3.894**	**4.674**
Oil Shale	1.327	1.232	0.990	0.533	0.822	0.742	0.710	0.568	0.841	0.519	0.573	0.549	0.503	0.450	0.496	0.672	0.554	1.029	0.748	0.583	0.628	1.047
Milled Peat	1.150	0.714	0.736	0.736	0.793	1.150	0.858	0.875	0.650	0.484	0.432	0.734	0.769	0.745	0.608	0.635	0.772	1.007	0.795	0.840	1.043	1.032
Sod Peat	0.000	0.000	0.000	0.000	0.000	0.000	0.638	0.552	0.555	0.439	0.437	0.385	0.478	0.482	0.503	0.374	0.357	0.386	0.371	0.361	0.315	0.137
Peat Briquette	3.737	3.465	2.732	2.049	1.541	2.148	2.040	1.110	0.558	0.536	0.488	0.280	0.307	0.319	0.229	0.219	0.183	0.207	0.277	0.154	0.176	0.200
Coal	23.749	25.277	8.502	4.055	0.847	4.005	6.919	7.232	5.294	6.298	5.112	4.660	5.175	3.287	5.706	4.976	4.139	2.503	2.123	1.668	1.588	2.113
Oil Shale Gas	0.414	0.345	0.238	0.160	0.154	0.216	0.189	0.194	0.108	0.043	0.068	0.078	0.082	0.085	0.089	0.092	0.101	0.105	0.149	0.121	0.142	0.145
Coke	0.086	0.068	0.018	0.017	0.009	0.006	0.007	0.003	0.007	0.006	0.010	0.026	0.007	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.002	0.000
Liquid Fuels	**27.680**	**25.040**	**12.923**	**12.869**	**13.722**	**12.402**	**12.704**	**14.052**	**11.208**	**12.504**	**11.178**	**13.037**	**11.748**	**10.595**	**9.721**	**9.370**	**9.108**	**8.880**	**8.761**	**8.652**	**8.752**	**5.653**
Heavy fuel oil	4.855	4.306	1.730	1.966	1.487	0.903	0.990	0.817	0.858	0.691	0.233	0.209	0.150	0.075	0.040	0.030	0.014	0.015	0.012	0.011	0.014	0.005
Light fuel oil	0.711	0.518	0.247	0.102	0.071	0.085	0.180	0.185	0.227	0.288	0.362	0.706	0.655	0.574	0.511	0.463	0.305	0.315	0.323	0.210	0.195	0.058
Motor gasoline	19.449	17.708	8.915	8.833	10.054	9.169	9.399	10.916	7.817	9.488	8.648	9.939	8.432	7.500	6.637	6.351	6.276	6.043	6.015	6.012	5.988	3.624
Diesel oil	2.517	2.355	1.453	1.501	1.634	1.759	1.762	1.761	1.987	1.685	1.632	1.832	2.174	2.109	2.183	2.200	2.231	2.276	2.174	2.209	2.314	1.514
LPG	0.142	0.146	0.049	0.032	0.035	0.029	0.033	0.034	0.037	0.032	0.033	0.036	0.026	0.029	0.028	0.030	0.028	0.036	0.037	0.028	0.037	0.033
Aviation Gasoline	0.006	0.006	0.002	0.002	0.002	0.003	0.004	0.003	0.004	0.004	0.003	0.003	0.007	0.006	0.005	0.005	0.007	0.006	0.006	0.005	0.005	0.004
Shale oil (heavy fraction)	0.000	0.000	0.526	0.433	0.439	0.453	0.338	0.335	0.279	0.316	0.268	0.312	0.304	0.302	0.317	0.290	0.249	0.188	0.194	0.177	0.200	0.169
Shale oil (light fraction)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.246
Natural Gas	**1.555**	**1.555**	**1.110**	**0.676**	**0.802**	**0.832**	**0.861**	**0.832**	**0.864**	**0.805**	**0.891**	**0.969**	**0.843**	**1.000**	**1.115**	**1.157**	**1.196**	**1.261**	**1.220**	**0.874**	**0.938**	**0.834**
Biomass	**39.105**	**37.225**	**35.695**	**35.629**	**54.885**	**99.001**	**115.689**	**120.436**	**94.978**	**92.782**	**93.514**	**92.944**	**92.745**	**98.347**	**99.532**	**87.561**	**84.500**	**106.653**	**109.582**	**116.954**	**122.983**	**108.432**
Solid Biomass	39.105	37.225	35.695	35.629	54.884	98.999	115.688	120.435	94.976	92.780	93.513	92.943	92.743	98.345	99.530	87.558	84.497	106.649	109.576	116.952	122.968	108.419
Liquid Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.012	0.010
Gaseous Biomass	0.000	0.000	0.000	0.000	0.000	0.002	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.004	0.004	0.002	0.002	0.003	0.003
Other Fuels	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.005**	**0.085**	**0.219**	**0.248**	**0.490**	**0.384**	**0.379**	**0.482**	**0.596**	**0.329**	**0.356**	**0.706**
Waste oils	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.079	0.209	0.214	0.459	0.376	0.362	0.411	0.373	0.157	0.104	0.121
Plastics	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.022	0.010	0.000
Municipal Solid Waste	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.010	0.035	0.032	0.008	0.017	0.071	0.221	0.151	0.242	0.585

Table A.2.11. N_2O emissions from fuel combustion, Gg CO_2 eq

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Solid Fuels	**16.733**	**15.378**	**10.361**	**6.906**	**6.311**	**8.148**	**9.034**	**7.326**	**6.239**	**5.172**	**5.165**	**5.643**	**5.264**	**4.710**	**7.949**	**11.330**	**11.920**	**13.712**	**13.332**	**10.857**	**11.510**	**12.248**
Oil Shale	2.703	2.524	2.013	1.050	1.641	1.480	1.411	1.109	1.684	1.022	1.112	1.057	0.957	0.835	3.951	7.663	7.957	8.714	8.724	6.883	7.494	8.405
Milled Peat	2.248	1.406	1.446	1.390	1.517	2.239	1.638	1.669	1.225	0.945	0.849	1.445	1.507	1.467	1.197	1.247	1.516	1.982	1.565	1.653	2.053	2.031
Sod Peat	0.000	0.000	0.000	0.000	0.000	0.000	1.238	1.054	1.075	0.847	0.851	0.748	0.934	0.936	0.970	0.730	0.701	0.759	0.730	0.708	0.619	0.260
Peat Briquette	4.448	4.144	3.235	2.522	1.957	2.672	2.481	1.365	0.683	0.637	0.587	0.339	0.374	0.403	0.291	0.265	0.240	0.260	0.340	0.192	0.222	0.247
Coal	6.924	6.973	3.467	1.757	1.031	1.579	2.088	1.957	1.461	1.645	1.646	1.883	1.357	0.934	1.403	1.283	1.352	1.838	1.796	1.238	0.908	1.091
Oil Shale Gas	0.219	0.182	0.158	0.150	0.146	0.164	0.163	0.164	0.096	0.063	0.100	0.115	0.121	0.126	0.131	0.136	0.150	0.155	0.175	0.179	0.209	0.215
Coke	0.190	0.150	0.041	0.037	0.020	0.013	0.015	0.007	0.014	0.013	0.021	0.058	0.014	0.009	0.006	0.005	0.004	0.004	0.003	0.003	0.005	0.000
Liquid Fuels	**82.259**	**78.925**	**49.914**	**47.973**	**41.782**	**41.723**	**48.296**	**45.737**	**40.818**	**34.765**	**38.116**	**55.185**	**61.487**	**44.272**	**45.120**	**43.227**	**37.886**	**38.616**	**37.120**	**40.734**	**42.681**	**44.060**
Heavy fuel oil	12.617	11.474	4.996	5.331	4.352	2.680	2.924	2.428	2.514	2.043	0.694	0.621	0.442	0.225	0.124	0.094	0.042	0.048	0.037	0.035	0.041	0.013
Light fuel oil	0.940	0.687	0.297	0.160	0.136	0.179	0.313	0.364	0.414	0.500	0.596	0.908	0.879	0.874	0.808	0.745	0.476	0.536	0.522	0.399	0.383	0.076
Motor gasoline	15.811	14.883	6.599	8.589	15.351	18.222	23.444	21.929	16.089	19.140	23.916	41.894	40.159	17.840	17.528	16.987	11.531	11.152	11.130	11.200	11.106	7.473
Diesel oil	52.784	51.778	36.430	32.622	20.619	19.229	20.480	19.885	20.949	12.112	12.083	10.801	19.074	24.409	25.670	24.491	25.079	26.293	24.837	28.564	30.532	35.471
LPG	0.049	0.045	0.017	0.010	0.015	0.010	0.010	0.011	0.012	0.010	0.010	0.011	0.008	0.009	0.009	0.010	0.008	0.011	0.011	0.009	0.011	0.011
Aviation Gasoline	0.058	0.058	0.019	0.039	0.026	0.036	0.033	0.037	0.027	0.028	0.026	0.026	0.027	0.026	0.035	0.020	0.016	0.016	0.025	0.019	0.019	0.027
Shale oil (heavy fraction)	0.000	0.000	1.556	1.221	1.283	1.366	1.090	1.084	0.814	0.932	0.790	0.924	0.898	0.889	0.946	0.879	0.734	0.561	0.557	0.509	0.588	0.473
Shale oil (light fraction)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.517
Natural Gas	**1.347**	**1.370**	**0.819**	**0.416**	**0.513**	**0.600**	**0.680**	**0.658**	**0.616**	**0.603**	**0.731**	**0.786**	**0.738**	**0.778**	**0.866**	**0.885**	**0.898**	**0.899**	**0.850**	**0.663**	**0.730**	**0.659**
Biomass	**10.701**	**10.504**	**10.059**	**9.584**	**15.522**	**25.126**	**30.038**	**30.656**	**26.102**	**26.244**	**26.480**	**27.869**	**28.246**	**29.742**	**30.744**	**30.142**	**26.934**	**30.495**	**32.797**	**36.090**	**42.357**	**38.613**
Solid Biomass	10.701	10.504	10.059	9.584	15.522	25.126	30.038	30.656	26.102	26.244	26.480	27.869	28.246	29.742	30.892	30.207	27.102	30.666	32.988	36.245	42.832	41.422
Liquid Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gaseous Biomass	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Other Fuels	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.010**	**0.167**	**0.432**	**0.489**	**0.965**	**0.756**	**0.745**	**0.949**	**1.174**	**0.648**	**0.700**	**1.390**
Waste oils	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.155	0.412	0.421	0.902	0.739	0.712	0.809	0.734	0.309	0.205	0.238
Plastics	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.005	0.043	0.019	0.000
Municipal Solid Waste	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012	0.020	0.068	0.062	0.016	0.034	0.141	0.434	0.297	0.476	1.152

1918
TALLINNA TEHNIKAÜLIKOOL
MÄEINSTITUUT

Inge Roos, national GHG
inventory energy expert
Department of Thermal
Engineering, Tallinn University
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Kopli 116
TALLINN

March 14, 2011 nr

Subject: Possible methane emission from
Estonian oil shale mining

In reply to your question whether methane exists in Estonian oil shale mining and in which kinds of Estonian studies this topic is treated, our answer is the following:

Estonian underground mines are continually ventilated and quality of air inside the mines is controlled. Oil shale is a mixture of clay and kerogen matter, and does not emit methane. During the 90-year long period of mining in Estonia there have never been any problems related to methane. Methane is non-existent in Estonian oil shale.

Risk of fire is related only to the kerogen matter in the oil shale, which can ignite. While oil shale is being crushed, fine dust is produced and it may explode.

So as methane does not exist in Estonian mines, it has not been an issue for scientific studies and there are no related publications dealing with Estonia.

Sincerely

Prof. Ingo Valgma
Director

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Annex 3. Other detailed methodological descriptions for individual source or sink categories, including for KP-LULUCF activities

A.3.1. Energy

In this chapter an additional information regarding CRF source category 1.AD Feedstocks and non-energy use is presented. Under this category carbon stored in products is reported.

The following fuels are reported under CRF source category 1.AD Feedsocks and non–energy use of fuels:

1.AD.2 Lubricants
1.AD.3 Bitumen
1.AD 5 Natural Gas
1.AD 10 Other/Oil Shale

Activity data on lubricants and bitumen consumption is received from IEA statistics; the national statistics does not publish this data. Data on natural gas use for non-energy use are taken from national energy balance sheet. Activity data on oil shale reported in the CRF 1.AD.10 is calculated (see Annex 2). This is oil shale semi coke – the by product of shale oil production and contains a small amount of organic matter (carbon). Oil shale semi-coke is stored in the oil shale waste dumps (carbon stored).

In the Table A.3.1_1 carbon stored in products is presented.

Table A.3.1_1. Carbon stored in products

Lubricants	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Fuel Consumption, TJ	1 085	1 045	683	522	683	442	482	362	402	281	362	322	241	281	241	161	161	281	201	161	161	161
Fraction of carbon stored	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
CEF, tC/TJ	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Carbon stored, Gg	10.85	10.45	6.83	5.22	6.83	4.42	4.82	3.62	4.02	2.81	3.62	3.22	2.41	2.81	2.41	1.61	1.61	2.81	2.01	1.61	1.61	1.61
Carbon, Gg	21.70	20.90	13.66	10.45	13.66	8.84	9.65	7.23	8.04	5.63	7.23	6.43	4.82	5.63	4.82	3.22	3.22	5.63	4.02	3.22	3.22	3.22
Bitumen	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Fuel Consumption, TJ	2 170	1 849	965	1 246	1 366	844	1 125	1 045	1 286	1 286	1 366	1 125	2 733	1 206	1 768	1 648	2 170	1 407	1 527	1 348	1 560	1 571
Fraction of carbon stored	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CEF, tC/TJ	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00
Carbon stored, Gg	47.75	40.67	21.22	27.41	30.06	18.57	24.76	22.99	28.29	28.29	30.06	24.76	60.12	26.53	38.90	36.25	47.75	30.95	33.60	29.66	34.32	34.57
Carbon, Gg	47.75	40.67	21.22	27.41	30.06	18.57	24.76	22.99	28.29	28.29	30.06	24.76	60.12	26.53	38.90	36.25	47.75	30.95	33.60	29.66	34.32	34.57
Natural Gas	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Fuel Consumption, TJ	7 657	7 361	3 665	1 440	4 736	4 978	4 930	4 859	4 899	4 674	4 166	4 459	1 152	2 413	4 533	4 915	4 919	4 715	4 872	538	NO	NO
Fraction of carbon stored	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	NA	NA
CEF, tC/TJ	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	15.07	NA	NA
Carbon stored, Gg	115.39	110.93	55.23	21.70	71.37	75.02	74.30	73.23	73.83	70.44	62.78	67.20	17.36	36.36	68.31	74.07	74.13	71.06	73.42	8.11	NA	NA
Carbon, Gg	115.39	110.93	55.23	21.70	71.37	75.02	74.30	73.23	73.83	70.44	62.78	67.20	17.36	36.36	68.31	74.07	74.13	71.06	73.42	8.11	NA	NA
Oil Shale	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Fuel Consumption, TJ	5 458	4 857	4 371	5 341	3 415	5 080	4 757	5 125	4 155	2 028	3 688	4 924	4 065	4 138	4 013	4 134	3 625	3 363	3 136	3 146	3 812	4 064
Fraction of carbon stored	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
CEF, tC/TJ	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49	30.49
Carbon stored, Gg	166.40	148.08	133.26	162.84	104.11	154.86	145.02	156.25	126.67	61.82	112.44	150.11	123.94	126.15	122.35	126.05	110.53	102.54	95.60	95.92	116.21	123.91
Carbon, Gg	166.40	148.08	133.26	162.84	104.11	154.86	145.02	156.25	126.67	61.82	112.44	150.11	123.94	126.15	122.35	126.05	110.53	102.54	95.60	95.92	116.21	123.91

Table A.3.1_2. Emission factors for LTO-cycle (kg/LTO)

	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Turbofans (Jets)*							
Airbus A310	4 853	0.5	0.2	23.2	25.8	5	1.5
Airbus A320	2 527	0.2	0.1	10.8	17.6	1.7	0.8
Bae 111	2 147	2.1	0.1	4.9	37.7	19.3	0.7
Bae 146	1 794	0.1	0.1	4.2	9.7	0.9	0.6
B727	4 450	0.7	0.1	12.6	26.4	6.5	1.4
B737-100	2 897	0.1	0.1	8	4.8	0.5	0.9
B737-400	2 600	0.1	0.1	8.3	11.8	0.6	0.8
B747-100-300	10 754	3.7	0.3	55.9	78.2	33.6	3.4
B747-400	10 717	0.2	0.3	56.6	19.5	1.6	3.4
B757	3 947	0.1	0.1	19.7	12.5	1.1	1.3
B767-300	5 094	0.1	0.2	26	6.1	0.8	1.6
B777	8 073	2.3	0.3	53.6	61.4	20.5	2.6
Fokker 100	2 345	0.1	0.1	5.8	13.7	1.3	0.7
Fokker 28	2 098	3.3	0.1	5.2	32.7	29.6	0.7
2XB737-100	5 794	0.2	0.2	16	9.6	1	1.8
McDonnell Douglas DC-9	2 760	0.1	0.1	7.3	5.4	0.7	0.9
McDonnell Douglas DC-10	7 501	2.3	0.2	41.7	61.6	20.5	2.4
McDonnell Douglas	3 160	0.2	0.1	12.3	6.5	1.4	1
C525	1 070	0.33	0.03	0.74	34.07	3.01	0.34
EC RJ_100ER	1 060	0.06	0.03	2.27	6.7	0.56	0.33
ERJ-145	990	0.06	0.03	2.69	6.18	0.5	0.31
GLF4	2 160	0.14	0.1	5.63	8.88	1.23	0.68
GLF5	1 890	0.03	0.1	5.58	8.42	0.28	0.6
RJ85	1 910	0.13	0.1	4.34	11.21	1.21	0.6
Turboprop**							
turboprop, <1000sph/engine	230	0.06	0.01	0.3	2.97	0.58	0.07
turboprop, 1000-2000 sph/engine	640	0	0.02	1.51	2.24	0	0.2
turboprop, >2000sph/engine	620	0.03	0.02	1.82	2.33	0.26	0.2
Piston engine***							
microlight aircraft	4.41	0.00	0.00	0.03	0.94	0.04	0.00
4 seat single engine (<180hp)	12.29	0.01	0.00	0.01	3.93	0.06	0.00
singe engine high performance (180-360hp)	23.63	0.02	0.00	0.02	7.33	0.16	0.00
twin engine high performance (2x235hp)	68.04	0.02	0.00	0.05	19.33	0.22	0.01
Helicopters****							
A109	103.32	0.10	0.00	0.13	1.31	0.89	0.02
A139	189.95	0.08	0.01	0.38	0.97	0.68	0.03
ALO3	67.47	0.03	0.00	0.11	0.40	0.28	0.01
AS32	243.81	0.05	0.01	0.65	0.68	0.49	0.04
AS35	86.63	0.02	0.00	0.18	0.32	0.22	0.01
AS50	79.38	0.03	0.00	0.15	0.35	0.24	0.01
AS55	109.62	0.09	0.00	0.15	1.20	0.82	0.02
H269	20.79	0.01	0.00	0.01	6.59	0.09	0.00
B412	242.55	0.05	0.01	0.64	0.69	0.49	0.04
B06	57.33	0.04	0.00	0.08	0.50	0.35	0.01
EC35	129.47	0.08	0.00	0.21	1.03	0.71	0.02
EN48	58.59	0.04	0.00	0.08	0.48	0.34	0.01
MI8	220.50	0.06	0.01	0.53	0.78	0.55	0.04
R22	19.53	0.01	0.00	0.01	6.21	0.09	0.00
R44	27.72	0.01	0.00	0.02	8.79	0.11	0.00
S76	151.83	0.07	0.00	0.29	0.85	0.59	0.02

***Turbofans (Jet engine)** – The original data source for the Large Commercial Aircraft group LTO emissions factors is the EMEP/EEA guidebook (EMEP/EEA air pollutant emission inventory guidebook — 2009, www.eea.europa.eu/emep-eea-guidebook), the ICAO Engine Exhaust Emissions Data Bank (http://www.dera.gov.uk) and IPCC Guidelines (2006 IPCC Guidelines for National Greenhouse Gas Inventories).*

*****Turboprops (Turbojet engine, driving a propeller)** - This group is represented by three typical aircraft size based on engine shaft horsepower (2006 IPCC Guidelines for National Greenhouse Gas Inventories).*

******Piston engine aircraft** – This group is represented by four typical aircraft size based on engine horsepower by "Aircraft Piston Engine Emissions Summary Report" (Federal Office of Civil Aviation FOCA) in Estonia's report.*

*******Helicopters** – Emission factor of helicopters used are taken from "Guidance on the Determination of Helicopter Emissions" (Federal Office of Civil Aviation FOCA).*

A.3.2. Industrial Processes

Table A.3.2_1. CO_2 emissions from ammonia production (Gg), Tier 1a

Year	Amount of Gas Consumed (m^3)	Carbon Content of Gas (kg/m^3)	Conversion Ratio	CO_2 Emitted (kg)	CO_2 Emitted (Gg)
	A	B	C	D	E
			44/12	D = (A x B x C)	E = D/1 000 000
1990	225 200 000	0.5087	44/12	420 050 547	420.051
1991	208 000 000	0.5123	44/12	390 714 133	390.714
1992	107 800 000	0.5067	44/12	200 277 667	200.278
1993	42 350 000	0.5079	44/12	78 868 405	78.868
1994	139 300 000	0.5076	44/12	259 265 160	259.265
1995	146 400 000	0.5216	44/12	279 968 040	279.968
1996	145 000 000	0.5060	44/12	269 012 700	269.013
1997	142 900 000	0.5039	44/12	264 026 803	264.027
1998	144 100 000	0.5050	44/12	266 825 167	266.825
1999	139 400 000	0.5046	44/12	257 917 880	257.918
2000	123 900 000	0.5092	44/12	231 329 560	231.330
2001	133 400 000	0.5080	44/12	248 479 733	248.480
2002	33 900 000	0.5111	44/12	63 529 730	63.530
2003	73 600 000	0.5061	44/12	136 579 520	136.580
2004	134 944 000	0.5067	44/12	250 712 458	250.712
2005	146 500 000	0.5066	44/12	272 128 633	272.129
2006	146 190 000	0.5067	44/12	271 606 401	271.606
2007	140 220 584	0.5058	44/12	260 053 095	260.053
2008	145 843 188	0.5062	44/12	270 694 680	270.695
2009	16 001 022	0.5055	44/12	29 657 894	29.658
2010	NO	NA	NA	NO	NO
2011	NO	NA	NA	NO	NO

A.3.3. Agriculture

APPENDIX A.3.3_I. LIVESTOCK POPULATION IN ESTONIA IN 1990–2011

Table A.3.3_I.1. Cattle population size in 1990–1998 in Estonia, 1000 heads

Year	Cattle, total	Dairy Cattle	Non-dairy cattle			
			Mature males	Mature females	Bovine animals (aged between 1 and 2 years)	Calves (less than 1 year old)
1990	757.8	280.7	4.2	47.0	172.1	251.9
1991	706.2	264.3	4.1	46.7	171.1	220.0
1992	614.6	253.4	3.4	38.1	139.4	178.8
1993	463.2	226.7	2.2	25.0	91.7	116.9
1994	419.5	211.4	1.9	21.3	77.9	105.8
1995	370.4	185.4	1.6	18.4	67.3	97.0
1996	343	171.6	1.5	17.2	63.0	89.1
1997	325.6	167.7	1.4	16.2	59.3	80.4
1998	307.5	158.6	1.3	14.9	54.7	77.1

Table A3.3_I.2. Swine population size in 1990–1998 in Estonia, 1000 heads

Year	Swine, total	…of which					
		Piglets, live weight less than 20 kg	Young pigs, live weight 20–50 kg	Pigs, live weight 50–80 kg	Pigs, live weight 80–110 kg	Pigs, live weight more than 110 kg	Breeding pigs, live weight more than 50 kg
1990	859.9	279.6	237.5	185.0	103.2	7.6	47.1
1991	798.6	260.1	221.3	172.3	96.1	7.0	41.5
1992	541.1	176.6	150.0	116.8	65.2	4.8	27.7
1993	424.3	137.2	116.6	90.8	50.6	3.7	25.3
1994	459.8	149.0	126.6	157.6	55.0	4.0	26.6
1995	448.8	146.3	124.3	96.8	54.0	4.0	23.4
1996	298.4	96.6	82.1	63.9	35.6	2.6	17.6
1997	306.3	98.0	83.3	64.9	36.2	2.6	21.3
1998	326.4	104.5	88.8	69.1	38.6	2.8	22.6

Table A.3.3_I.3. Total dairy-cattle population size in 1994–1998 by counties of Estonia, 1000 heads (Agriculture 1994)

County	1994	1995	1996	1997	1998
Total	211.4	185.4	171.6	167.7	158.6
Harju	17.6	13.7	10.6	10.7	9.9
Hiiu	2.3	2.1	1.8	1.7	1.6
Ida-Viru	6.9	5.9	5.4	5	4.6
Jõgeva	17.7	15.7	15.5	14.9	13.9
Järva	22.1	20.6	20.7	20.7	20.9
Lääne	8.8	8	7.3	7.1	6.9
Lääne-Viru	20.8	18.5	17.1	16.5	16.5
Põlva	11.9	11.1	10.7	10.3	9.6
Pärnu	22.1	19.9	18.7	18.4	16.8
Rapla	14.6	12	12	12.6	11.4
Saare	13.9	11.1	10.6	10.2	9.8
Tartu	13.8	13	11.1	10.6	10.1
Valga	8.5	7.9	7.4	6.7	6.2
Viljandi	19.7	16	13.8	13.4	12.4
Võru	10.7	9.9	8.9	8.9	8

Table A.3.3_I.4. Number of cattle in 1999 by counties of Estonia, 1000 heads (Agriculture 1999)

	Total	of which												
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)		
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
COUNTRY TOTAL														
1999	**267.3**	**138.4**	**0.5**	**1.6**	**14.0**	**0.5**	**13.5**	**8.3**	**40.2**	**1.8**	**38.4**	**64.3**	**10.8**	**42.9**	**10.6**
Harju	18.7	10.4	…	0.1	0.9	…	…	0.7	2.5	…	…	4.1	…	…	…
Hiiu	2.6	1.2	…	0.0	0.2	…	…	0.1	0.4	…	…	0.7	…	…	…
Ida-Viru	7.7	4.0	…	0.0	0.3	…	…	0.3	1.2	…	…	1.9	…	…	…
Jõgeva	23.6	12.0	…	0.3	1.0	…	…	0.5	3.8	…	…	6.0	…	…	…
Järva	38.4	19.9	…	0.1	2.1	…	…	0.7	6.2	…	…	9.4	…	…	…
Lääne	11.3	5.3	…	0.1	0.7	…	…	0.8	1.5	…	…	2.8	…	…	…
Lääne-Viru	30.5	14.5	…	0.1	2.0	…	…	1.3	4.7	…	…	7.8	…	…	…
Põlva	13.7	7.2	…	0.1	0.8	…	…	0.3	2.2	…	…	3.1	…	…	…
Pärnu	26.9	14.7	…	0.2	1.6	…	…	0.5	3.9	…	…	6.0	…	…	…
Rapla	18.6	10.2	…	0.1	0.7	…	…	0.5	2.8	…	…	4.2	…	…	…
Saare	15.8	8.1	…	0.1	0.8	…	…	0.5	2.3	…	…	4.0	…	…	…
Tartu	16.6	8.5	…	0.1	0.7	…	…	0.6	2.6	…	…	4.0	…	…	…
Valga	9.9	4.8	…	0.1	0.5	…	…	0.4	1.6	…	…	2.5	…	…	…
Viljandi	21.3	11.0	…	0.1	1.1	…	…	0.8	3.0	…	…	5.3	…	…	…
Võru	11.7	6.6	…	0.1	0.6	…	…	0.3	1.5	…	…	2.5	…	…	…
ENTERPRISES														
1999	**167.1**	**82.1**	**0.4**	**0.7**	**11.7**	**0.3**	**11.4**	**4.3**	**28.1**	**1.0**	**27.1**	**39.8**	**7.7**	**27.8**	**4.3**
Harju	13.0	6.3	0.0	0.1	0.8	0.0	0.8	0.6	2.1	0.2	1.9	3.1	0.8	1.7	0.6
Hiiu	0.8	0.3	0.0	0.0	0.1	0.0	0.1	0.0	0.2	-	0.2	0.2	0.0	0.1	0.1
Ida-Viru	3.4	1.6	0.0	0.0	0.2	0.0	0.2	0.1	0.7	0.1	0.6	0.8	0.2	0.5	0.1
Jõgeva	18.1	8.9	0.0	0.3	0.9	0.2	0.7	0.2	3.2	0.2	3.0	4.6	1.0	3.1	0.5
Järva	30.4	15.4	0.0	0.0	1.9	0.0	1.9	0.4	5.2	0.1	5.1	7.5	1.2	5.7	0.6
Lääne	5.8	2.1	0.1	0.1	0.6	0.0	0.6	0.6	0.8	0.0	0.8	1.5	0.6	0.8	0.1
Lääne-Viru	22.9	10.7	0.1	0.0	1.8	0.1	1.7	1.0	3.7	0.0	3.7	5.6	0.9	3.7	1.0
Põlva	8.2	4.2	0.0	0.0	0.7	0.0	0.7	0.1	1.5	0.0	1.5	1.7	0.1	1.4	0.2
Pärnu	17.7	9.2	0.0	0.2	1.4	0.0	1.4	0.1	2.8	0.1	2.7	4.0	0.8	3.0	0.2
Rapla	9.6	4.9	0.0	0.0	0.5	0.0	0.5	0.2	1.8	0.0	1.8	2.2	0.3	1.7	0.2
Saare	7.6	3.8	0.0	0.0	0.6	0.0	0.6	0.1	1.3	0.1	1.2	1.8	0.3	1.4	0.1
Tartu	10.1	4.8	0.1	0.0	0.6	0.0	0.6	0.4	1.8	0.1	1.7	2.4	0.6	1.5	0.3
Valga	4.3	2.2	0.0	0.0	0.4	0.0	0.4	0.1	0.7	0.0	0.7	0.9	0.2	0.6	0.1
Viljandi	10.2	4.8	0.0	0.0	0.8	0.0	0.8	0.4	1.6	0.1	1.5	2.6	0.6	1.8	0.2
Võru	5.0	2.9	0.1	0.0	0.4	0.0	0.4	0.0	0.7	0.0	0.7	0.9	0.1	0.8	0.0
PRIVATE FARMS														
1999	**55.9**	**30.0**	**0.1**	**0.5**	**1.3**	**0.1**	**1.2**	**2.4**	**7.2**	**0.5**	**6.7**	**14.4**	**1.8**	**8.9**	**3.7**

	Total	of which														
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)				
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding		
		dairy	other													
Harju	3.5	2.5	…	0.0	0.0	…	…	0.1	0.3	…	…	0.6	…	…	…	
Hiiu	1.1	0.5	…	0.0	0.1	…	…	0.1	0.1	…	…	0.3	…	…	…	
Ida-Viru	2.1	0.9	…	0.0	0.1	…	…	0.1	0.3	…	…	0.7	…	…	…	
Jõgeva	2.9	1.6	…	0.0	0.1	…	…	0.2	0.3	…	…	0.7	…	…	…	
Järva	6.1	3.5	…	0.1	0.1	…	…	0.2	0.8	…	…	1.4	…	…	…	
Lääne	1.7	1.1	…	0.0	0.0	…	…	0.0	0.2	…	…	0.4	…	…	…	
Lääne-Viru	4.9	2.1	…	0.1	0.1	…	…	0.3	0.8	…	…	1.5	…	…	…	
Põlva	3.6	1.8	…	0.1	0.1	…	…	0.1	0.5	…	…	1.0	…	…	…	
Pärnu	4.1	2.2	…	0.0	0.0	…	…	0.2	0.6	…	…	1.1	…	…	…	
Rapla	4.9	2.7	…	0.1	0.1	…	…	0.2	0.5	…	…	1.2	…	…	…	
Saare	3.5	1.7	…	0.0	0.1	…	…	0.2	0.5	…	…	1.0	…	…	…	
Tartu	3.4	1.9	…	0.0	0.1	…	…	0.1	0.4	…	…	0.9	…	…	…	
Valga	3.6	1.5	…	0.1	0.1	…	…	0.2	0.5	…	…	1.2	…	…	…	
Viljandi	7.1	4.2	…	0.0	0.2	…	…	0.2	0.9	…	…	1.6	…	…	…	
Võru	3.4	1.8	…	0.0	0.1	…	…	0.2	0.5	…	…	0.8	…	…	…	
HOUSEHOLD PLOTS																
1999	**44.3**	**26.3**	**0.0**	**0.4**	**1.0**	**0.1**	**0.9**	**1.6**	**4.9**	**0.3**	**4.6**	**10.1**	**1.3**	**6.2**	**2.6**	
Harju	2.2	1.6	…	0.0	0.1	…	…	0.0	0.1	…	…	0.4	…	…	…	
Hiiu	0.7	0.4	…	0.0	0.0	…	…	0.0	0.1	…	…	0.2	…	…	…	
Ida-Viru	2.2	1.5	…	0.0	0.0	…	…	0.1	0.2	…	…	0.4	…	…	…	
Jõgeva	2.6	1.5	…	0.0	0.0	…	…	0.1	0.3	…	…	0.7	…	…	…	
Järva	1.9	1.0	…	0.0	0.1	…	…	0.1	0.2	…	…	0.5	…	…	…	
Lääne	3.8	2.1	…	0.0	0.1	…	…	0.2	0.5	…	…	0.9	…	…	…	
Lääne-Viru	2.7	1.7	…	0.0	0.1	…	…	0.0	0.2	…	…	0.7	…	…	…	
Põlva	1.9	1.2	…	0.0	0.0	…	…	0.1	0.2	…	…	0.4	…	…	…	
Pärnu	5.1	3.3	…	0.0	0.2	…	…	0.2	0.5	…	…	0.9	…	…	…	
Rapla	4.1	2.6	…	0.0	0.1	…	…	0.1	0.5	…	…	0.8	…	…	…	
Saare	4.7	2.6	…	0.1	0.1	…	…	0.2	0.5	…	…	1.2	…	…	…	
Tartu	3.1	1.8	…	0.1	0.0	…	…	0.1	0.4	…	…	0.7	…	…	…	
Valga	2.0	1.1	…	0.0	0.0	…	…	0.1	0.4	…	…	0.4	…	…	…	
Viljandi	4.0	2.0	…	0.1	0.1	…	…	0.2	0.5	…	…	1.1	…	…	…	
Võru	3.3	1.9	…	0.1	0.1	…	…	0.1	0.3	…	…	0.8	…	…	…	

Table A.3.3_I.5. Swine population size in 1999 by counties of Estonia, 1000 heads (Agriculture 1999)

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total				
					50–80 kg	80–110 kg	more than 110 kg			covered sows	of which covered for the first time	other sows	of which gilts not yet covered
COUNTRY TOTAL													
1999	**285.7**	**75.2**	**77.9**	**98.8**	**66.0**	**29.0**	**3.8**	**1.6**	**32.2**	**18.5**	**6.1**	**13.7**	**6.2**
Harju	18.3	3.7	5.8	6.4	…	…	…	…	2.3	…	…	…	…
Hiiu	0.4	0.1	0.1	0.2	…	…	…	…	0.0	…	…	…	…
Ida-Viru	7.4	2.1	2.5	2.1	…	…	…	…	0.6	…	…	…	…
Jõgeva	20.5	4.7	6.6	6.7	…	…	…	…	2.3	…	…	…	…
Järva	29.2	6.8	7.1	11.8	…	…	…	…	3.3	…	…	…	…
Lääne	9.2	1.6	2.4	4.2	…	…	…	…	1.0	…	…	…	…
Lääne-Viru	32.9	7.1	8.1	14.3	…	…	…	…	3.2	…	…	…	…
Põlva	11.2	2.6	2.9	4.6	…	…	…	…	1.0	…	…	…	…
Pärnu	8.9	2.3	3.0	2.6	…	…	…	…	0.9	…	…	…	…
Rapla	27.4	8.1	8.2	7.7	…	…	…	…	3.3	…	…	…	…
Saare	14.1	4.6	3.8	3.9	…	…	…	…	1.7	…	…	…	…
Tartu	19.9	4.1	5.6	8.2	…	…	…	…	1.9	…	…	…	…
Valga	12.8	2.6	3.4	5.4	…	…	…	…	1.3	…	…	…	…
Viljandi	68.3	23.9	16.9	18.5	…	…	…	…	8.8	…	…	…	…
Võru	5.2	0.9	1.5	2.2	…	…	…	…	0.6	…	…	…	…
ENTERPRISES													
1999	**238.3**	**67.1**	**64.8**	**77.0**	**50.5**	**24.0**	**2.5**	**1.1**	**28.3**	**15.5**	**5.3**	**12.8**	**5.9**
Harju	16.7	3.4	5.3	5.7	3.7	2.0	-	0.1	2.2	1.2	0.4	1.0	0.6
Hiiu	-	-	-	-	-	-	-	-	-	-	-	-	-
Ida-Viru	6.4	2.0	2.2	1.6	1.3	0.3	-	0.1	0.5	0.4	0.2	0.1	0.1
Jõgeva	18.2	4.3	6.0	5.6	3.4	2.1	0.1	0.2	2.1	1.2	0.3	0.9	0.6
Järva	25.1	6.1	6.0	9.9	7.6	2.3	-	0.1	3.0	1.6	0.4	1.4	0.9
Lääne	7.9	1.4	2.0	3.6	1.6	1.0	1.0	0.0	0.9	0.7	0.3	0.2	0.1
Lääne-Viru	26.3	6.0	6.3	11.3	7.0	4.1	0.2	0.1	2.6	1.8	0.5	0.8	0.5
Põlva	6.6	1.8	1.6	2.5	2.4	0.0	0.1	0.1	0.6	0.4	0.0	0.2	0.1
Pärnu	4.9	1.6	1.9	0.8	0.7	0.1	-	0.0	0.6	0.4	0.0	0.2	0.1
Rapla	22.1	7.2	6.7	5.2	2.1	3.1	0.0	0.1	2.9	1.8	0.6	1.1	0.3
Saare	13.2	4.4	3.6	3.5	2.6	0.9	0.0	0.1	1.6	0.5	0.3	1.1	0.3
Tartu	16.7	3.6	4.7	6.7	4.6	2.0	0.1	0.1	1.6	1.0	0.2	0.6	0.2
Valga	10.3	2.2	2.7	4.3	3.9	0.4	0.0	0.0	1.1	1.0	0.3	0.1	0.1
Viljandi	62.2	22.8	15.3	15.7	9.2	5.5	1.0	0.1	8.3	3.3	1.8	5.0	1.9
Võru	1.7	0.3	0.5	0.6	0.4	0.2	-	0.0	0.3	0.2	0.0	0.1	0.1
PRIVATE FARMS													
1999	**29.4**	**5.0**	**8.1**	**13.6**	**9.7**	**3.1**	**0.8**	**0.3**	**2.4**	**1.8**	**0.5**	**0.6**	**0.2**

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total	covered sows	of which covered for the first time	other sows	of which gilts not yet covered
					50–80 kg	80–110 kg	more than 110 kg						
Harju	0.9	0.2	0.3	0.4	…	…	…	…	0.0	…	…	…	…
Hiiu	0.3	0.1	0.1	0.1	…	…	…	…	0.0	…	…	…	…
Ida-Viru	0.4	0.0	0.1	0.2	…	…	…	…	0.1	…	…	…	…
Jõgeva	1.4	0.2	0.4	0.7	…	…	…	…	0.1	…	…	…	…
Järva	3.2	0.5	0.9	1.5	…	…	…	…	0.2	…	…	…	…
Lääne	0.4	0.1	0.1	0.2	…	…	…	…	0.0	…	…	…	…
Lääne-Viru	5.3	0.9	1.4	2.4	…	…	…	…	0.5	…	…	…	…
Põlva	3.5	0.6	1.0	1.6	…	…	…	…	0.3	…	…	…	…
Pärnu	1.5	0.3	0.4	0.7	…	…	…	…	0.1	…	…	…	…
Rapla	3.6	0.6	1.0	1.7	…	…	…	…	0.3	…	…	…	…
Saare	0.5	0.1	0.1	0.2	…	…	…	…	0.1	…	…	…	…
Tartu	1.5	0.2	0.4	0.8	…	…	…	…	0.1	…	…	…	…
Valga	1.4	0.2	0.4	0.6	…	…	…	…	0.2	…	…	…	…
Viljandi	3.8	0.7	1.0	1.7	…	…	…	…	0.3	…	…	…	…
Võru	1.7	0.3	0.5	0.8	…	…	…	…	0.1	…	…	…	…
HOUSEHOLD PLOTS													
1999	**18.0**	**3.1**	**5.0**	**8.2**	**5.8**	**1.9**	**0.5**	**0.2**	**1.5**	**1.2**	**0.3**	**0.3**	**0.1**
Harju	0.7	0.1	0.2	0.3	…	…	…	…	0.1	…	…	…	…
Hiiu	0.1	0.0	0.0	0.1	…	…	…	…	0.0	…	…	…	…
Ida-Viru	0.6	0.1	0.2	0.3	…	…	…	…	0.0	…	…	…	…
Jõgeva	0.9	0.2	0.2	0.4	…	…	…	…	0.1	…	…	…	…
Järva	0.9	0.2	0.2	0.4	…	…	…	…	0.1	…	…	…	…
Lääne	0.9	0.1	0.3	0.4	…	…	…	…	0.1	…	…	…	…
Lääne-Viru	1.3	0.2	0.4	0.6	…	…	…	…	0.1	…	…	…	…
Põlva	1.1	0.2	0.3	0.5	…	…	…	…	0.1	…	…	…	…
Pärnu	2.5	0.4	0.7	1.1	…	…	…	…	0.2	…	…	…	…
Rapla	1.7	0.3	0.5	0.8	…	…	…	…	0.1	…	…	…	…
Saare	0.4	0.1	0.1	0.2	…	…	…	…	0.0	…	…	…	…
Tartu	1.7	0.3	0.5	0.7	…	…	…	…	0.2	…	…	…	…
Valga	1.1	0.2	0.3	0.5	…	…	…	…	0.0	…	…	…	…
Viljandi	2.3	0.4	0.6	1.1	…	…	…	…	0.2	…	…	…	…
Võru	1.8	0.3	0.5	0.8	…	…	…	…	0.2	…	…	…	…

Table A.3.3_I.6. Number of cattle in 2000 by counties of Estonia, 1000 heads (Agriculture 2000)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
COUNTRY TOTAL															
2000	**252.8**	**131.0**	**0.7**	**1.2**	**14.0**	**0.2**	**13.8**	**9.2**	**35.6**	**1.1**	**34.5**	**61.1**	**10.5**	**39.5**	**11.1**
Harju	17.4	9.6	…	0.0	1.0	…	…	0.6	2.4	…	…	3.7	…	…	…
Hiiu	2.9	1.4	…	0.0	0.1	…	…	0.3	0.4	…	…	0.7	…	…	…
Ida-Viru	6.7	3.4	…	0.0	0.5	…	…	0.3	1.1	…	…	1.4	…	…	…
Jõgeva	23.5	11.9	…	0.1	1.2	…	…	0.8	3.4	…	…	6.1	…	…	…
Järva	37.6	19.8	…	0.1	2.6	…	…	0.8	5.6	…	…	8.7	…	…	…
Lääne	10.2	4.4	…	0.2	0.7	…	…	1.1	1.4	…	…	2.1	…	…	…
Lääne-Viru	28.2	12.9	…	0.1	1.6	…	…	1.6	4.5	…	…	7.4	…	…	…
Põlva	14.0	7.8	…	0.1	0.7	…	…	0.3	1.6	…	…	3.5	…	…	…
Pärnu	25.0	13.7	…	0.3	1.5	…	…	0.3	3.3	…	…	5.9	…	…	…
Rapla	16.3	9.0	…	0.1	0.8	…	…	0.5	2.2	…	…	3.6	…	…	…
Saare	15.9	8.3	…	0.1	0.7	…	…	0.6	2.3	…	…	3.9	…	…	…
Tartu	14.9	7.7	…	0.0	0.6	…	…	0.4	2.1	…	…	4.1	…	…	…
Valga	9.5	4.5	…	0.0	0.7	…	…	0.5	1.3	…	…	2.5	…	…	…
Viljandi	19.5	10.3	…	0.1	0.8	…	…	0.7	2.6	…	…	5.0	…	…	…
Võru	11.2	6.3	…	0.0	0.5	…	…	0.4	1.4	…	…	2.5	…	…	…
ENTERPRISES															
2000	**154.6**	**75.4**	**0.2**	**0.7**	**11.6**	**0.1**	**11.5**	**4.2**	**24.9**	**0.7**	**24.2**	**37.6**	**6.4**	**27.1**	**4.1**
Harju	11.9	5.6	0.0	0.0	0.8	0.0	0.8	0.5	2.0	0.2	1.8	3.0	0.5	1.8	0.7
Hiiu	1.0	0.4	0.0	0.0	0.1	-	0.1	0.1	0.2	-	0.2	0.2	0.0	0.2	0.0
Ida-Viru	3.0	1.4	0.0	0.0	0.3	0.0	0.3	0.1	0.5	0.0	0.5	0.7	0.1	0.5	0.1
Jõgeva	18.2	8.7	0.0	0.1	1.0	0.0	1.0	0.6	2.9	0.2	2.7	4.9	1.0	3.3	0.6
Järva	29.7	15.2	-	0.1	2.4	0.0	2.4	0.4	4.5	0.1	4.4	7.1	0.7	5.7	0.7
Lääne	4.2	1.6	0.0	0.1	0.5	-	0.5	0.4	0.8	0.0	0.8	0.8	0.3	0.5	0.0
Lääne-Viru	21.2	9.7	0.0	0.1	1.5	0.1	1.4	1.0	3.5	0.1	3.4	5.4	1.1	3.4	0.9
Põlva	7.7	3.9	0.0	0.0	0.6	-	0.6	0.1	1.2	-	1.2	1.9	0.3	1.5	0.1
Pärnu	15.5	7.9	0.0	0.1	1.5	-	1.5	0.1	2.3	0.0	2.3	3.6	0.5	2.8	0.3
Rapla	8.8	4.4	0.1	0.1	0.6	0.0	0.6	0.1	1.6	0.1	1.5	1.9	0.2	1.6	0.1
Saare	7.6	3.8	0.0	0.1	0.6	0.0	0.6	0.1	1.3	-	1.3	1.7	0.2	1.4	0.1
Tartu	9.0	4.3	-	0.0	0.5	0.0	0.5	0.2	1.5	-	1.5	2.5	0.7	1.6	0.2
Valga	4.1	2.1	0.0	0.0	0.4	0.0	0.4	0.2	0.6	-	0.6	0.8	0.2	0.6	0.0
Viljandi	8.2	4.0	0.0	0.0	0.5	0.0	0.5	0.3	1.2	0.0	1.2	2.2	0.5	1.5	0.2
Võru	4.5	2.4	0.1	0.0	0.3	-	0.3	0.0	0.8	-	0.8	0.9	0.1	0.7	0.1
PRIVATE FARMS															
2000	**54.7**	**29.8**	**0.2**	**0.3**	**1.4**	**0.0**	**1.4**	**2.9**	**6.3**	**0.2**	**6.1**	**13.8**	**2.5**	**7.2**	**4.1**

	Total	of which														
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)				
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding		
		dairy	other													
Maakonnad								0.1	0.2	…	…	0.4	…	…	…	
Counties																
Harju	3.3	2.4	…	0.0	0.1	…	…	0.2	0.1	…	…	0.3	…	…	…	
Hiiu	1.2	0.6	…	0.0	-	…	…	0.1	0.4	…	…	0.4	…	…	…	
Ida-Viru	1.8	0.8	…	0.0	0.1	…	…	0.1	0.3	…	…	0.6	…	…	…	
Jõgeva	2.8	1.7	…	0.0	0.1	…	…	0.3	0.8	…	…	1.3	…	…	…	
Järva	6.1	3.5	…	0.0	0.2	…	…	0.2	0.1	…	…	0.5	…	…	…	
Lääne	1.9	1.0	…	0.0	0.0	…	…	0.5	0.7	…	…	1.4	…	…	…	
Lääne-Viru	4.5	1.8	…	0.0	0.1	…	…	0.1	0.3	…	…	1.1	…	…	…	
Põlva	4.1	2.4	…	0.1	0.1	…	…	0.1	0.5	…	…	1.2	…	…	…	
Pärnu	4.2	2.3	…	0.1	0.0	…	…	0.2	0.4	…	…	1.0	…	…	…	
Rapla	4.0	2.3	…	0.0	0.1	…	…	0.2	0.5	…	…	1.1	…	…	…	
Saare	3.6	1.8	…	0.0	0.0	…	…	0.1	0.3	…	…	0.9	…	…	…	
Tartu	3.1	1.7	…	-	0.1	…	…	0.2	0.5	…	…	1.1	…	…	…	
Valga	3.4	1.4	…	0.0	0.2	…	…	0.3	0.8	…	…	1.6	…	…	…	
Viljandi	7.3	4.3	…	0.1	0.2	…	…	0.2	0.4	…	…	0.9	…	…	…	
Võru	3.4	1.8	…	0.0	0.1	…	…									
HOUSEHOLD PLOTS																
2000	**43.5**	**25.8**	**0.3**	**0.2**	**1.0**	**0.1**	**0.9**	**2.1**	**4.4**	**0.2**	**4.2**	**9.7**	**1.6**	**5.2**	**2.9**	
Harju	2.2	1.6	…	0.0	0.1	…	…	0.0	0.2	…	…	0.3	…	…	…	
Hiiu	0.7	0.4	…	0.0	-	…	…	0.0	0.1	…	…	0.2	…	…	…	
Ida-Viru	1.9	1.2	…	0.0	0.1	…	…	0.1	0.2	…	…	0.3	…	…	…	
Jõgeva	2.5	1.5	…	0.0	0.1	…	…	0.1	0.2	…	…	0.6	…	…	…	
Järva	1.8	1.1	…	0.0	0.0	…	…	0.1	0.3	…	…	0.3	…	…	…	
Lääne	4.1	1.8	…	0.1	0.2	…	…	0.5	0.5	…	…	0.8	…	…	…	
Lääne-Viru	2.5	1.4	…	0.0	0.0	…	…	0.1	0.3	…	…	0.6	…	…	…	
Põlva	2.2	1.5	…	0.0	0.0	…	…	0.1	0.1	…	…	0.5	…	…	…	
Pärnu	5.3	3.5	…	0.1	0.0	…	…	0.1	0.5	…	…	1.1	…	…	…	
Rapla	3.5	2.3	…	0.0	0.1	…	…	0.2	0.2	…	…	0.7	…	…	…	
Saare	4.7	2.7	…	0.0	0.1	…	…	0.3	0.5	…	…	1.1	…	…	…	
Tartu	2.8	1.7	…	-	0.0	…	…	0.1	0.3	…	…	0.7	…	…	…	
Valga	2.0	1.0	…	0.0	0.1	…	…	0.1	0.2	…	…	0.6	…	…	…	
Viljandi	4.0	2.0	…	0.0	0.1	…	…	0.1	0.6	…	…	1.2	…	…	…	
Võru	3.3	2.1	…	0.0	0.1	…	…	0.2	0.2	…	…	0.7	…	…	…	

Table A.3.3_I.7. Swine population size in 2000 by counties of Estonia, 1000 heads (Agriculture 2000)

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total	covered sows	of which covered for the first time	other sows	of which gilts not yet covered
					50–80 kg	80–110 kg	more than 110 kg						
COUNTRY TOTAL													
2000	**300.2**	**81.2**	**79.5**	**99.0**	**63.8**	**32.0**	**3.2**	**1.9**	**38.6**	**26.1**	**6.7**	**12.5**	**8.0**
Harju	19.8	4.8	5.9	6.5	…	…	…	…	2.5	…	…	…	…
Hiiu	0.7	-	0.2	0.5	…	…	…	…	0.0	…	…	…	…
Ida-Viru	5.3	1.3	1.9	1.4	…	…	…	…	0.6	…	…	…	…
Jõgeva	25.1	6.4	7.9	7.7	…	…	…	…	3.0	…	…	…	…
Järva	32.2	8.6	7.0	12.0	…	…	…	…	4.3	…	…	…	…
Lääne	9.0	1.6	2.4	4.0	…	…	…	…	0.9	…	…	…	…
Lääne-Viru	40.0	8.3	10.6	17.8	…	…	…	…	3.1	…	…	…	…
Põlva	8.9	2.6	1.7	3.7	…	…	…	…	0.8	…	…	…	…
Pärnu	10.8	1.6	4.0	3.3	…	…	…	…	1.7	…	…	…	…
Rapla	24.2	8.0	4.8	6.9	…	…	…	…	4.2	…	…	…	…
Saare	16.1	4.6	4.1	5.3	…	…	…	…	2.0	…	…	…	…
Tartu	25.1	6.2	6.0	10.4	…	…	…	…	2.3	…	…	…	…
Valga	6.3	1.6	1.5	2.4	…	…	…	…	0.8	…	…	…	…
Viljandi	71.3	24.3	20.8	14.7	…	…	…	…	11.4	…	…	…	…
Võru	5.4	1.3	0.7	2.4	…	…	…	…	1.0	…	…	…	…
ENTERPRISES													
2000	**242.9**	**73.6**	**65.1**	**70.5**	**45.4**	**23.6**	**1.5**	**1.0**	**32.7**	**22.1**	**5.6**	**10.6**	**7.0**
Harju	17.7	4.3	5.1	5.9	3.7	2.2	0.0	0.1	2.3	1.3	0.4	1.0	0.3
Hiiu	-	-	-	-	-	-	-	-	-	-	-	-	-
Ida-Viru	3.4	1.2	1.0	0.7	0.5	0.2	-	0.1	0.4	0.3	0.1	0.1	0.0
Jõgeva	22.6	5.6	7.2	7.1	4.9	2.2	0.0	0.1	2.6	1.7	0.5	0.9	0.7
Järva	27.5	8.4	6.1	9.4	6.6	2.7	0.1	0.1	3.5	2.1	0.6	1.4	0.6
Lääne	7.7	1.3	1.9	3.6	1.5	1.2	0.9	0.1	0.8	0.8	0.2	0.0	0.1
Lääne-Viru	30.3	7.4	9.2	10.8	8.5	2.2	0.1	0.1	2.8	1.9	0.3	0.9	0.5
Põlva	4.9	2.0	1.1	1.2	1.0	0.2	0.0	0.0	0.6	0.5	0.1	0.1	0.1
Pärnu	4.1	1.2	0.9	1.4	0.9	0.5	-	0.0	0.6	0.4	0.0	0.2	0.1
Rapla	18.7	7.8	4.0	3.4	1.9	1.5	0.0	0.1	3.4	2.0	0.6	1.4	1.0
Saare	14.3	4.4	4.0	4.1	3.0	1.1	-	0.1	1.7	1.3	0.6	0.4	0.1
Tartu	20.2	5.0	5.0	8.0	5.0	2.9	0.1	0.1	2.1	1.6	0.5	0.5	0.2
Valga	4.0	1.0	0.9	1.6	0.9	0.7	0.0	0.0	0.5	0.4	0.1	0.1	0.1
Viljandi	65.7	23.5	18.6	12.5	6.4	5.8	0.3	0.1	11.0	7.7	1.5	3.3	3.0
Võru	1.8	0.5	0.1	0.8	0.6	0.2	0.0	0.0	0.4	0.1	0.1	0.3	0.2
PRIVATE FARMS													
2000	**35.0**	**4.5**	**8.1**	**18.5**	**12.0**	**5.7**	**0.8**	**0.5**	**3.4**	**2.4**	**0.8**	**1.0**	**0.6**

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total	covered sows	of which covered for the first time	other sows	of which gilts not yet covered
					50–80 kg	80–110 kg	more than 110 kg						
Harju	1.2	0.3	0.4	0.3	…	…	…	…	0.2	…	…	…	…
Hiiu	0.5	-	0.1	0.4	…	…	…	…	0.0	…	…	…	…
Ida-Viru	0.8	0.1	0.4	0.3	…	…	…	…	0.0	…	…	…	…
Jõgeva	1.5	0.5	0.4	0.4	…	…	…	…	0.2	…	…	…	…
Järva	3.7	0.2	0.7	2.1	…	…	…	…	0.6	…	…	…	…
Lääne	0.4	0.1	0.2	0.1	…	…	…	…	0.0	…	…	…	…
Lääne-Viru	7.7	0.7	1.1	5.6	…	…	…	…	0.2	…	…	…	…
Põlva	3.0	0.4	0.5	1.9	…	…	…	…	0.1	…	…	…	…
Pärnu	2.5	0.1	1.2	0.7	…	…	…	…	0.4	…	…	…	…
Rapla	3.7	0.2	0.5	2.3	…	…	…	…	0.6	…	…	…	…
Saare	1.0	0.1	0.1	0.6	…	…	…	…	0.2	…	…	…	…
Tartu	2.4	0.6	0.5	1.1	…	…	…	…	0.2	…	…	…	…
Valga	1.3	0.3	0.3	0.5	…	…	…	…	0.2	…	…	…	…
Viljandi	3.5	0.5	1.4	1.4	…	…	…	…	0.2	…	…	…	…
Võru	1.8	0.4	0.3	0.8	…	…	…	…	0.3	…	…	…	…
HOUSEHOLD PLOTS													
2000	**22.3**	**3.1**	**6.3**	**10.0**	**6.4**	**2.7**	**0.9**	**0.4**	**2.5**	**1.6**	**0.3**	**0.9**	**0.4**
Harju	0.9	0.2	0.4	0.3	…	…	…	…	0.0	…	…	…	…
Hiiu	0.2	-	0.1	0.1	…	…	…	…	0.0	…	…	…	…
Ida-Viru	1.1	0.0	0.5	0.4	…	…	…	…	0.2	…	…	…	…
Jõgeva	1.0	0.3	0.3	0.2	…	…	…	…	0.2	…	…	…	…
Järva	1.0	0.0	0.2	0.5	…	…	…	…	0.2	…	…	…	…
Lääne	0.9	0.2	0.3	0.3	…	…	…	…	0.1	…	…	…	…
Lääne-Viru	2.0	0.2	0.3	1.4	…	…	…	…	0.1	…	…	…	…
Põlva	1.0	0.2	0.1	0.6	…	…	…	…	0.1	…	…	…	…
Pärnu	4.2	0.3	1.9	1.2	…	…	…	…	0.7	…	…	…	…
Rapla	1.8	0.0	0.3	1.2	…	…	…	…	0.2	…	…	…	…
Saare	0.8	0.1	0.0	0.6	…	…	…	…	0.1	…	…	…	…
Tartu	2.5	0.6	0.5	1.3	…	…	…	…	0.0	…	…	…	…
Valga	1.0	0.3	0.3	0.3	…	…	…	…	0.1	…	…	…	…
Viljandi	2.1	0.3	0.8	0.8	…	…	…	…	0.2	…	…	…	…
Võru	1.8	0.4	0.3	0.8	…	…	…	…	0.3	…	…	…	…

Table A.3.3_I.8. Number of cattle in 2001 by counties of Estonia, 1000 heads (Agriculture 2001)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
2001 TOTAL	**260.5**	**128.6**	**0.8**	**1.2**	**11.2**	**0.4**	**10.8**	**11.1**	**37.7**	**3.6**	**34.1**	**69.9**	**16.8**	**38.9**	**14.2**
Harju	18.1	8.9	0.1	0.0	0.7	0.0	0.7	0.9	2.5	0.2	2.3	5.0	1.0	2.7	1.3
Hiiu	3.0	1.2	0.1	0.0	0.1	0.0	0.1	0.3	0.4	0.1	0.3	0.9	0.2	0.4	0.3
Ida-Viru	6.7	3.7	0.0	0.0	0.3	0.0	0.3	0.3	0.7	0.0	0.7	1.7	0.4	0.9	0.4
Jõgeva	28.2	12.5	0.0	0.0	1.1	0.1	1.0	1.5	4.3	0.3	4.0	8.8	1.7	4.4	2.7
Järva	37.1	18.7	0.0	0.1	2.0	0.1	1.9	0.7	6.1	0.3	5.8	9.5	1.9	6.5	1.1
Lääne	10.9	4.6	0.1	0.2	0.8	0.1	0.7	0.8	1.3	0.2	1.1	3.1	1.1	1.4	0.6
Lääne-Viru	30.8	12.9	0.1	0.3	1.5	0.0	1.5	2.0	4.8	0.3	4.5	9.2	2.5	4.6	2.1
Põlva	15.1	7.2	0.1	0.1	0.7	0.0	0.7	0.6	2.2	0.4	1.8	4.2	1.0	2.5	0.7
Pärnu	25.4	13.5	0.0	0.1	1.0	0.0	1.0	0.7	4.0	0.5	3.5	6.1	0.9	4.0	1.2
Rapla	16.6	9.0	0.1	0.1	0.7	0.0	0.7	0.5	2.1	0.2	1.9	4.1	1.1	2.3	0.7
Saare	14.2	7.0	0.1	0.0	0.8	0.1	0.7	0.7	2.1	0.3	1.8	3.5	0.9	2.0	0.6
Tartu	14.6	8.3	0.0	0.1	0.4	0.0	0.4	0.4	1.9	0.1	1.8	3.5	1.2	1.9	0.4
Valga	9.1	4.8	0.0	0.0	0.2	0.0	0.2	0.4	1.3	0.2	1.1	2.4	0.7	1.2	0.5
Viljandi	20.1	10.5	0.1	0.1	0.7	0.0	0.7	0.9	2.6	0.3	2.3	5.2	1.5	2.7	1.0
Võru	10.6	5.8	0.0	0.1	0.2	0.0	0.2	0.4	1.4	0.2	1.2	2.7	0.7	1.4	0.6
Agricultural holdings	257.8	127.1	0.8	1.2	11.1	0.4	10.7	11.0	37.4	3.6	33.8	69.2	16.6	38.5	14.1
natural persons	97.1	51.9	0.6	0.6	1.9	0.3	1.6	6.4	10.7	2.9	7.8	25.0	7.1	10.1	7.8
legal persons	160.7	75.2	0.2	0.6	9.2	0.1	9.1	4.6	26.7	0.7	26.0	44.2	9.5	28.4	6.3
Harju	17.8	8.7	0.1	0.0	0.7	0.0	0.7	0.8	2.5	0.2	2.3	5.0	1.0	2.7	1.3
Hiiu	3.0	1.2	0.1	0.0	0.1	0.0	0.1	0.3	0.4	0.1	0.3	0.9	0.2	0.4	0.3
Ida-Viru	6.3	3.5	0.0	0.0	0.3	0.0	0.3	0.2	0.7	0.0	0.7	1.6	0.4	0.8	0.4
Jõgeva	28.0	12.5	0.0	0.0	1.1	0.1	1.0	1.5	4.2	0.3	3.9	8.7	1.7	4.4	2.6
Järva	37.0	18.6	0.0	0.1	2.0	0.1	1.9	0.7	6.1	0.3	5.8	9.5	1.9	6.5	1.1
Lääne	10.8	4.5	0.1	0.2	0.8	0.1	0.7	0.8	1.3	0.2	1.1	3.1	1.1	1.4	0.6
Lääne-Viru	30.5	12.8	0.1	0.3	1.4	0.0	1.4	2.0	4.8	0.3	4.5	9.1	2.5	4.5	2.1
Põlva	15.0	7.2	0.1	0.1	0.7	0.0	0.7	0.6	2.2	0.4	1.8	4.1	1.0	2.4	0.7
Pärnu	25.2	13.4	0.0	0.1	1.0	0.0	1.0	0.7	4.0	0.5	3.5	6.0	0.9	3.9	1.2
Rapla	16.5	8.9	0.1	0.1	0.7	0.0	0.7	0.6	2.0	0.2	1.8	4.1	1.1	2.3	0.7
Saare	14.0	6.9	0.1	0.0	0.8	0.1	0.7	0.7	2.0	0.3	1.7	3.5	0.9	2.0	0.6
Tartu	14.3	8.1	0.0	0.1	0.4	0.0	0.4	0.4	1.9	0.1	1.8	3.4	1.1	1.9	0.4
Valga	8.9	4.7	0.0	0.0	0.2	0.0	0.2	0.4	1.3	0.2	1.1	2.3	0.6	1.2	0.5
Viljandi	20.0	10.4	0.1	0.1	0.7	0.0	0.7	0.9	2.6	0.3	2.3	5.2	1.5	2.7	1.0
Võru	10.5	5.7	0.0	0.1	0.2	0.0	0.2	0.4	1.4	0.2	1.2	2.7	0.7	1.4	0.6
Agricultural households	2.7	1.5	0.0	0.0	0.1	0.0	0.1	0.1	0.3	0.0	0.3	0.7	0.2	0.4	0.1

Table A.3.3_I.9. Swine population size in 2001 by counties of Estonia, 1000 heads (Agriculture 2001)

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total	covered sows	of which covered for the first time	other sows	of which gilts not yet covered
					50–80 kg	80–110 kg	more than 110 kg						
COUNTRY TOTAL													
2001	**345.0**	**100.3**	**103.6**	**99.5**	**57.0**	**40.8**	**1.7**	**1.5**	**40.1**	**26.1**	**7.4**	**14.0**	**7.4**
Harju	20.0	4.3	8.2	5.2	3.3	1.9	0.0	0.1	2.2	1.4	0.3	0.8	0.4
Hiiu	4.1	0.2	2.0	1.9	0.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ida-Viru	5.8	1.5	2.5	1.2	0.8	0.4	0.0	0.1	0.5	0.4	0.1	0.1	0.0
Jõgeva	29.2	6.4	10.4	8.8	6.6	2.1	0.1	0.1	3.5	2.3	0.5	1.2	0.7
Järva	34.0	8.6	9.5	11.4	7.3	4.0	0.1	0.1	4.4	2.6	1.2	1.8	0.8
Lääne	11.5	2.2	3.1	4.9	3.1	1.8	0.0	0.1	1.2	0.7	0.3	0.5	0.2
Lääne-Viru	47.2	11.1	13.8	17.8	9.6	7.8	0.4	0.1	4.4	3.1	0.7	1.3	0.6
Põlva	10.5	3.1	3.0	3.2	2.4	0.6	0.2	0.1	1.1	0.8	0.2	0.3	0.1
Pärnu	9.2	1.9	3.4	2.9	1.9	0.8	0.2	0.1	0.9	0.6	0.1	0.3	0.2
Rapla	29.6	6.8	9.2	9.6	4.9	4.7	0.0	0.1	3.9	2.5	0.7	1.4	0.8
Saare	17.2	5.3	5.2	4.6	2.8	1.7	0.1	0.1	2.0	1.1	0.2	0.9	0.6
Tartu	26.7	6.2	7.8	9.7	6.1	3.4	0.2	0.2	2.8	1.9	0.6	0.9	0.4
Valga	7.2	1.7	2.5	2.2	1.5	0.6	0.1	0.1	0.7	0.5	0.1	0.2	0.1
Viljandi	86.0	39.7	20.2	14.1	5.4	8.5	0.2	0.1	11.9	7.9	2.3	4.0	2.4
Võru	6.8	1.3	2.8	2.0	1.2	0.7	0.1	0.1	0.6	0.3	0.1	0.3	0.1
Agricultural holdings	342.8	99.8	102.8	98.8	56.5	40.6	1.7	1.5	39.9	26.0	7.4	13.9	7.4
natural persons	53.5	12.3	19.8	16.9	10.9	5.1	0.9	0.5	4.0	2.6	0.8	1.4	0.5
legal persons	289.3	87.5	83.0	81.9	45.6	35.5	0.8	1.0	35.9	23.4	6.6	12.5	6.9
Harju	19.9	4.3	8.2	5.1	3.3	1.8	0.0	0.1	2.2	1.4	0.3	0.8	0.4
Hiiu	4.1	0.2	2.0	1.9	0.1	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ida-Viru	5.7	1.4	2.5	1.2	0.8	0.4	0.0	0.1	0.5	0.4	0.1	0.1	0.0
Jõgeva	29.1	6.4	10.4	8.8	6.6	2.1	0.1	0.1	3.4	2.3	0.5	1.1	0.7
Järva	33.7	8.5	9.4	11.3	7.2	4.0	0.1	0.1	4.4	2.6	1.2	1.8	0.8
Lääne	11.5	2.2	3.1	4.9	3.1	1.8	0.0	0.1	1.2	0.7	0.3	0.5	0.2
Lääne-Viru	47.0	11.1	13.7	17.7	9.5	7.8	0.4	0.1	4.4	3.1	0.7	1.3	0.6
Põlva	10.4	3.0	3.0	3.2	2.4	0.6	0.2	0.1	1.1	0.8	0.2	0.3	0.1
Pärnu	8.9	1.8	3.3	2.8	1.8	0.8	0.2	0.1	0.9	0.6	0.1	0.3	0.2
Rapla	29.5	6.8	9.2	9.5	4.8	4.7	0.0	0.1	3.9	2.5	0.7	1.4	0.8
Saare	17.1	5.3	5.1	4.6	2.8	1.7	0.1	0.1	2.0	1.1	0.2	0.9	0.6
Tartu	26.5	6.2	7.7	9.6	6.0	3.4	0.2	0.2	2.8	1.9	0.6	0.9	0.4
Valga	7.1	1.7	2.4	2.2	1.5	0.6	0.1	0.1	0.7	0.5	0.1	0.2	0.1
Viljandi	85.7	39.6	20.1	14.1	5.4	8.5	0.2	0.1	11.8	7.8	2.3	4.0	2.4
Võru	6.6	1.3	2.7	1.9	1.2	0.6	0.1	0.1	0.6	0.3	0.1	0.3	0.1
Agricultural households	2.2	0.5	0.8	0.7	0.5	0.2	0.0	0.0	0.2	0.1	0.0	0.1	0.0

Table A.3.3_I.10. Number of cattle in 2002 by counties of Estonia, 1000 heads (Agriculture 2002)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
COUNTRY TOTAL **2002**	**253.9**	**115.6**	**1.6**	**1.1**	**10.5**	**0.2**	**10.3**	**11.5**	**43.6**	**2.2**	**41.4**	**70.0**	**6.0**	**40.7**	**23.3**
Harju	19.2	8.2	0.3	0.0	1.2	0.0	1.2	1.5	3.0	0.2	2.8	5.0	0.5	2.6	1.9
Hiiu	3.0	1.1	0.0	0.1	0.1	0.0	0.1	0.2	0.8	0.0	0.8	0.7	0.1	0.3	0.3
Ida-Viru	6.8	2.8	0.0	0.0	0.3	0.0	0.3	0.5	1.2	0.1	1.1	2.0	0.3	1.0	0.7
Jõgeva	25.4	10.7	0.0	0.0	1.1	0.0	1.1	1.2	4.0	0.0	4.0	8.4	0.4	4.4	3.6
Järva	36.9	18.3	0.2	0.1	1.5	0.0	1.5	0.8	7.6	0.1	7.5	8.4	0.6	6.5	1.3
Lääne	9.7	4.0	0.0	0.0	0.5	0.0	0.5	0.7	1.4	0.1	1.3	3.1	0.2	1.4	1.5
Lääne-Viru	28.6	12.5	0.1	0.3	1.0	0.1	0.9	1.6	5.4	0.2	5.2	7.7	0.7	4.2	2.8
Põlva	13.8	6.4	0.1	0.2	0.8	0.0	0.8	0.4	2.0	0.0	2.0	3.9	0.3	2.9	0.7
Pärnu	24.6	12.4	0.0	0.1	0.8	0.0	0.8	0.9	4.2	0.3	3.9	6.2	0.6	3.5	2.1
Rapla	18.8	8.1	0.1	0.1	0.7	0.0	0.7	0.9	3.4	0.5	2.9	5.5	0.3	2.4	2.8
Saare	12.5	6.0	0.1	0.0	0.7	0.1	0.6	0.3	1.7	0.1	1.6	3.7	0.4	2.3	1.0
Tartu	17.5	8.5	0.0	0.2	0.2	0.0	0.2	0.5	3.1	0.2	2.9	5.0	0.6	2.8	1.6
Valga	8.3	3.6	0.0	0.0	0.3	0.0	0.3	0.4	1.7	0.0	1.7	2.3	0.4	1.4	0.5
Viljandi	18.6	8.1	0.1	0.0	1.1	0.0	1.1	1.2	2.6	0.3	2.3	5.5	0.4	3.3	1.8
Võru	10.2	4.9	0.6	0.0	0.2	0.0	0.2	0.4	1.5	0.1	1.4	2.6	0.2	1.7	0.7
Agricultural holdings	251.5	114.5	1.6	1.1	10.4	0.2	10.2	11.3	43.3	2.1	41.2	69.3	5.8	40.4	23.1
natural persons	87.1	39.1	0.7	0.4	3.6	0.1	3.5	4.1	14.9	0.8	14.1	24.3	2.1	14.0	8.2
legal persons	164.4	75.4	0.9	0.7	6.8	0.1	6.7	7.2	28.4	1.3	27.1	45.0	3.7	26.4	14.9
Harju	18.9	8.1	0.3	0.0	1.2	0.0	1.2	1.4	3.0	0.2	2.8	4.9	0.5	2.6	1.8
Hiiu	3.0	1.1	0.0	0.1	0.1	0.0	0.1	0.2	0.8	0.0	0.8	0.7	0.1	0.3	0.3
Ida-Viru	6.5	2.7	0.0	0.0	0.2	0.0	0.2	0.5	1.1	0.1	1.0	2.0	0.3	1.0	0.7
Jõgeva	25.3	10.7	0.0	0.0	1.1	0.0	1.1	1.2	4.0	0.0	4.0	8.3	0.4	4.4	3.5
Järva	36.7	18.2	0.2	0.1	1.5	0.0	1.5	0.8	7.5	0.1	7.4	8.4	0.6	6.5	1.3
Lääne	9.6	3.9	0.0	0.0	0.5	0.0	0.5	0.7	1.4	0.1	1.3	3.1	0.2	1.4	1.5
Lääne-Viru	28.5	12.4	0.1	0.3	1.0	0.1	0.9	1.6	5.4	0.2	5.2	7.7	0.7	4.2	2.8
Põlva	13.7	6.4	0.1	0.2	0.8	0.0	0.8	0.4	2.0	0.0	2.0	3.8	0.3	2.8	0.7
Pärnu	24.4	12.3	0.0	0.1	0.8	0.0	0.8	0.9	4.1	0.2	3.9	6.2	0.6	3.5	2.1
Rapla	18.6	8.0	0.1	0.1	0.7	0.0	0.7	0.9	3.4	0.5	2.9	5.4	0.3	2.3	2.8
Saare	12.4	6.0	0.1	0.0	0.7	0.1	0.6	0.2	1.7	0.1	1.6	3.7	0.4	2.3	1.0
Tartu	17.2	8.3	0.0	0.2	0.2	0.0	0.2	0.5	3.1	0.2	2.9	4.9	0.6	2.7	1.6
Valga	8.2	3.6	0.0	0.0	0.3	0.0	0.3	0.4	1.7	0.0	1.7	2.2	0.3	1.4	0.5
Viljandi	18.4	8.0	0.1	0.0	1.1	0.0	1.1	1.2	2.6	0.3	2.3	5.4	0.3	3.3	1.8
Võru	10.1	4.8	0.6	0.0	0.2	0.0	0.2	0.4	1.5	0.1	1.4	2.6	0.2	1.7	0.7
Agricultural households	2.4	1.1	0.0	0.0	0.1	0.0	0.1	0.2	0.3	0.1	0.2	0.7	0.2	0.3	0.2

Table A.3.3_I.11. Swine population size in 2002 by counties of Estonia, 1000 heads (Agriculture 2002)

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total	covered sows	of which covered for the first time	other sows	of which gilts not yet covered
					50–80 kg	80–110 kg	more than 110 kg						
COUNTRY TOTAL **2002**	**340.8**	**104.1**	**82.8**	**114.1**	**64.7**	**45.8**	**3.6**	**2.1**	**37.7**	**27.4**	**5.5**	**10.3**	**4.8**
Harju	21.2	4.6	6.3	7.4	4.0	3.1	0.3	0.1	2.8	1.7	0.4	1.1	0.5
Hiiu	5.8	0.1	1.5	4.1	1.9	1.7	0.5	0.0	0.1	0.1	0.0	0.0	0.0
Ida-Viru	4.4	1.1	1.6	1.4	1.0	0.4	0.0	0.0	0.3	0.2	0.0	0.1	0.0
Jõgeva	26.2	6.5	7.8	8.7	6.9	1.8	0.0	0.1	3.1	2.1	0.4	1.0	0.6
Järva	28.2	7.7	7.5	9.9	5.9	3.3	0.7	0.1	3.0	2.1	0.6	0.9	0.4
Lääne	9.6	2.1	2.1	4.3	3.6	0.5	0.2	0.1	1.0	0.7	0.2	0.3	0.1
Lääne-Viru	51.2	13.2	11.5	20.0	10.0	9.8	0.2	0.9	5.6	3.1	0.5	2.5	0.4
Põlva	10.6	3.2	4.0	2.4	1.9	0.3	0.2	0.1	0.9	0.7	0.3	0.2	0.0
Pärnu	7.5	1.7	2.1	3.0	1.6	1.1	0.3	0.0	0.7	0.4	0.1	0.3	0.1
Rapla	28.4	7.4	9.4	8.4	4.7	3.7	0.0	0.1	3.1	2.3	0.6	0.8	0.4
Saare	19.8	4.1	7.5	6.1	3.6	2.5	0.0	0.1	2.0	1.3	0.3	0.7	0.4
Tartu	23.3	4.5	6.6	9.5	5.4	4.0	0.1	0.2	2.5	2.1	0.3	0.4	0.2
Valga	4.8	1.6	0.8	1.7	1.1	0.5	0.1	0.1	0.6	0.5	0.2	0.1	0.1
Viljandi	90.9	43.2	12.7	24.0	10.7	12.3	1.0	0.1	10.9	9.3	1.5	1.6	1.4
Võru	8.9	3.1	1.4	3.2	2.4	0.8	0.0	0.1	1.1	0.8	0.1	0.3	0.2
Agricultural holdings	338.2	103.5	81.8	113.3	64.2	45.5	3.6	2.1	37.5	27.3	5.5	10.2	4.8
natural persons	40.8	11.7	10.6	13.7	8.2	5.0	0.5	0.3	4.5	3.2	0.7	1.3	0.5
legal persons	297.4	91.8	71.2	99.6	56.0	40.5	3.1	1.8	33.0	24.1	4.8	8.9	4.3
Harju	21.0	4.5	6.3	7.3	4.0	3.0	0.3	0.1	2.8	1.7	0.4	1.1	0.5
Hiiu	5.7	0.1	1.5	4.0	1.9	1.6	0.5	0.0	0.1	0.1	0.0	0.0	0.0
Ida-Viru	4.3	1.1	1.5	1.4	1.0	0.4	0.0	0.0	0.3	0.2	0.0	0.1	0.0
Jõgeva	26.0	6.5	7.7	8.6	6.8	1.8	0.0	0.1	3.1	2.1	0.4	1.0	0.6
Järva	28.0	7.7	7.4	9.8	5.8	3.3	0.7	0.1	3.0	2.1	0.6	0.9	0.4
Lääne	9.5	2.1	2.1	4.3	3.6	0.5	0.2	0.1	0.9	0.7	0.2	0.2	0.1
Lääne-Viru	50.9	13.1	11.4	19.9	9.9	9.8	0.2	0.9	5.6	3.1	0.5	2.5	0.4
Põlva	10.5	3.2	3.9	2.4	1.9	0.3	0.2	0.1	0.9	0.7	0.3	0.2	0.0
Pärnu	7.3	1.6	2.1	2.9	1.5	1.1	0.3	0.0	0.7	0.4	0.1	0.3	0.1
Rapla	28.2	7.4	9.3	8.4	4.7	3.7	0.0	0.1	3.0	2.2	0.6	0.8	0.4
Saare	19.7	4.1	7.4	6.1	3.6	2.5	0.0	0.1	2.0	1.3	0.3	0.7	0.4
Tartu	23.0	4.4	6.5	9.4	5.4	3.9	0.1	0.2	2.5	2.1	0.3	0.4	0.2
Valga	4.8	1.6	0.8	1.7	1.1	0.5	0.1	0.1	0.6	0.5	0.2	0.1	0.1
Viljandi	90.6	43.1	12.6	23.9	10.6	12.3	1.0	0.1	10.9	9.3	1.5	1.6	1.4
Võru	8.7	3.0	1.3	3.2	2.4	0.8	0.0	0.1	1.1	0.8	0.1	0.3	0.2
Agricultural households	2.6	0.6	1.0	0.8	0.5	0.3	0.0	0.0	0.2	0.1	0.0	0.1	0.0

Table A.3.3_I.12. Number of cattle in 2003 by counties of Estonia, 1000 heads (Agriculture 2003)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
COUNTRY TOTAL **2003**	**257.2**	**116.8**	**2.0**	**0.8**	**12.5**	**0.4**	**12.1**	**12.6**	**40.2**	**1.7**	**38.5**	**72.3**	**7.3**	**42.7**	**22.3**
Harju	19.3	8.6	0.3	0.0	0.8	0.0	0.8	1.0	3.2	0.2	3.0	5.4	0.4	3.3	1.7
Hiiu	2.8	0.9	0.1	0.1	0.3	0.0	0.3	0.2	0.4	0.1	0.3	0.8	0.0	0.5	0.3
Ida-Viru	6.6	2.6	0.0	0.0	0.3	0.0	0.3	0.5	0.9	0.1	0.8	2.3	0.5	0.9	0.9
Jõgeva	26.0	11.3	0.1	0.0	1.1	0.0	1.1	1.1	4.2	0.0	4.2	8.2	1.2	4.2	2.8
Järva	35.1	17.9	0.1	0.0	1.4	0.0	1.4	0.9	5.8	0.0	5.8	9.0	1.1	6.4	1.5
Lääne	11.5	3.5	0.1	0.2	1.5	0.0	1.5	1.3	1.6	0.2	1.4	3.3	0.8	1.5	1.0
Lääne-Viru	28.9	12.6	0.0	0.2	1.2	0.1	1.1	2.0	4.5	0.1	4.4	8.4	0.2	4.9	3.3
Põlva	13.5	6.6	0.5	0.0	0.5	0.0	0.5	0.4	2.2	0.0	2.2	3.3	0.3	2.5	0.5
Pärnu	24.9	12.7	0.1	0.0	1.6	0.2	1.4	1.0	3.8	0.1	3.7	5.7	0.5	4.0	1.2
Rapla	19.0	7.9	0.3	0.2	0.5	0.0	0.5	1.0	2.6	0.0	2.6	6.5	0.2	3.4	2.9
Saare	14.7	7.1	0.0	0.0	1.0	0.1	0.9	0.9	2.0	0.4	1.6	3.7	0.4	2.5	0.8
Tartu	14.9	7.1	0.0	0.0	0.6	0.0	0.6	0.5	2.6	0.0	2.6	4.1	0.2	2.5	1.4
Valga	11.8	5.0	0.1	0.0	0.4	0.0	0.4	0.4	2.0	0.0	2.0	3.9	1.3	1.2	1.4
Viljandi	19.6	9.2	0.0	0.1	0.9	0.0	0.9	1.1	3.0	0.3	2.7	5.3	0.2	3.3	1.8
Võru	8.6	3.8	0.3	0.0	0.4	0.0	0.4	0.3	1.4	0.2	1.2	2.4	0.0	1.6	0.8
Agricultural holdings	253.7	115.2	2.0	0.8	12.3	0.3	12.0	12.3	39.8	1.6	38.2	71.3	7.0	42.3	22.0
natural persons	89.9	39.5	0.9	0.4	4.8	0.1	4.7	4.7	14.0	0.8	13.2	25.6	2.7	14.8	8.1
legal persons	163.8	75.7	1.1	0.4	7.5	0.2	7.3	7.6	25.8	0.8	25.0	45.7	4.3	27.5	13.9
Harju	19.0	8.5	0.3	0.0	0.8	0.0	0.8	1.0	3.1	0.2	2.9	5.3	0.4	3.2	1.7
Hiiu	2.7	0.9	0.1	0.1	0.3	0.0	0.3	0.2	0.3	0.1	0.2	0.8	0.0	0.5	0.3
Ida-Viru	6.3	2.5	0.0	0.0	0.3	0.0	0.3	0.4	0.9	0.1	0.8	2.2	0.5	0.8	0.9
Jõgeva	25.8	11.1	0.1	0.0	1.1	0.0	1.1	1.1	4.2	0.0	4.2	8.2	1.2	4.2	2.8
Järva	34.7	17.7	0.1	0.0	1.4	0.0	1.4	0.8	5.8	0.0	5.8	8.9	1.1	6.3	1.5
Lääne	11.4	3.4	0.1	0.2	1.5	0.0	1.5	1.3	1.6	0.2	1.4	3.3	0.8	1.5	1.0
Lääne-Viru	28.6	12.5	0.0	0.2	1.1	0.1	1.0	2.0	4.5	0.1	4.4	8.3	0.2	4.9	3.2
Põlva	13.3	6.5	0.5	0.0	0.5	0.0	0.5	0.4	2.1	0.0	2.1	3.3	0.3	2.5	0.5
Pärnu	24.7	12.6	0.1	0.0	1.6	0.2	1.4	1.0	3.8	0.1	3.7	5.6	0.4	4.0	1.2
Rapla	18.8	7.8	0.3	0.2	0.5	0.0	0.5	1.0	2.6	0.0	2.6	6.4	0.2	3.4	2.8
Saare	14.5	7.1	0.0	0.0	0.9	0.0	0.9	0.9	2.0	0.4	1.6	3.6	0.4	2.5	0.7
Tartu	14.6	7.0	0.0	0.0	0.6	0.0	0.6	0.4	2.6	0.0	2.6	4.0	0.2	2.4	1.4
Valga	11.6	4.9	0.1	0.0	0.4	0.0	0.4	0.4	2.0	0.0	2.0	3.8	1.2	1.2	1.4
Viljandi	19.2	9.0	0.0	0.1	0.9	0.0	0.9	1.1	2.9	0.2	2.7	5.2	0.1	3.3	1.8
Võru	8.5	3.7	0.3	0.0	0.4	0.0	0.4	0.3	1.4	0.2	1.2	2.4	0.0	1.6	0.8
Agricultural households	3.5	1.6	0.0	0.0	0.2	0.1	0.1	0.3	0.4	0.1	0.3	1.0	0.3	0.4	0.3

Table A.3.3_I.13. Swine population size in 2003 by counties of Estonia, 1000 heads (Agriculture 2003)

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total				
					50–80 kg	80–110 kg	more than 110 kg			covered sows	of which covered for the first time	other sows	of which gilts not yet covered
COUNTRY TOTAL													
2003	**344.6**	**104.1**	**91.9**	**110.7**	**64.3**	**44.6**	**1.8**	**1.3**	**36.6**	**26.3**	**5.4**	**10.3**	**3.1**
Harju	21.6	3.1	6.8	9.2	5.4	3.8	0.0	0.1	2.4	1.0	0.3	1.4	0.6
Hiiu	6.1	0.2	2.1	3.8	2.1	1.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Ida-Viru	4.1	0.8	1.5	1.5	1.1	0.4	0.0	0.0	0.3	0.2	0.0	0.1	0.0
Jõgeva	33.0	7.7	9.1	11.9	9.2	2.6	0.1	0.2	4.1	3.1	0.6	1.0	0.6
Järva	23.0	4.7	7.1	9.1	4.7	3.8	0.6	0.1	2.0	1.2	0.2	0.8	0.2
Lääne	8.5	1.7	1.7	4.1	3.3	0.8	0.0	0.0	1.0	0.7	0.1	0.3	0.0
Lääne-Viru	50.5	13.7	13.3	18.0	11.5	6.2	0.3	0.2	5.3	3.3	0.9	2.0	0.5
Põlva	8.6	2.1	3.4	2.2	0.8	1.3	0.1	0.0	0.9	0.7	0.2	0.2	0.0
Pärnu	8.3	1.4	2.4	3.8	2.3	1.5	0.0	0.1	0.6	0.4	0.1	0.2	0.1
Rapla	22.5	5.0	7.4	7.1	3.6	3.5	0.0	0.1	2.9	2.0	0.5	0.9	0.1
Saare	23.1	6.8	6.7	7.3	4.3	3.0	0.0	0.1	2.2	1.6	0.3	0.6	0.3
Tartu	22.4	6.7	6.3	7.8	3.2	4.6	0.0	0.1	1.5	1.2	0.3	0.3	0.1
Valga	4.9	1.5	1.0	1.8	1.4	0.4	0.0	0.1	0.5	0.4	0.1	0.1	0.1
Viljandi	99.2	45.9	21.0	20.2	9.9	10.2	0.1	0.1	12.0	10.0	1.7	2.0	0.5
Võru	8.8	2.8	2.1	2.9	1.5	0.9	0.5	0.1	0.9	0.5	0.1	0.4	0.0
Agricultural holdings	340.9	103.3	90.5	109.5	63.6	44.2	1.7	1.2	36.4	26.2	5.3	10.2	3.1
natural persons	34.3	9.3	9.8	11.6	6.4	4.9	0.3	0.1	3.5	2.4	0.5	1.1	0.3
legal persons	306.6	94.0	80.7	97.9	57.2	39.3	1.4	1.1	32.9	23.8	4.8	9.1	2.8
Harju	21.4	3.1	6.7	9.1	5.4	3.7	0.0	0.2	2.3	1.0	0.3	1.3	0.6
Hiiu	6.0	0.1	2.1	3.8	2.1	1.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Ida-Viru	4.0	0.8	1.4	1.5	1.1	0.4	0.0	0.0	0.3	0.2	0.0	0.1	0.0
Jõgeva	32.7	7.7	9.0	11.7	9.1	2.5	0.1	0.2	4.1	3.1	0.6	1.0	0.6
Järva	22.8	4.7	6.9	9.1	4.6	3.9	0.6	0.1	2.0	1.2	0.2	0.8	0.2
Lääne	8.3	1.6	1.6	4.1	3.3	0.8	0.0	0.0	1.0	0.7	0.1	0.3	0.0
Lääne-Viru	50.0	13.6	13.1	17.8	11.4	6.2	0.2	0.2	5.3	3.3	0.9	2.0	0.5
Põlva	8.4	2.1	3.3	2.1	0.7	1.3	0.1	0.0	0.9	0.7	0.2	0.2	0.0
Pärnu	8.0	1.3	2.4	3.6	2.2	1.4	0.0	0.1	0.6	0.4	0.0	0.2	0.1
Rapla	22.3	4.9	7.4	7.0	3.5	3.5	0.0	0.1	2.9	2.0	0.5	0.9	0.1
Saare	22.8	6.7	6.5	7.3	4.3	3.0	0.0	0.1	2.2	1.6	0.3	0.6	0.3
Tartu	22.1	6.7	6.2	7.7	3.2	4.5	0.0	0.1	1.4	1.1	0.3	0.3	0.1
Valga	4.8	1.5	1.0	1.8	1.4	0.4	0.0	0.0	0.5	0.4	0.1	0.1	0.1
Viljandi	98.6	45.7	20.8	20.0	9.8	10.1	0.1	0.1	12.0	10.0	1.7	2.0	0.5
Võru	8.7	2.8	2.1	2.9	1.5	0.9	0.5	0.0	0.9	0.5	0.1	0.4	0.0
Agricultural households	3.7	0.8	1.4	1.2	0.7	0.4	0.1	0.1	0.2	0.1	0.1	0.1	0.0

Table A.3.3_I.14. Number of cattle in 2004 by counties of Estonia, 1000 heads (Agriculture 2004)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		Total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
2004	**249.8**	**116.5**	**2.7**	**1.3**	**12.0**	**0.1**	**11.9**	**10.2**	**40.8**	**1.1**	**39.7**	**66.3**	**3.5**	**40.1**	**22.7**
Agricultural holdings	249.4	116.1	2.7	1.3	12.0	0.1	11.9	10.2	40.8	1.1	39.7	66.3	3.5	40.1	22.7
natural persons	88.3	40.1	1.1	0.5	4.6	0.0	4.6	3.9	14.4	0.4	14.0	23.7	1.3	14.2	8.2
legal persons	161.1	76.0	1.6	0.8	7.4	0.1	7.3	6.3	26.4	0.7	25.7	42.6	2.2	25.9	14.5
Harju	14.5	6.2	0.2	0.1	0.8	0.1	0.7	0.8	2.5	0.2	2.3	3.9	0.4	2.1	1.4
Hiiu	2.5	1.0	0.1	0.0	0.1	0.0	0.1	0.2	0.3	0.0	0.3	0.8	0.0	0.4	0.4
Ida-Viru	7.4	3.6	0.0	0.0	0.3	0.0	0.3	0.3	1.5	0.0	1.5	1.7	0.1	1.0	0.6
Jõgeva	26.3	11.5	0.2	0.0	1.0	0.0	1.0	1.4	4.0	0.1	3.9	8.2	0.3	4.5	3.4
Järva	36.6	18.7	0.1	0.1	1.6	0.0	1.6	0.5	6.7	0.3	6.4	8.9	0.6	6.7	1.6
Lääne	8.5	3.5	0.1	0.1	0.5	0.0	0.5	0.7	1.3	0.0	1.3	2.3	0.1	1.3	0.9
Lääne-Viru	28.6	12.1	0.6	0.2	1.3	0.0	1.3	1.5	5.0	0.1	4.9	7.9	0.2	4.4	3.3
Põlva	14.7	7.2	0.1	0.0	0.7	0.0	0.7	0.5	1.9	0.0	1.9	4.3	0.2	2.9	1.2
Pärnu	25.7	13.2	0.3	0.1	1.3	0.0	1.3	0.6	4.4	0.2	4.2	5.8	0.4	3.9	1.5
Rapla	17.1	7.8	0.1	0.2	0.6	0.0	0.6	0.7	3.0	0.1	2.9	4.7	0.2	2.4	2.1
Saare	14.3	6.2	0.2	0.1	0.7	0.0	0.7	1.1	1.9	0.0	1.9	4.1	0.6	2.1	1.4
Tartu	15.0	7.1	0.1	0.0	0.3	0.0	0.3	0.6	2.5	0.0	2.5	4.4	0.1	2.7	1.6
Valga	9.5	4.6	0.2	0.3	0.9	0.0	0.9	0.1	1.1	0.0	1.1	2.3	0.1	1.6	0.6
Viljandi	19.1	8.7	0.1	0.1	1.4	0.0	1.4	0.8	3.5	0.0	3.5	4.5	0.2	2.7	1.6
Võru	9.6	4.7	0.3	0.0	0.5	0.0	0.5	0.4	1.2	0.1	1.1	2.5	0.0	1.4	1.1
Agricultural households	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table A.3.3_I.15. Swine population size in 2004 by counties of Estonia, 1000 heads (Agriculture 2004)

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total	covered sows	of which covered for the first time	other sows	of which gilts not yet covered
					50–80 kg	80–110 kg	more than 110 kg						
2004	**340.1**	**113.7**	**83.9**	**106.6**	**65.5**	**37.8**	**3.3**	**1.2**	**34.7**	**22.6**	**5.0**	**12.1**	**4.2**
Agricultural holdings	339.2	113.5	83.6	106.3	65.3	37.7	3.3	1.2	34.6	22.5	5.0	12.1	4.2
natural persons	31.4	9.6	7.6	10.9	6.6	4.1	0.2	0.2	3.1	2.2	0.5	0.9	0.3
legal persons	307.8	103.9	76.0	95.4	58.7	33.6	3.1	1.0	31.5	20.3	4.5	11.2	3.9
Harju	26.3	4.9	9.2	9.4	4.5	4.9	0.0	0.1	2.7	1.5	0.4	1.2	0.4
Hiiu	x	x	x	x	x	x	x	x	x	x	x	x	x
Ida-Viru	5.5	0.9	1.3	2.9	1.8	1.1	0.0	0.0	0.4	0.3	0.0	0.1	0.0
Jõgeva	27.4	5.8	8.8	9.8	8.0	1.8	0.0	0.2	2.8	2.1	0.4	0.7	0.4
Järva	17.6	4.3	4.9	6.6	3.6	2.8	0.2	0.1	1.7	1.0	0.2	0.7	0.2
Lääne	9.2	1.9	2.2	4.2	3.0	1.2	0.0	0.0	0.9	0.7	0.3	0.2	0.2
Lääne-Viru	44.1	13.3	12.0	14.1	10.0	4.0	0.1	0.1	4.6	3.5	0.9	1.1	0.3
Põlva	9.9	3.9	2.2	2.7	0.8	1.9	0.0	0.1	1.0	0.9	0.2	0.1	0.0
Pärnu	6.9	1.6	1.0	3.6	3.0	0.6	0.0	0.1	0.6	0.4	0.1	0.2	0.1
Rapla	20.8	5.8	5.5	6.5	4.1	2.3	0.1	0.1	2.9	2.4	0.4	0.5	0.1
Saare	20.2	7.3	5.9	4.6	2.7	1.8	0.1	0.1	2.3	1.7	0.3	0.6	0.4
Tartu	24.5	6.3	7.5	9.1	7.4	1.7	0.0	0.1	1.5	1.2	0.3	0.3	0.1
Valga	5.3	1.2	1.4	2.0	1.3	0.5	0.2	0.1	0.6	0.4	0.1	0.2	0.1
Viljandi	x	x	x	x	x	x	x	x	x	x	x	x	x
Võru	11.4	2.1	2.5	5.9	3.5	2.4	0.0	0.0	0.9	0.5	0.1	0.4	0.2
Agricultural households	0.9	0.2	0.3	0.3	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0

Table A.3.3_I.16. Number of cattle in 2005 by counties of Estonia, 1000 heads (Agriculture 2005)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
2005	**249.5**	**112.8**	**4.8**	**0.8**	**12**	**0.4**	**11.6**	**11.2**	**40.7**	**1.1**	**39.6**	**67.2**	**3.8**	**40.6**	**22.8**
Agricultural holdings	247.2	111.8	4.8	0.8	11.9	0.4	11.5	11	40.4	1.1	39.3	66.5	3.6	40.3	22.6
natural persons	83.6	35	2.2	0.3	4.3	0.2	4.1	4	13.9	0.5	13.4	23.9	1.4	14.3	8.2
legal persons	163.6	76.8	2.6	0.5	7.6	0.2	7.4	7	26.5	0.6	25.9	42.6	2.2	26	14.4
Harju	14	6.2	0.3	0.1	1.1	0.1	1	0.5	2.2	0.1	2.1	3.6	0.3	2.1	1.2
Hiiu	2.8	0.9	0.3	0	0.1	0	0.1	0.2	0.4	0	0.4	0.9	0	0.5	0.4
Ida-Viru	6.7	3.1	0.1	0	0.3	0.1	0.2	0.4	1	0.1	0.9	1.8	0	0.9	0.9
Jõgeva	25.9	11.3	0.1	0	1	0	1	1.7	4.1	0	4.1	7.7	0.5	4.3	2.9
Järva	36.2	18.1	0.3	0.1	1.4	0	1.4	0.7	6.7	0.1	6.6	8.9	0.3	6.4	2.2
Lääne	9	3	1	0.1	0.5	0	0.5	0.6	1.1	0.2	0.9	2.7	0	1.4	1.3
Lääne-Viru	29.8	12.3	0.5	0.1	1.2	0	1.2	2.2	5.4	0.1	5.3	8.1	0.2	4.8	3.1
Põlva	14	6.8	0.1	0	0.8	0	0.8	0.3	2.1	0	2.1	3.9	0.4	2.7	0.8
Pärnu	24.3	12.4	0.3	0.1	1.4	0	1.4	0.5	4	0.1	3.9	5.6	0.3	3.8	1.5
Rapla	18.1	7.8	0.4	0.2	0.8	0	0.8	1.2	2.8	0	2.8	4.9	0.1	2.5	2.3
Saare	14.9	6.5	0.4	0	0.9	0.1	0.8	0.7	2.3	0.1	2.2	4.1	0.5	2.5	1.1
Tartu	14.8	6.5	0.2	0	0.7	0	0.7	0.6	2.6	0	2.6	4.2	0.2	2.3	1.7
Valga	8.8	3.9	0.3	0	0.4	0	0.4	0.3	1.2	0	1.2	2.7	0.1	1.5	1.1
Viljandi	18.3	8.6	0.3	0.1	0.9	0	0.9	0.7	3	0.1	2.9	4.7	0.2	3	1.5
Võru	9.6	4.4	0.2	0	0.4	0.1	0.3	0.4	1.5	0.2	1.3	2.7	0.5	1.6	0.6
Agricultural households	2.3	1	0	0	0.1	0	0.1	0.2	0.3	0	0.3	0.7	0.2	0.3	0.2

Table A.3.3_I.17. Swine population size in 2005 by counties of Estonia, 1000 heads (Agriculture 2005)

	Total	of which						breeding pigs, live weight more than 50 kg					
				fattening pigs				boars	sows				
					of which, live weight				total				
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	total	50–80 kg	80–110 kg	more than 110 kg			covered sows	of which covered for the first time	other sows	of which gilts not yet covered
2005	**346.5**	**113.3**	**87.2**	**110.4**	**77.2**	**31.7**	**1.5**	**1.3**	**34.3**	**26.3**	**5.3**	**8**	**4.3**
Agricultural holdings	343.8	112.7	86.2	109.4	76.6	31.4	1.4	1.3	34.2	26.2	5.3	8	4.3
natural persons	34.7	11.1	9	11.4	8.1	3.1	0.2	0.2	3	2.3	0.5	0.7	0.3
legal persons	309.1	101.6	77.2	98	68.5	28.3	1.2	1.1	31.2	23.9	4.8	7.3	4
Harju	22.7	4.2	6.4	9.8	6	3.8	0	0.2	2.1	1.5	0.3	0.6	0.3
Hiiu	x	x	x	x	x	x	x	x	x	x	x	x	x
Ida-Viru	3.5	0.7	1	1.5	0.9	0.6	0	0	0.3	0.2	0	0.1	0
Jõgeva	28.1	7.4	7	10.7	9.1	1.6	0	0.2	2.8	2.1	0.4	0.7	0.6
Järva	16.1	4.8	3.8	5.6	3.1	2.2	0.3	0.1	1.8	1.2	0.2	0.6	0.3
Lääne	9.3	1.8	2.5	4.2	2.9	1	0.3	0.1	0.7	0.5	0.1	0.2	0
Lääne-Viru	x	x	x	x	x	x	x	x	x	x	x	x	x
Põlva	17.5	10.9	3.6	2.7	1.7	1	0	0	0.3	0.2	0	0.1	0
Pärnu	6.7	1.1	2.3	2.8	1.9	0.9	0	0	0.5	0.4	0.1	0.1	0.1
Rapla	20.8	5.4	6.2	6.6	5.2	1.4	0	0.1	2.5	1.9	0.6	0.6	0.1
Saare	23	7.7	6.6	6.2	3.5	2.6	0.1	0.1	2.4	1.7	0.4	0.7	0.3
Tartu	24	4.5	9.7	8	6.1	1.9	0	0.1	1.7	1.4	0.2	0.3	0.1
Valga	6.6	1.1	0.8	4.3	3.4	0.8	0.1	0	0.4	0.3	0	0.1	0
Viljandi	101	49.2	18.2	20.4	12.7	7.5	0.2	0.2	13	10.5	1.8	2.5	1.9
Võru	13.2	2.5	3.9	5.9	4.1	1.5	0.3	0.1	0.8	0.6	0.1	0.2	0.1
Agricultural households	2.7	0.6	1	1	0.6	0.3	0.1	0	0.1	0.1	0	0	0

Table A.3.3_I.18. Number of cattle in 2006 by counties of Estonia, 1000 heads (SE, 2011)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
2006	**244.8**	**108.4**	**6**	**1.7**	**11.1**	**0.4**	**10.7**	**8.7**	**42.9**	**1.5**	**41.4**	**66**	**3.1**	**62.9**	**42.4**
Harju	14.7	7	0.3	0	0.8	0	0.8	0.5	2.7	0.4	2.3	5.1	0.2	4.2	2.9
Hiiu	2.9	0.8	0.5	0	0.1	0	0.1	0.2	0.4	0.1	0.3	0.9	0	0.9	0.5
Ida-Viru	6	2.7	0.3	0.1	0.2	0	0.2	0.2	0.9	0	0.9	1.6	0	1.6	1
Jõgeva	23.4	10.6	0.2	0.2	0.9	0	0.9	1	4.1	0	4.1	6.4	0.1	6.3	4.3
Järva	32.3	16.2	0	0.1	1.3	0	1.3	0.4	6.5	0.1	6.4	7.8	0.3	7.5	5.7
Lääne	9.7	2.8	1	0.1	0.4	0.1	0.3	0.7	1.5	0.2	1.3	3.2	0.1	3.1	1.6
Lääne-Viru	31	12.9	1	0.2	1.4	0	1.4	1.5	5.6	0.1	5.5	8.4	0.4	8	5.3
Põlva	14	6.7	0.1	0	1.2	0	1.2	0.3	2.2	0	2.2	3.5	0.2	3.3	2.5
Pärnu	24.5	12.6	0.2	0.2	1.3	0.1	1.2	0.3	4	0	4	5.9	0.4	5.5	4.2
Rapla	19.2	8.4	0.5	0.3	0.8	0.1	0.7	0.7	3.4	0.4	3	5.1	0.3	4.8	3
Saare	15.3	6.5	0.6	0.2	0.7	0.1	0.6	0.9	2.6	0.1	2.5	3.8	0.3	3.5	2.4
Tartu	14.4	6.5	0.2	0	0.5	0	0.5	0.5	2.4	0	2.4	4.3	0.3	4	2.5
Valga	9.2	3.4	0.5	0.1	0.4	0	0.4	0.4	1.6	0	1.6	2.8	0.1	2.7	1.7
Viljandi	16.2	7.4	0.4	0.1	0.9	0	0.9	0.5	2.8	0	2.8	4.1	0.1	4	2.8
Võru	9.7	3.9	0.2	0.1	0.2	0	0.2	0.4	1.8	0	1.8	3.1	0.1	3	1.7

Table A.3.3_I.19. Swine population size in 2006 by counties of Estonia, 1000 heads (SE, 2011)

		of which						breeding pigs, live weight more than 50 kg					
				fattening pigs				boars	sows				
					of which, live weight				total				
	Total	piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	total	50–80 kg	80–110 kg	more than 110 kg			covered sows	of which covered for the first time	other sows	of which gilts not yet covered
2006	**345.8**	**118.8**	**76.9**	**111.7**	**72.8**	**36.5**	**2.4**	**1**	**37.4**	**26.3**	**5.3**	**11.1**	**4.5**
Harju	18.9	2.6	7.1	7.1	4.1	3	0	0	2.1	1.1	0.3	1	0.7
Hiiu	4.5	.	.	.	.	.	.	.	.	.	.	.	.
Ida-Viru	4.5	.	.	.	.	.	.	.	.	.	.	.	.
Jõgeva	29.2	8.5	6.9	9.5	6.7	2.6	0.2	0.2	4.1	2.7	0.6	1.4	0.4
Järva	11.6	2.5	3.6	4.2	2.4	1.7	0.1	0.1	1.2	0.8	0.1	0.4	0.2
Lääne	8.1	2.9	1.5	2.8	1.9	0.9	0	0	0.9	0.6	0.1	0.3	0.1
Lääne-Viru	53.9	13.4	13.4	21.1	14.8	6.1	0.2	0.2	5.8	4.1	1.2	1.7	0.4
Põlva	26.7	13	2.3	11.1	10.8	0.2	0.1	0	0.3	0.3	0	0	0
Pärnu	5.3	0.9	1.2	2.6	1.7	0.9	0	0	0.6	0.4	0.1	0.2	0
Rapla	19.4	4.9	5.3	6.1	3.9	2.2	0	0.1	3	1.9	0.4	1.1	0.5
Saare	25.1	8.6	7.2	6.6	3.4	3.1	0.1	0.1	2.6	2	0.5	0.6	0.3
Tartu	23.4	4.7	7.7	9.2	6.3	1.9	1	0.1	1.7	1.4	0.3	0.3	0.1
Valga	6.3	2.3	1	2.4	1.6	0.6	0.2	0	0.6	0.5	0.1	0.1	0
Viljandi	96.5	47.3	14.9	21.3	10.7	10.2	0.4	0.1	12.9	9.2	1.5	3.7	1.7
Võru	12.4	2.2	3.2	6.2	3.6	2.6	0	0.1	0.7	0.6	0.1	0.1	0.1

Table A.3.3_I.20. Number of cattle in 2007 by counties of Estonia, 1000 heads (SE, 2011)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
2007	**240.5**	103.0	8.5	**1.8**	**11.6**	0.7	10.9	8.4	42.7	1.4	41.3	**64.5**	3	42.3	19.2
Harju	12.9	5.8	0.5	0	0.5	0	0.5	0.6	2.4	0.1	2.3	3.8	0	2.2	0.9
Hiiu	3.5	0.8	0.7	0.1	0.1	0	0.1	0.3	0.4	0.1	0.3	1.1	0	0.5	0.6
Ida-Viru	5.9	2.3	0.2	0.1	0.3	0	0.3	0.2	1.1	0.2	0.9	1.7	0	1.1	0.6
Jõgeva	22.1	9.9	0.1	0.1	1.2	0.1	1.1	0.5	4.1	0.2	3.9	6.2	0.2	3.8	2.2
Järva	30.8	15.4	0.3	0.1	1.4	0	1.4	0.3	5.4	0	5.4	7.9	0.3	6.2	1.4
Lääne	10.7	2.7	1.5	0.1	0.5	0.2	0.3	0.9	1.8	0.1	1.7	3.2	0.3	1.7	1.2
Lääne-Viru	29.4	12.8	0.8	0.1	1	0.1	0.9	1	6	0.1	5.9	7.7	0.1	5.2	2.4
Põlva	14.1	6.6	0.1	0.1	1.1	0.1	1	0.4	2.3	0	2.3	3.5	0.2	2.4	0.9
Pärnu	23.9	10.9	0.7	0.1	0.9	0	0.9	0.6	4.7	0.1	4.6	6	0.4	4.4	1.2
Rapla	18.1	7.2	0.9	0.6	0.6	0.2	0.4	0.7	3.1	0.2	2.9	5	0.4	3.2	1.4
Saare	15.4	6.1	0.9	0.1	0.7	0	0.7	0.7	2.6	0.1	2.5	4.3	0.2	2.6	1.5
Tartu	15.4	6.4	0.3	0	0.7	0	0.7	0.6	2.9	0	2.9	4.5	0.3	2.6	1.6
Valga	9.3	3.5	0.7	0	1.1	0	1.1	0.4	1.2	0	1.2	2.4	0.2	1.3	0.9
Viljandi	16.9	7.6	0.5	0.1	1.2	0	1.2	0.5	2.5	0	2.5	4.5	0.2	3.1	1.2
Võru	9.8	4.0	0.3	0.2	0.3	0	0.3	0.5	1.8	0.1	1.7	2.7	0	1.7	1

Table A.3.3_I.21. Swine population size in 2007 by counties of Estonia, 1000 heads (SE, 2011)

		of which						breeding pigs, live weight more than 50 kg					
				fattening pigs				boars	sows				
					of which, live weight				total				
	Total	piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	total	50–80 kg	80–110 kg	more than 110 kg			covered sows	of which covered for the first time	other sows	of which gilts not yet covered
2007	**379**	**123.3**	**81.8**	**137.4**	**78.5**	**56.3**	**2.6**	**0.8**	**35.7**	**25.1**	**5.1**	**10.6**	**3.5**
Harju	20.4	2.2	8	8.8	6	2.7	0.1	0	1.4	1	0.2	0.4	0.1
Hiiu	*4.5*	*27.45*	*7.9*	*15.9*	*5.95*	*9.9*	*0.05*	*0.05*	*6.5*	*4.4*	*0.85*	*2.1*	*0.7*
Ida-Viru	3.3	1.5	0.6	0.8	0.5	0.3	0	0	0.4	0.3	0.1	0.1	0
Jõgeva	34.6	8.4	9.4	12.6	6.1	6	0.5	0.1	4.1	3.6	0.9	0.5	0.4
Järva	12.2	2.5	4.4	4.2	2.8	1.3	0.1	0	1.1	0.9	0.1	0.2	0.2
Lääne	8.4	2.9	2.8	1.8	1.8	0	0	0	0.9	0.8	0.2	0.1	0.1
Lääne-Viru	55.4	13.6	9.2	27.1	13.7	13.1	0.3	0.1	5.4	3.5	0.6	1.9	0.5
Põlva	30.8	15.5	2	12.9	11.4	0.7	0.8	0	0.4	0.2	0.1	0.2	0.1
Pärnu	6.4	1.1	1.1	3.6	2.7	0.9	0	0	0.6	0.4	0.1	0.2	0.1
Rapla	18.9	4.1	5.6	6.6	4.2	2.4	0	0.1	2.5	1.6	0.3	0.9	0.1
Saare	27	8.9	8.3	7.4	5	2.3	0.1	0.1	2.3	1.6	0.5	0.7	0.3
Tartu	28.8	4.8	9.7	11.9	7.5	4.4	0	0.1	2.3	1.6	0.2	0.7	0.2
Valga	4.9	1.2	1	2.2	1.5	0.5	0.2	0.1	0.4	0.2	0	0.2	0
Viljandi	*111.1*	*27.45*	*7.9*	*15.9*	*5.95*	*9.9*	*0.05*	*0.05*	*6.5*	*4.4*	*0.85*	*2.1*	*0.7*
Võru	12.3	1.7	3.9	5.7	3.4	1.9	0.4	0.1	0.9	0.6	0.1	0.3	0

Table A.3.3_I.22. Number of cattle in 2008 by counties of Estonia, 1000 heads (SE, 2011)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
2008	237.9	100.4	8.2	2.2	14.5	1	13.5	7.5	39.5	1.4	38.1	65.6	3.2	41.8	20.6
Harju	12.4	5.0	0.6	0.2	1.0	0.1	0.9	0.4	1.8	0.1	1.7	3.3	0.1	2	1.2
Hiiu	3.7	0.7	0.6	0.1	0.2	0.1	0.1	0.3	0.5	0.1	0.4	1.2	0	0.7	0.5
Ida-Viru	6.4	2.2	0.3	0	0.5	0	0.5	0.3	1	0.2	0.8	2.0	0.1	1.2	0.7
Jõgeva	22.6	10.7	0.3	0.1	1.0	0.1	0.9	0.4	3.8	0.2	3.6	6.2	0.2	4	2
Järva	31.0	15.1	0.2	0.2	1.5	0	1.5	0.4	5.7	0.1	5.6	7.8	0.3	6	1.5
Lääne	10.3	3.1	1.2	0.2	0.7	0.3	0.4	0.6	1.5	0	1.5	2.9	0.2	1.6	1.1
Lääne-Viru	29.6	12.5	0.6	0.1	1.7	0.1	1.6	0.9	5.2	0.1	5.1	8.5	0.2	5.5	2.8
Põlva	14.2	6.2	0.2	0.1	0.7	0	0.7	0.4	2.5	0	2.5	4.0	0.2	2.7	1.1
Pärnu	23.5	10.5	0.7	0.3	1.7	0	1.7	0.5	4.1	0.1	4	5.6	0.3	4	1.3
Rapla	16.4	5.9	0.9	0.3	1.1	0.3	0.8	0.7	2.7	0.2	2.5	4.7	0.3	2.8	1.6
Saare	16.0	6.3	1	0.1	1.2	0	1.2	0.6	2.5	0.1	2.4	4.2	0.2	2.6	1.4
Tartu	15.0	6.6	0.2	0.2	0.9	0	0.9	0.4	2.4	0	2.4	4.2	0.4	2.4	1.4
Valga	10.9	4.1	0.4	0	0.7	0	0.7	0.5	1.7	0	1.7	3.4	0.3	1.7	1.4
Viljandi	16.6	7.8	0.4	0.3	0.9	0	0.9	0.5	2.4	0	2.4	4.2	0.2	2.7	1.3
Võru	10.0	4.1	0.6	0	0.6	0	0.6	0.4	1.4	0.1	1.3	2.7	0	1.6	1.1

Table A.3.3_I.23. Swine population size in 2008 by counties of Estonia, 1000 heads (SE, 2011)

		of which						breeding pigs, live weight more than 50 kg					
				fattening pigs				boars	sows				
					of which, live weight				total				
	Total	piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	total	50–80 kg	80–110 kg	more than 110 kg			covered sows	of which covered for the first time	other sows	of which gilts not yet covered
2008	364.9	117.1	96.2	116.9	70.1	44.2	2.6	0.6	34.1	22.5	5	11.6	4
Harju	19.2	3.5	6.8	7.7	4.5	3.2	0	0	1.2	0.9	0.3	0.3	0.1
Hiiu	58.4	23.7	16.4	11.7	6.9	4.8	0.0	0.1	6.6	3.3	0.9	3.3	1.0
Ida-Viru	2.2	0.9	0.6	0.4	0.2	0.2	0	0	0.3	0.2	0.1	0.1	0
Jõgeva	40.5	9.2	12	14.3	6	8	0.3	0.1	4.9	4	0.7	0.9	0.8
Järva	11.4	3.3	2.8	4.3	4	0.3	0	0	1	0.8	0.3	0.2	0.1
Lääne	8.9	3.6	0.2	4	4	0	0	0	1.1	0.7	0.2	0.4	0.3
Lääne-Viru	52.3	12.8	11.8	22.8	12.2	9.2	1.4	0.1	4.8	3.7	0.4	1.1	0.4
Põlva	28.2	14.5	4.8	8.6	5.1	3.5	0	0	0.3	0.2	0	0.1	0
Pärnu	6.6	1.7	0.8	3.5	1.3	2.2	0	0	0.6	0.4	0.3	0.2	0.1
Rapla	12.6	2	4.1	4.6	3.6	1	0	0.1	1.8	1.1	0.2	0.7	0
Saare	27.8	8.7	9.4	7.4	4.5	2.3	0.6	0.1	2.2	1.7	0.3	0.5	0.1
Tartu	26.5	7.6	6.2	10.6	8.8	1.7	0.1	0.1	2	1.6	0.4	0.4	0.2
Valga	2.8	0.6	0.9	1.1	0.9	0.2	0	0	0.2	0.2	0	0	0
Viljandi	58.4	23.7	16.4	11.7	6.9	4.8	0.0	0.1	6.6	3.3	0.9	3.3	1.0
Võru	9.1	1.4	3	4.2	1.2	2.8	0.2	0	0.5	0.4	0.1	0.1	0

Table A.3.3_I.24. Number of cattle in 2009 by counties of Estonia, 1000 heads (SE, 2011)

	Total	of which														
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
2009	234.7	96.7	10.3	2.0	14.3	1	13.3	8.3	39.6	1.4	38.2	63.5	3.2	40.4	19.9
Harju	11.5	4.6	0.7	0.2	0.8	0	0.8	0.4	1.8	0.1	1.7	3.0	0.1	1.8	1.1
Hiiu	4.2	0.5	0.9	0.1	0.3	0.1	0.2	0.4	0.6	0.1	0.5	1.4	0	0.8	0.6
Ida-Viru	5.8	2.2	0.3	0	0.4	0	0.4	0.3	0.9	0.2	0.7	1.7	0.1	1	0.6
Jõgeva	21.8	10.5	0.4	0	0.9	0.1	0.8	0.6	4	0.2	3.8	6.6	0.2	3.8	1.9
Järva	29.8	14.1	0.3	0.1	1.8	0	1.8	0.6	5.9	0.1	5.6	7.5	0.3	5.8	1.4
Lääne	10.1	3.0	1.3	0.3	0.8	0.3	0.5	0.5	1.4	0.1	1.4	2.8	0.2	1.5	1.1
Lääne-Viru	28.1	12.0	0.8	0.2	1.4	0.1	1.3	1	5.1	0.1	5	7.6	0.2	4.9	2.5
Põlva	13.2	5.7	0.3	0.1	0.6	0	0.6	0.4	2.4	0	2.4	3.7	0.2	2.5	1
Pärnu	23.5	10.8	0.9	0.1	1.7	0	1.7	0.5	4.2	0.1	4.2	5.8	0.3	4.1	1.4
Rapla	16.2	5.8	1	0.2	1.1	0.3	0.8	1	2.7	0.2	2.5	4.5	0.3	2.6	1.6
Saare	16.5	6.1	1.4	0.1	1.1	0	1.1	0.7	2.6	0.1	2.5	4.5	0.2	2.8	1.5
Tartu	13.5	5.9	0.2	0.2	0.7	0.1	0.6	0.3	2.3	0	2.3	3.9	0.3	2.3	1.3
Valga	10.6	3.6	0.6	0.1	0.8	0	0.8	0.6	1.6	0	1.6	3.3	0.3	1.7	1.3
Viljandi	17.0	7.6	0.6	0.2	1.2	0	1.2	0.5	2.5	0	2.5	4.4	0.2	2.9	1.3
Võru	10.6	4.3	0.6	0.1	0.7	0	0.7	0.5	1.6	0.1	1.5	2.8	0.1	1.6	1.1

Table A.3.3_I.25. Swine population size in 2009 by counties of Estonia, 1000 heads (SE, 2011)

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total				
					50–80 kg	80–110 kg	more than 110 kg			covered sows	of which covered for the first time	other sows	of which gilts not yet covered
2009	365.1	120.7	94.6	115.2	68.4	36.7	10.1	0.5	34.1	24.1	4.7	10	3.5
Harju	19.7	2.3	7.3	8.7	5.4	3.3	0	0	1.4	1.2	0.3	0.2	0.1
Hiiu	2.6	0.6	1.0	0.8	0.5	0.3	0.0	0.0	0.2	0.1	0.0	0.1	0.0
Ida-Viru	2.9	0.9	0.8	0.9	0.4	0.4	0.1	0	0.3	0.3	0.1	0	0
Jõgeva	56.3	9.3	18.2	23	18.8	4	0.2	0.1	5.7	3.9	0.7	1.8	1.1
Järva	9.3	2.1	2.9	3.2	2.6	0.6	0	0	1.1	1	0	0.1	0
Lääne	1.4	0.3	0.2	0.7	0.6	0.1	0	0	0.2	0.1	0	0.1	0
Lääne-Viru	51.5	14.9	15	16.7	9.2	7.4	0.1	0.1	4.8	3.7	0.6	1.1	0.2
Põlva	6.7	1.1	1.2	3.8	2.1	1.5	0.2	0	0.6	0.4	0.1	0.2	0.1
Pärnu	7.5	1.9	1.4	3.7	1.4	2.3	0	0	0.5	0.4	0.1	0.1	0
Rapla	10.5	1.4	3.6	3.7	2.1	1.6	0	0.1	1.7	1	0.2	0.7	0.1
Saare	27.9	9.3	9	7.3	4.6	2.4	0.3	0.1	2.2	1.7	0.3	0.5	0.1
Tartu	32.7	8.6	11.2	10.6	8.3	2.1	0.2	0	2.3	1.8	0.4	0.5	0.2
Valga	2.6	0.7	0.6	1.1	0.8	0.3	0	0	0.2	0.2	0	0	0
Viljandi	122.8	63.9	17.2	29.2	10.8	9.4	9.0	0.1	12.4	7.9	1.8	4.5	1.6
Võru	10.7	3.4	5	1.8	0.8	1	0	0	0.5	0.4	0.1	0.1	0

Table A.3.3_I.26. Number of cattle in 2010 by counties of Estonia, 1000 heads (SE, 2011)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
2010	236.3	96.5	12.1	2.3	15.0	1	14	8.1	39.6	1.4	38.2	3.1	59.6	41.7	17.9
Harju	12.6	4.6	0.9	0.2	1.1	0.1	1	0.5	2	0.1	1.9	0.1	3.2	2.2	1
Hiiu	4.3	0.6	0.9	0.1	0.4	0.1	0.3	0.4	0.6	0.1	0.5	0	1.3	0.7	0.6
Ida-Viru	6.0	1.9	0.4	0.1	0.4	0	0.4	0.3	1	0.2	0.8	0.1	1.8	1.2	0.6
Jõgeva	21.0	9.7	0.4	0.1	1.0	0.1	0.9	0.5	3.8	0.2	3.6	0.2	5.3	4	1.3
Järva	30.1	13.7	0.5	0.1	1.8	0	1.8	0.6	5.8	0.1	5.7	0.3	7.3	5.9	1.4
Lääne	10.6	3.2	1.4	0.3	1.0	0.4	0.6	0.4	1.5	0	1.5	0.2	2.6	1.6	1
Lääne-Viru	28.1	12.0	1	0.2	1.8	0.1	1.7	0.9	4.9	0.1	4.8	0.2	7.1	5.1	2
Põlva	13.5	6.3	0.3	0.1	0.6	0	0.6	0.4	2.2	0	2.2	0.2	3.4	2.4	1
Pärnu	23.4	11.2	1.1	0.2	1.7	0	1.7	0.6	3.9	0.1	3.8	0.3	5.4	4	1.4
Rapla	16.3	5.7	1.3	0.2	0.9	0.2	0.7	0.7	2.9	0.2	2.7	0.3	4.3	2.8	1.5
Saare	15.6	5.5	1.5	0.1	1.1	0	1.1	0.7	2.5	0.1	2.4	0.2	4	2.7	1.3
Tartu	15.0	7.1	0.2	0.2	0.8	0	0.8	0.3	2.5	0	2.5	0.3	3.6	2.6	1
Valga	10.5	4.1	0.6	0.1	0.6	0	0.6	0.5	1.5	0	1.5	0.3	2.8	1.6	1.2
Viljandi	17.9	7.7	0.8	0.2	1.1	0	1.1	0.7	2.8	0	2.8	0.2	4.4	3.1	1.3
Võru	9.1	3.2	0.8	0.1	0.6	0	0.6	0.4	1.4	0.1	1.3	0	2.6	1.5	1.1

Table A.3.3_I.27. Swine population size in 2010 by counties of Estonia, 1000 heads (SE, 2011)

	Total	of which						breeding pigs, live weight more than 50 kg					
				fattening pigs				boars	sows				
					of which, live weight				total				
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	total	50–80 kg	80–110 kg	more than 110 kg			covered sows	of which covered for the first time	other sows	of which gilts not yet covered
2010	371.7	116.1	100.2	119.7	73.7	44.5	1.5	0.6	35.1	27	4.9	8.1	4
Harju	20	3	5.8	9.9	6.3	3.6	0	0	1.3	1	0.2	0.3	0.1
Hiiu	2.6	0.6	1.0	0.8	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ida-Viru	2.5	0.3	0.8	0.9	0.4	0.4	0.1	0	0.5	0.3	0.1	0.2	0.2
Jõgeva	55.2	10.8	20.4	18.2	16.1	2	0.1	0	5.8	4	0.8	1.8	0.9
Järva	8.9	2.2	2.6	3.1	2	1.1	0	0	1	0.9	0.1	0.1	0
Lääne	1.4	0.3	0.2	0.7	0.6	0.1	0	0.1	1	0.6	0.15	0.4	0.25
Lääne-Viru	58.7	15.4	14.9	23.4	12.5	10.8	0.1	0.1	4.9	3.3	0.5	1.6	0.3
Põlva	8.6	2.7	1.2	4.2	2.8	1.4	0	0.0	0.5	0.4	0	0.1	0
Pärnu	5.2	2.5	0.6	1.5	1	0.5	0	0.1	0.5	0.4	0	0.1	0
Rapla	10.6	2	3.6	3.3	3.3	0	0	0.1	1	0.6	0.15	0.4	0.25
Saare	28.2	8.5	10.3	7	2.3	3.8	0.9	0.1	2.3	1.9	0.3	0.4	0.1
Tartu	36.1	6.9	14.1	12.2	8.4	3.7	0.1	0.1	2.8	2	0.5	0.8	0.2
Valga	2.8	0.7	0.8	1	0.9	0.1	0	0	0.3	0.3	0.1	0	0
Viljandi	122.3	58.2	20.0	31.3	15.3	15.8	0.2	0.1	12.7	10.9	1.9	1.8	1.7
Võru	8.6	2	3.9	2.2	1.3	0.9	0	0	0.5	0.4	0.1	0.1	0

Table A.3.3_I.28. Number of cattle in 2011 by counties of Estonia, 1000 heads (SE, 2012)

	Total	of which													
		cows, bulls and heifers (2 years and over)						bovine animals (aged between 1 and 2 years)				calves (less than 1 year old)			
		cows		bulls	heifers			bulls	heifers			total	for slaughter	for breeding	
		dairy cows	other		total	for slaughter	for breeding		total	for slaughter	for breeding			heifers	bulls
2011	238.3	96.2	14.5	2.4	15.3	1.2	14.1	6.5	40.8	1.4	39.4	62.6	3.2	42.1	17.3
No distribution by county	2.3	1	0	0	0.1	0	0.1	0.2	0.3	0.1	0.2	0.7	0.2	0.3	0.2
Harju	12.2	5	0.7	0.2	1	0	1	0.5	1.9	0.1	1.8	2.9	0.1	1.9	0.9
Hiiu	4.3	0.5	1.1	0.1	0.3	0.1	0.2	0.3	0.6	0.1	0.5	1.4	0	0.8	0.6
Ida-Viru	5.6	1.8	0.5	0	0.4	0	0.4	0.2	1.1	0.2	0.9	1.6	0.1	1	0.5
Jõgeva	21.4	9.9	0.5	0.1	1.1	0.1	1	0.2	3.9	0.2	3.7	5.7	0.2	4.1	1.4
Järva	29.6	13.8	0.6	0.1	1.5	0	1.5	0.4	5.6	0	5.6	7.6	0.3	5.7	1.6
Lääne	11.8	3.1	1.9	0.3	1.1	0.4	0.7	0.5	1.8	0.1	1.7	3.1	0.2	1.8	1.1
Lääne-Viru	27.6	11.9	1.3	0.2	1.8	0.1	1.7	0.6	4.7	0.1	4.6	7.1	0.2	5.1	1.8
Põlva	14.1	6.3	0.4	0.1	0.8	0.1	0.7	0.3	2.6	0	2.6	3.6	0.2	2.5	0.9
Pärnu	23.2	9.9	1.4	0.2	1.6	0	1.6	0.5	3.9	0.1	3.8	5.7	0.3	4	1.4
Rapla	17.4	5.7	1.5	0.3	1.4	0.4	1	0.7	3.1	0.2	2.9	4.7	0.3	3	1.4
Saare	16.5	5.6	1.9	0.2	1.4	0	1.4	0.6	2.6	0.1	2.5	4.2	0.2	2.8	1.2
Tartu	16.7	7.5	0.2	0.2	0.8	0	0.8	0.2	3.2	0	3.2	4.6	0.4	3.1	1.1
Valga	10.2	3.8	0.7	0.1	0.5	0	0.5	0.5	1.6	0	1.6	3	0.3	1.6	1.1
Viljandi	17.1	7.5	0.9	0.2	1.1	0	1.1	0.5	2.6	0	2.6	4.3	0.2	2.9	1.2
Võru	8.3	2.9	0.9	0.1	0.4	0	0.4	0.3	1.3	0.1	1.2	2.4	0	1.5	0.9

Table A.3.3_I.29. Swine population size in 2011 by counties of Estonia, 1000 heads (SE, 2012)

	Total	of which						breeding pigs, live weight more than 50 kg					
		piglets, live weight less than 20 kg	young pigs, live weight 20–50 kg	fattening pigs				boars	sows				
				total	of which, live weight				total				
					50–80 kg	80–110 kg	more than 110 kg			covered sows	of which covered for the first time	other sows	of which gilts not yet covered
2011	365.7	113.9	98.4	117.2	72.6	42.2	2.4	0.6	35.6	27.5	5.8	8	4.3
No distribution by county	2.6	0.6	1	0.8	0.5	0.3	0	0	0.2	0.1	0	0.1	0
Harju	23.7	3.8	6.9	10.1	6.2	3.5	0.4	0.1	2.8	2.2	1.1	0.6	0.3
Hiiu	0	0	0	0	0	0	0	0	0	0	0	0	0
Ida-Viru	3.8	0.3	1.1	2.1	1	1	0.1	0	0.3	0.3	0.1	0	0
Jõgeva	51.4	10.7	19.4	15.2	13.5	1.6	0.1	0.1	6	3.8	1	2.2	1.2
Järva	6.1	2	1.1	2.6	2.3	0.2	0.1	0	0.4	0.4	0	0	0
Lääne	7.5	1.5	2.5	2.6	1.9	0.7	0.0	0	1.1	.	.	.	.
Lääne-Viru	57.9	15.6	15.6	21.6	12.6	8.6	0.4	0.1	5	3.7	0.5	1.3	0.4
Põlva	7.5	2.1	0.9	4.1	1.8	1.7	0.6	0	0.4	0.3	0.1	0.1	0
Pärnu	8.1	1.8	1.8	3.6	1.9	1.7	0	0	0.9	0.7	0.1	0.2	0.1
Rapla	7.5	1.5	2.5	2.6	1.9	0.7	0.0	0	1.1	.	.	.	.
Saare	26.8	6.9	10.3	7.3	2	4.8	0.5	0	2.3	1.8	0.3	0.5	0.1
Tartu	37.3	8	13.6	13.1	10	3	0.1	0.1	2.5	2	0.5	0.5	0.3
Valga	1.6	0.2	0.4	0.9	0.7	0.2	0	0	0.1	0	0	0	0
Viljandi	119.2	58.2	20.4	28.2	14.1	14.1	0	0.1	12.3	10.7	1.7	1.6	1.5
Võru	7.2	1.4	2	3.3	2.7	0.5	0.1	0	0.5	0.4	0.1	0.1	0

APPENDIX A.3.3_II. MILK YIELD PER COW, FAT CONTENT OF MILK AND PERCENTAGE OF COW THAT GAVE BIRTH IN ESTONIA IN 1990–2011

Table A.3.3_II.1. Average milk yield per cow in 1991–1993, kg/cow (Agriculture 1994)

Year	Average yield per cow, kg
1991	3 968
1992	3 530
1993	3 322

Table A.3.3_II.2. Average milk yield per cow in 1994–2011, kg/cow/year (Agriculture 1994–2005; SE, 2011)

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Average yield per cow, kg	3 455	3 588	3 809	4 484	4 456	4 049	4 652	5 313	5 138	5 231	5 596	5 886	6 285
Harju county	3 016	3 027	3 301	3 775	4 137	3 831	3 951	4 843	4 588	4 816	5 141	5 756	5 937
Hiiu county	2 566	2 498	2 669	3 079	3 132	3 964	4 540	5 603	4 589	4 663	4 510	4 987	4 720
Ida-Viru county	2 374	2 143	2 449	2 960	3 320	3 397	4 057	4 425	4 767	4 593	4 706	5 492	5 612
Jõgeva county	3 399	3 596	3 769	3 870	4 731	4 218	4 960	5 392	5 461	5 362	5 744	6 188	6 715
Järva county	4 066	4 224	4 458	5 020	5 399	4 751	5 375	6 216	6 057	6 058	6 243	6 330	6 900
Lääne county	2 520	2 513	2 742	3 017	3 297	3 494	3 513	4 039	4 111	4 223	4 558	4 731	5 343
Lääne-Viru county	3 548	3 418	3 950	4 394	4 721	4 061	4 685	5 420	5 291	5 391	5 954	6 205	6 542
Põlva county	3 134	3 616	4 111	4 684	4 874	4 517	5 040	6 310	5 868	6 213	6 180	6 506	7 123
Pärnu county	3 220	3 256	3 380	3 666	4 210	3 736	4 451	5 005	4 920	4 986	5 373	5 806	6 326
Rapla county	3 088	3 301	3 763	4 077	4 673	4 301	4 767	5 232	5 047	5 066	5 809	6 105	6 101
Saare county	2 732	2 573	2 894	3 330	3 657	3 817	4 071	5 162	4 341	4 496	5 034	5 113	5 464
Tartu county	3 337	3 417	3 785	4 089	4 457	3 767	4 898	5 099	5 028	5 556	6 070	6 423	6 812
Valga county	2 553	2 776	2 961	3 135	3 384	3 076	3 496	4 089	4 503	3 866	4 878	5 259	5 598
Viljandi county	3 143	2 865	3 140	3 544	3 829	3 406	4 167	4 921	4 918	4 663	4 894	5 098	5 436
Võru county	3 126	3 188	3 431	3 747	3 972	3 581	3 880	4 982	4 893	4 996	5 070	5 481	5 810

Table A.3.3_II.2. Average milk yield per cow in 1994–2011, kg/cow/year (continued)

Country	2007	2008	2009	2010	2011
Average yield per cow, kg	6 484	6 781	6 838	7 021	7 168
Harju county	6 019	6 396	6 359	6 402	6 600
Hiiu county	4 687	4 646	5 052	4 520	4 667
Ida-Viru county	5 438	6 053	6 039	6 334	6 298
Jõgeva county	6 812	7 119	7 058	7 230	7 465
Järva county	7 045	7 164	7 048	7 254	7 473
Lääne county	5 512	6 295	6 281	6 368	6 388
Lääne-Viru county	6 823	7 096	7 139	7 390	7 524
Põlva county	7 339	7 562	7 581	7 671	7 737
Pärnu county	6 407	6 651	6 733	6 948	7 294
Rapla county	6 325	6 796	7 078	7 355	7 267
Saare county	5 619	5 844	6 008	6 243	6 179
Tartu county	7 103	7 880	8 019	7 997	8 237
Valga county	5 870	5 851	5 926	6 127	6 470
Viljandi county	5 932	6 205	6 530	6 784	6 711
Võru county	6 281	6 319	6 493	6 461	6 345

Table A.3.3_II.3. Average fat content of milk in Estonia in 1990–1997, % (EARC, 2011)[228]

Year	Fat content, %
1990	4.18
1991	4.14
1992	4.07
1993	4.10
1994	4.12
1995	4.20
1996	4.34
1997	4.32

[228] Results of animal recording in Estonia in 1997–2011. Annual Reports. Available at: www.jkkeskus.ee/page.php?page=0147.

Table A.3.3_II.4. Fat content of milk in 1998–2011 by county of Estonia, % (EARC, 2011)[229]

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Harju	4.25	4.23	4.31	4.38	4.32	4.34	4.29	4.27	4.21	4.18	4.14	4.17	4.11	4.07
Hiiu	4.46	4.40	4.25	4.29	4.38	4.38	4.26	4.19	4.24	4.28	4.34	4.44	4.41	4.37
Ida-Viru	4.32	4.33	4.31	4.29	4.21	4.25	4.23	4.09	4.06	4.08	4.08	4.09	4.07	4.11
Jõgeva	4.37	4.32	4.36	4.39	4.46	4.46	4.30	4.28	4.24	4.20	4.18	4.17	4.14	4.14
Järva	4.18	4.19	4.25	4.25	4.23	4.29	4.27	4.17	4.14	4.11	4.08	4.09	4.07	4.03
Lääne	4.36	4.24	4.34	4.36	4.28	4.27	4.28	4.25	4.28	4.28	4.24	4.29	4.2	4.13
Lääne-Viru	4.18	4.14	4.19	4.21	4.19	4.20	4.16	4.11	4.07	4.03	4.02	4.01	4.01	4.05
Põlva	4.29	4.24	4.28	4.38	4.33	4.30	4.30	4.23	4.14	4.11	4.09	4.08	4.14	4.12
Pärnu	4.23	4.20	4.36	4.41	4.32	4.35	4.33	4.27	4.20	4.19	4.16	4.17	4.12	4.08
Rapla	4.23	4.16	4.21	4.27	4.19	4.20	4.21	4.11	4.05	4.06	4.00	4.12	4.18	4.21
Saare	4.46	4.40	4.38	4.36	4.40	4.40	4.38	4.27	4.26	4.23	4.17	4.22	4.15	4.13
Tartu	4.3	4.26	4.25	4.28	4.32	4.28	4.28	4.22	4.19	4.13	4.08	4.09	4.02	4.03
Valga	4.25	4.18	4.27	4.30	4.25	4.26	4.29	4.21	4.19	4.22	4.25	4.29	4.17	4.14
Viljandi	4.28	4.19	4.32	4.31	4.31	4.39	4.31	4.26	4.27	4.26	4.21	4.22	4.12	4.10
Võru	4.22	4.25	4.35	4.33	4.34	4.32	4.25	4.26	4.28	4.29	4.21	4.29	4.24	4.22

Table A.3.3_II.5. Percentage of cow that gave birth in 1990–1998, %

Year	%
1990	80.0
1991	80.0
1992	80.0
1993	80.0
1994	80.0
1995	80.0
1996	95.8
1997	94.9

[229] Results of animal recording in Estonia in 1997–2011. Annual Reports. Available at: www.jkkeskus.ee/page.php?page=0147.

Table A.3.3_II.6. Percentage of cow that gave birth in 1998–2011 by county of Estonia, %

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
The average of Estonia	97.1	81.3	76.9	76.3	82.8	81.3	81.7	84.0	92.2	88.4	89.2	93.3	93.0	88.8
Harju county	100.0	75.2	67.1	78.0	77.4	68.2	81.2	70.9	79.5	78.3	86.8	94.4	93.8	86.3
Hiiu county	69.3	63.0	64.6	66.8	53.7	68.9	63.5	73.2	78.4	73.0	64.3	82.4	78.5	88.6
Ida-Viru county	59.6	60.0	64.1	55.3	81.8	85.2	70.6	82.3	75.7	82.1	90.4	89.2	94.3	97.4
Jõgeva county	100.0	100.0	89.7	81.6	91.1	87.9	89.3	89.8	100.0	98.9	91.5	93.5	98.4	93.2
Järva county	100.0	90.0	85.9	89.4	88.8	90.9	85.4	75.7	99.7	94.2	94.8	98.8	100.0	92.6
Lääne county	74.0	65.5	66.5	62.6	73.5	77.3	72.1	86.4	99.3	99.1	92.4	97.2	82.8	85.5
Lääne-Viru county	100.0	87.4	92.0	85.5	88.2	88.7	89.8	91.6	95.9	91.5	91.5	95.3	90.7	88.5
Põlva county	87.3	85.0	71.5	75.9	85.8	86.7	80.7	89.0	92.9	87.3	94.8	100.0	98.9	90.5
Pärnu county	100.0	87.7	78.1	81.5	84.8	79.8	77.8	82.5	88.1	89.1	90.6	88.1	82.7	92.5
Rapla county	98.6	80.5	80.1	78.4	82.3	86.3	87.0	86.7	77.6	81.6	91.8	94.2	97.3	87.0
Saare county	78.6	76.0	67.6	77.1	86.3	76.7	86.1	85.9	87.1	85.4	84.8	88.9	95.7	87.5
Tartu county	90.2	76.0	77.7	70.9	69.6	79.3	75.1	94.2	100.0	92.1	92.2	100.0	83.5	76.3
Valga county	89.5	68.1	66.2	58.7	80.6	59.9	68.6	76.9	94.9	87.2	83.4	90.6	85.6	87.2
Viljandi county	99.4	73.9	67.3	64.0	80.3	71.1	80.9	89.3	97.4	88.4	87.7	89.7	92.8	88.3
Võru county	73.0	63.9	58.6	54.6	67.9	75.9	69.0	75.2	83.8	78.1	77.1	71.7	100.0	85.6

APPENDIX A.3.3_III. WEIGHT OF DAIRY CATTLE BY CATTLE BREED IN ESTONIA IN 1990–2011

Table A.3.3_III.1. Average weight of dairy cattle by breed in Estonia in 1990–2011

Year	Population by dairy-cattle breed				Average weight of cows, kg
	Estonian Red	Estonian Holstein	Estonian Native	Total number in Registry	
Typical weight, kg[230]	540	550	460		
1990	121 125	125 235	566	246 926	544.9
1991	107 873	121 077	549	229 499	545.1
1992	94 610	116 722	577	211 909	545.3
1993	74 543	106 033	563	181 139	545.6
1994	59 691	91 676	564	151 931	545.7
1995	49 285	79 767	555	129 607	545.8
1996	43 537	74 968	570	119 075	545.9
1997	40 118	74 186	535	114 839	546.1
1998	38 705	77 717	504	116 926	546.3
1999	33 820	75 589	472	109 881	546.5
2000	29 875	71 799	443	102 117	546.7
2001	27 981	73 173	481	101 635	546.8
2002	26 726	74 733	507	101 966	546.9
2003	26 314	74 981	490	101 785	547.0
2004	26 571	73 781	538	100 890	546.9
2005	26 607	73 261	537	100 405	546.9
2006	25 348	72 894	544	98 786	546.9
2007	23 842	70 816	514	95 172	547.0
2008	22 357	69 599	517	92 473	547.1
2009	20 578	68 058	475	89 111	547.2
2010	19 724	67 904	461	88 089	547.3
2011	18 917	69 216	493	88 626	547.4

Table A.3.3_III.2. Data on weight and weight gain of non-dairy cattle used in the estimates

Cattle category	Weight, kg	Weight gain, kg/day
Manure non-dairy cattle[231]:		
…Mature females	500	
…Mature males	600	
Bovine animals (aged between 1 and 2 years)[232]	300	0.70
Calves (6-12 months)[233]	200	0.55

[230] References sources: Estonian Red and Estonian Holstein – (Ling et al., 2012); Estonian Native – (Kalamees, K., 2008).
[231] Dairy Cattle – Table A-1; Non-dairy cattle – Table A-2 of the 1996 Revised IPCC guidelines, pp. 4.42-4.43 (for Eastern European countries). The data correspond to Estonian data on weight of mature cattle.
[232] Bovine animals – (Juhend, 2008).

Cattle category	Weight, kg	Weight gain, kg/day
Calves (0-6 months) [234]	40	0.90

Table A.3.3_III.3. Data on weight of main swine categories used in the estimates

Swine category	Weight, kg
Piglets, live weight less than 20 kg	10
Young pigs, live weight 20–<50 kg	35
Fattening pigs	
…live weight 50–<80 kg	65
…live weight 80–<110 kg	95
…live weight 110 kg or more	110
Breeding pigs, live weight 50 kg or more	75

[233] Calves (6-12 months) – the start weight was calculated based on the final weight of calves (0-6 months) and their weight gain. The weigh gain of calves (6-12 months) was estimated taking into account the start weigh of mature cattle. Production cycle at 183 days per year was applied.

[234] Calves (0-6 months): the start weigh and weight gain were obtain from (Lehtsalu et al., 2010). Production cycle at 182 days per year was applied.

APPENDIX A.3.3_IV. MANURE MANAGEMENT SYSTEMS

Manure management systems: cattle and swine livestock categories

Country-specific module on manure management system (MMS) was started to be developed in the 2012 submission and was finalized by the 2013 submission.

Data on cattle and swine livestock population, housing technology and data on location of MMS were used as a basis for development of the MMS module. The data on livestock population and MMS location were collected by SE in the framework of Agricultural Survey of 2001 and 2010. The both databases contain data on village level. Actually, village was a basis for merging of two datasets. Since, it was adjusted that type of MMS built and located in a certain village is a main type of storage for manure generated by livestock kept in this village. In addition, information presented in the environmental permits, which were applied by farms under the IPPC directive (Saastuse komplekse..., 2011), was consulted to determine type of MMS built for storage animal waste and housing technology applied in a certain agricultural holdings. Data due to a project launched by Ministry of the Environment (ELLE, 2010) to monitor conditions of MMSs located on nitrate vulnerable zones were consulted as well.

The country-specific MMS module for 1990 has been developed based on statistical data on livestock population and structure by country of Estonia and expert opinions regarding housing technology applied for cattle and swine.

The interpolation was applied between 1990 and 2001, and between 2001 and 2010 to develop country-specific module on MMS for cattle and swine for the entire inventory period.

<u>1990</u>: to develop the module on MMS, data on size and number of cattle and swine breeding holdings were used from the annual statistical report (Eesti…, 1991).

In general, a major number of holdings, which kept cattle and swine, were large in the beginning of ninetieth: about 90% of the total number of farms were with more than 1000 heads of cattle and swine (Table A.3.3_IV.1). High number of animals per swine farm, in greater degree, stipulated housing technology occurred in holdings – mostly partially or completely slatted floors, with liquid/slurry MMS, was applied (Table A.3.3_IV.4). With exception of a low number of swine, which kept in private farms, where mainly solid storage MMS was applied in Estonia.

Table A.3.3_IV.1. Structure of cattle and swine breeding farms by size and herd in 1989 (Eesti…, 1991)

Number of livestock	Collective farms/holdings		State farms/holdings	
	Cattle	Swine	Cattle	Swine
< 600	1.6	4.1	3.3	7.8
600–999	4.7	9.2	4.0	3.5
1000–3000	77.0	35.7	74.6	53.5
> 3000	16.7	51.1	18.1	35.1

In 1990, mainly (only) tie stall housing system occurred in dairy-cattle and non-dairy cattle (including young animals) holdings. The housing technology assumes generation and storage of solid manure. It means that in the beginning of the nineties, mainly solid storage MMS was applied in cattle breeding holdings. The housing technology applied in dairy cattle as well non-dairy cattle breeding holdings has started to be changed in the beginning of 2000-ties – in 2002, the first farm with loose-housing technology was built up in Jõgeva county. The technology of young cattle housing has started to change also in that time, the changes from tie stall technology to loose-technology with slatted floor and deep litter, namely from solid storage MMS to liquid/slurry MMS or Deep Litter MMS (in accordance, with the definitions established in the IPCC) have started to be launched.

It was assumed that the housing technology of calves has not changed since 1990 until nowadays. Hence, in the nineties, calves (0-6 months) were kept in groups or individual boxes with solid storage MMS.

2001: more than 30,500 holdings with different size of livestock herds and about 1,700 holdings with different types of MMS were analyzed. The large difference in numbers of holdings keeping livestock and those, which have MMS, is explained by size of livestock herds. In Estonia, holdings with less than 10 livestock units are not under obligatory to build MMS for animal waste storage (Veeseadus, 2011), usually these holdings storage animal waste in cattle-shed or pigsty, in manure-heap, truck etc. i.e., there is typical for these farms to store animal waste in 'solid storage MMS' (according to the classification established under the IPCC[235]).

In general, a share of holdings that kept less than 10 cattle heads was 86% of the total number of agricultural holdings in 2001, the holdings kept about 18% of the total population of cattle of Estonia. A share of small holdings keeping less than 10 heads[236] of dairy cows was 93% of the total agricultural holdings with dairy cattle, these holdings kept about 24% of the total population of 2001 (Tables A.3.3.IV.2 – A.3.3.IV.4). The total number of large holdings was more than 1% (246 holdings in total) from the total number of cattle breeding farms, which kept about 60% of the total cattle population in Estonia. The main research focus was paid on these large holdings.

As it was mentioned, the cattle housing technology occurred in holdings has started to be changed in the beginning of 2000-ties – from tie stall housing to loose-housing technology and from solid storage MMS to liquid/slurry MMS. Hence, this information was also kept in mind, in the process of analyzing of two datasets on cattle population and MMS location.

Table A.3.3_IV.2. Cattle breeding by size of herd in 2001–2010 (SE, 2012)

		total	1–9	10–49	50–99	100–299	>=300
Number of holdings	2001	20 281	17 443	2 239	229	184	186
	2010	4 620	2 779	1 121	469	223	191
Number of cows	2001	280 884	50 316	42 472	15 472	33 128	139 496
	2010	241 025	8 981	25 811	21 316	37 198	147 719

Table A.3.3_IV.3. Dairy cattle breeding by size of herd in 2001–2010 (SE, 2012)

		total	1–9	10–49	50–99	100–299	>=300
Number of holdings	2001	17 527	16 254	920	104	173	76
	2003	12 398	11 220	834	97	166	81
	2005	9 210	8 082	771	112	159	86

235 IPCC 1997. Agriculture. Reference Manual. Table 4-8, pp. 4.25.
236 1 dairy cow = 1 livestock unit (Põllumajandusministri määrus nr 130, 12.12.2009).

		total	1–9	10–49	50–99	100–299	>=300
	2007	6 120	5 067	686	132	144	91
	2010	3 520	2 598	580	124	129	89
Number of dairy cows	2001	127 969	31 042	16 834	7 352	30 761	41 980
	2003	119 805	20 646	16 309	6 766	30 587	45 497
	2005	115 229	14 876	15 222	7 280	28 602	49 249
	2007	107 884	9 686	13 394	8 650	26 089	50 065
	2010	96 263	5 297	10 827	7 267	22 321	50 551

A share of holdings kept less than 50 pigs (about 10 livestock unit) was 98% of the total number of holdings keeping pigs. The population of pigs in these swine holdings made up 13% of the total pig population in Estonia in 2001. The swine population in large holdings (more than 1000 pigs) was more than 73% of the total swine population, the contribution of large farms to the total number of the swine holdings was less than 1% from the total number. In fact, these holdings were analyzed in detail.

Swine housing technology, and MMS applied in farms, in greater degree, depends on swine herd size – namely, liquid/slurry MMS mainly in large holdings, solid storage MMS – in holdings with low number of pigs. It is important to note that structure of swine population by size of herd has changed remarkably from the nineties (Table A.3.3_IV.1 and Table A.3.3_IV.4), hence the changes occurred also in MMS applied from swine manure storage.

Table A.3.3_IV.4. Swine breeding by size of herd (SE, 2012)

		total	1–9	10–49[237]	50–199	200–1000	1000–1999	>=2000
Number of holdings	2001	11 791	10 822	730	103	74	31	31
	2003	7 675	6 901	551	88	68	30	37
	2005	4 708	4 188	350	49	58	20	43
	2007	2 889	2 540	211	34	39	25	40
	2010	1 549	1 294	149	27	23	11	45
Number of swine	2001	328 920	26 782	13 763	9 791	39 812	45 984	192 788
	2003	356 898	17 170	11 255	8 479	34 854	42 098	243 042
	2005	355 242	10 760	7 072	5 011	28 951	27 062	276 386
	2007	369 734	6 825	3 878	2 910	21 582	37 361	297 178
	2010	388 502	3 504	2 865	2 529	9 443	15 610	354 551

2010: more than 5 800 holdings with different size of livestock herds and about 2 800 holdings with MMSs were analyzed in the framework of development of country-specific module on MMS in 2010. The combination of two datasets was made based on village level. Especial attention was paid on large holdings, which contributed a major share to the total cattle and swine population of Estonia: on cattle breeding holdings with more than 100 cattle heads (more than 70% of the total cattle population) and on swine breeding holdings with more than 200 swine heads (more than 95% of the total swine population).

During the last ten years (since 2001 to 2010), Estonian agriculture has changed markedly. The total number of holdings decreased, the main decline was in the number of holdings, which keep

[237] Data of the table were used from web-based dataset of SE. Therefore, an average conversion factor (at 0.2 swine heads = 1 livestock unit (Põllumajandusministri määrus nr 130, 12.12.2009)) to number of livestock unit was used for pigs. However, more detailed data (based on pig categories) were used in the analysis, these data are confidential.

1–9 heads of swine or cattle. However, number of swine and cattle population and the number of large holdings has increased during the last ten years (Tables A.3.3_IV.2.–A.3.3_IV.4).

As it was mentioned several times, the changes in cattle housing technology has started to be implemented in the beginning of 2000-ties and since then, the technology has been applied very intensively during the last ten years. If, in 2002 was only one farm (in Jõgeva county) with loose-housing technology occurred, then by 2011 – about 150 holdings with cattle have been implemented loose-housing technology. Hence, share of liquid/slurry MMS for dairy cattle has markedly increased since 2002 by 2010. The changes in the housing technology were occurred also in bovine and young cattle keeping – from tie stall to loose-housing with slatted floor or with deep litter.

For mature non-dairy cattle, it was assumed that the technology of cattle housing has not changed sine the nineties, and until nowadays tie stall technology is applied for mature non-dairy cattle, which stipulates solid storage MMS. The housing technology has not changed for calves (0-6 months) as well, which are(were) kept in group or individual boxes with solid storage MMS.

In the context of swine MMS development, also additional information regarding organic livestock farming was taken into account. The organic farming has started to be developed in the mid of 2000ties in Estonia. The farming stipulates pasture of swine livestock. Data of Agricultural Board were used to evaluate share of manure left on pasture by pigs.

In addition, in 2006, the first pig-slurry based biogas production was launched, which uses swine slurry and operates until nowadays. The plant is located in Saare county. Swine liquid/slurry generated and used in the facility was defined as liquid/slurry in the inventory report. However, the emissions from biogas treated manure were calculated separately from the emissions occurred in swine liquid/slurry storage, the experience of Danish colleagues were used in the estimations (Danish NIR, 2011).

To specify grazing period of cattle and quantity of manure generated on pasture, the average pasture-period was used from (Taustauuring, 2009). The ratios of agricultural holdings, which graze cattle, were taken from the same study. The results of the study illustrated that a share of dairy and non-dairy cattle population, which is depastured, depends on size of herd. For example, agricultural holdings, which keep less than 20 dairy cattle, all depasture cattle; however, only 89% from the total cattle holding, with herd population at 200–400 heads of dairy cattle, depasture cattle livestock. Swine holdings do not have practice to graze swine livestock in Estonia.

Table A.3.3_IV.5. Ratio of agricultural holding, which depasture cattle livestock, by size of cattle herds (Taustauuring, 2009)

Cattle herd size	Agricultural holding, which keep…		
	Dairy cows	Mature cattle	Young cattle
less than 20 cattle	100	100	97
20…99 cattle	89	79	89
101…199 cattle	96	92	96
200…399 cattle	89	56	89
more than 400 cattle	95	86	94

Table A.3.3_IV.6. Number of grazing days by category of livestock

Livestock category	Number of grazing days	Reference
Cattle	160	Taustauuring, 2009, p. 35
Sheep	180	Taustauuring, 2009, p. 32
Goats	180	Taustauuring, 2009, p. 32
Horses	150	Taustauuring, 2009, p. 33

To sum up, the module on MMS was developed for each county of Estonia based on data of 1990, 2003 and 2010. The data will be interpolated between 1990th and 2000, and between 2000 and 2010. The results of the investigations performed are presented below, in Tables A.3.3_IV.7 – A.3.3_IV.16.

Country-specific manure management systems of Dairy cattle

Table A.3.3_IV.7. Share of Liquid/Slurry MMS in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2003	5.6	0.0	0.0	8.0	16.3	0.0	9.5	18.6	8.1	4.9	2.0	7.3	7.3	5.2	0.0
2004	6.9	0.0	2.5	9.3	17.2	1.9	12.2	20.5	11.9	8.3	3.9	12.5	9.6	7.8	1.7
2005	8.2	0.0	5.0	10.6	18.1	3.8	15.0	22.4	15.7	11.8	5.9	17.7	11.9	10.3	3.4
2006	9.5	0.0	7.6	12.0	19.0	5.7	17.7	24.3	19.6	15.2	7.8	22.8	14.2	12.9	5.2
2007	10.7	0.0	10.1	13.3	19.9	7.6	20.5	26.3	23.4	18.7	9.7	28.0	16.5	15.4	6.9
2008	12.0	0.0	12.6	14.7	20.9	9.5	23.2	28.2	27.3	22.1	11.6	33.2	18.8	18.0	8.6
2009	13.3	0.0	15.1	16.0	21.8	11.4	26.0	30.1	31.1	25.6	13.6	38.4	21.2	20.5	10.3
2010	14.6	0.0	17.7	17.4	22.7	13.3	28.7	32.0	34.9	29.0	15.5	43.5	23.5	23.1	12.1
2011	14.6	0.0	17.7	17.4	22.7	13.3	28.7	32.0	34.9	29.0	15.5	43.5	23.5	23.1	12.1

Table A.3.3_IV.8. Share of Solid Storage MMS in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1991	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1992	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1993	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1994	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1995	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1996	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1997	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1998	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1999	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
2000	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
2001	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
2002	56.2	56.2	56.2	54.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
2003	52.0	56.2	56.2	50.0	44.5	56.8	50.0	45.7	51.0	53.4	54.2	48.8	49.6	53.2	57.0
2004	51.1	56.2	54.1	48.8	43.4	55.7	47.7	43.2	48.0	50.2	52.7	44.0	47.3	51.0	55.3
2005	50.3	56.2	52.0	47.7	42.3	54.5	45.4	40.7	45.0	46.9	51.1	39.2	45.0	48.7	53.7
2006	49.4	56.2	50.0	46.5	41.1	53.3	43.1	38.1	42.0	43.7	49.6	34.5	42.7	46.5	52.0
2007	48.5	56.2	47.9	45.4	40.0	52.1	40.7	35.6	39.0	40.5	48.1	29.7	40.4	44.2	50.4
2008	47.6	56.2	45.8	44.2	38.8	50.9	38.4	33.1	36.0	37.2	46.6	24.9	38.1	42.0	48.7
2009	46.7	56.2	43.7	43.1	37.7	49.7	36.1	30.5	33.1	34.0	45.1	20.1	35.8	39.7	47.1
2010	45.9	56.2	41.7	42.0	36.6	48.6	33.8	28.0	30.1	30.8	43.6	15.3	33.5	37.5	45.4
2011	45.9	56.2	41.7	42.0	36.6	48.6	33.8	28.0	30.1	30.8	43.6	15.3	33.5	37.5	45.4

Table A.3.3_IV.9. Share of Pasture, Range and Paddock in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1991	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1992	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1993	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1994	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1995	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1996	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1997	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1998	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1999	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
2000	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
2001	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
2002	43.8	43.8	43.8	41.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
2003	42.6	43.8	43.8	42.1	39.2	43.2	40.5	35.7	41.0	41.7	43.8	43.8	43.1	41.5	43.0
2004	42.1	43.8	43.4	41.9	39.4	42.4	40.1	36.3	40.1	41.5	43.4	43.5	43.1	41.2	43.0
2005	41.7	43.8	42.9	41.7	39.6	41.7	39.7	36.9	39.3	41.3	43.0	43.1	43.1	40.9	42.9
2006	41.3	43.8	42.5	41.5	39.9	41.0	39.2	37.5	38.4	41.0	42.6	42.7	43.1	40.6	42.8
2007	40.9	43.8	42.0	41.3	40.1	40.3	38.8	38.1	37.6	40.8	42.2	42.3	43.1	40.3	42.7
2008	40.4	43.8	41.6	41.1	40.3	39.5	38.4	38.8	36.7	40.6	41.8	41.9	43.1	40.0	42.7
2009	40.0	43.8	41.1	40.9	40.5	38.8	37.9	39.4	35.8	40.4	41.3	41.6	43.1	39.7	42.6
2010	39.6	43.8	40.7	40.7	40.7	38.1	37.5	40.0	35.0	40.2	40.9	41.2	43.1	39.4	42.5
2011	39.6	43.8	40.7	40.7	40.7	38.1	37.5	40.0	35.0	40.2	40.9	41.2	43.1	39.4	42.5

Country-specific manure management systems of Bovine cattle (young cattle in the CRF reporter)

Table A.3.3_IV.10. Share of Solid Storage MMS in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1991	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1992	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1993	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1994	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1995	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1996	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1997	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1998	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
1999	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
2000	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
2001	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
2002	56.2	56.2	56.2	52.3	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
2003	52.8	56.2	56.2	46.6	46.6	56.3	50.7	47.7	50.8	54.4	54.0	49.1	47.9	53.8	56.2
2004	52.2	56.2	56.2	45.1	45.3	55.5	49.9	44.6	49.3	52.2	53.9	45.0	47.0	53.6	56.4
2005	51.7	56.2	56.3	43.5	43.9	54.7	49.1	41.6	47.7	49.9	53.8	40.9	46.0	53.4	56.6
2006	51.2	56.2	56.4	42.0	42.5	54.0	48.3	38.6	46.2	47.7	53.7	36.8	45.0	53.2	56.8
2007	50.7	56.2	56.5	40.5	41.2	53.2	47.5	35.6	44.7	45.4	53.6	32.7	44.1	52.9	57.1
2008	50.2	56.2	56.6	38.9	39.8	52.4	46.7	32.6	43.2	43.2	53.5	28.6	43.1	52.7	57.3
2009	49.7	56.2	56.6	37.4	38.4	51.6	45.9	29.6	41.6	40.9	53.4	24.5	42.2	52.5	57.5
2010	49.2	56.2	56.7	35.9	37.1	50.8	45.1	26.6	40.1	38.6	53.2	20.4	41.2	52.3	57.7
2011	49.2	56.2	56.7	35.9	37.1	50.8	45.1	26.6	40.1	38.6	53.2	20.4	41.2	52.3	57.7

Table A.3.3_IV.11. Share of Liquid/Slurry MMS in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2003	0.7	0.0	0.0	1.9	1.9	0.0	1.7	1.7	1.1	0.3	0.4	1.4	1.6	0.5	0.0
2004	1.8	0.0	0.3	2.3	3.0	0.0	1.7	3.3	2.7	0.3	0.6	3.1	1.4	0.5	0.0
2005	2.8	0.0	0.6	2.7	4.1	0.0	1.7	4.9	4.4	0.2	0.8	4.7	1.2	0.4	0.0
2006	3.9	0.0	1.0	3.1	5.2	0.0	1.6	6.6	6.0	0.2	1.0	6.4	0.9	0.4	0.0
2007	4.9	0.0	1.3	3.5	6.4	0.0	1.6	8.2	7.7	0.1	1.2	8.0	0.7	0.4	0.0
2008	6.0	0.0	1.6	3.9	7.5	0.0	1.6	9.8	9.3	0.1	1.4	9.7	0.5	0.4	0.0
2009	7.1	0.0	1.9	4.3	8.6	0.0	1.5	11.4	11.0	0.0	1.6	11.4	0.2	0.4	0.0
2010	8.1	0.0	2.2	4.7	9.7	0.0	1.5	13.1	12.6	0.0	1.8	13.0	0.0	0.4	0.0
2011	8.1	0.0	2.2	4.7	9.7	0.0	1.5	13.1	12.6	0.0	1.8	13.0	0.0	0.4	0.0

Table A.3.3_IV.12. Share of Deep litter MMS in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1998	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2003	2.8	0.0	0.0	7.7	7.6	0.0	6.9	6.8	4.3	1.4	1.7	5.7	6.6	1.9	0.0
2004	3.7	0.0	0.7	9.3	8.5	1.7	8.4	8.8	5.5	4.3	2.6	9.1	8.0	3.2	0.1
2005	4.7	0.0	1.5	10.9	9.4	3.5	10.0	10.9	6.7	7.2	3.4	12.5	9.4	4.5	0.2
2006	5.7	0.0	2.2	12.5	10.3	5.2	11.5	12.9	7.9	10.1	4.2	16.0	10.7	5.9	0.4
2007	6.7	0.0	3.0	14.1	11.2	7.0	13.0	14.9	9.2	13.0	5.0	19.4	12.1	7.2	0.5
2008	7.6	0.0	3.7	15.7	12.1	8.7	14.6	16.9	10.4	15.8	5.8	22.9	13.5	8.5	0.6
2009	8.6	0.0	4.4	17.3	13.0	10.5	16.1	19.0	11.6	18.7	6.6	26.3	14.9	9.8	0.7
2010	9.6	0.0	5.2	18.9	13.9	12.2	17.6	21.0	12.8	21.6	7.5	29.8	16.3	11.1	0.9
2011	9.6	0.0	5.2	18.9	13.9	12.2	17.6	21.0	12.8	21.6	7.5	29.8	16.3	11.1	0.9

Table A.3.3_IV.13. Share of Pasture, Range and Paddock in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1991	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1992	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1993	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1994	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1995	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1996	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1997	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1998	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
1999	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
2000	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
2001	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
2002	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
2003	43.9	43.8	43.8	43.8	43.8	43.7	40.7	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
2004	42.3	43.8	42.7	43.4	43.2	42.7	40.0	43.2	42.5	43.2	42.9	42.8	43.6	42.7	43.5
2005	40.8	43.8	41.6	42.9	42.5	41.8	39.3	42.6	41.2	42.7	42.0	41.8	43.5	41.7	43.1
2006	39.3	43.8	40.4	42.4	41.9	40.8	38.6	41.9	39.8	42.1	41.1	40.8	43.3	40.6	42.8
2007	37.7	43.8	39.3	41.9	41.3	39.9	37.9	41.3	38.5	41.5	40.2	39.8	43.1	39.5	42.4
2008	36.2	43.8	38.2	41.4	40.6	38.9	37.2	40.7	37.1	40.9	39.3	38.8	42.9	38.4	42.1
2009	34.6	43.8	37.0	41.0	40.0	37.9	36.5	40.0	35.8	40.3	38.4	37.8	42.7	37.3	41.8
2010	33.1	43.8	35.9	40.5	39.3	37.0	35.8	39.4	34.5	39.7	37.5	36.8	42.5	36.2	41.4
2011	33.1	43.8	35.9	40.5	39.3	37.0	35.8	39.4	34.5	39.7	37.5	36.8	42.5	36.2	41.4

Country-specific manure management systems of Swine livestock

Table A.3.3_IV.14. Share of Solid Storage MMS in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990	12.4	11.6	11.4	11.0	10.8	13.3	13.7	12.0	10.6	15.2	14.0	11.2	14.3	11.9	18.7
1991	13.5	14.1	16.1	12.9	11.4	15.6	15.5	19.5	12.2	17.0	14.4	13.5	21.2	12.5	25.6
1992	14.6	16.6	20.8	14.7	11.9	18.0	17.3	26.9	13.7	18.7	14.9	15.8	28.0	13.1	32.4
1993	15.7	19.1	25.5	16.5	12.5	20.3	19.0	34.3	15.3	20.4	15.4	18.2	34.8	13.7	39.3
1994	16.7	21.6	30.1	18.3	13.0	22.7	20.8	41.7	16.8	22.2	15.9	20.5	41.6	14.3	46.1
1995	17.0	32.8	30.4	19.6	15.1	22.6	19.7	41.3	22.7	21.0	16.1	22.7	45.2	13.4	48.2
1996	17.3	44.0	30.6	20.9	17.2	22.6	18.5	40.9	28.7	19.8	16.4	25.0	48.8	12.5	50.3
1997	17.7	55.2	30.9	22.2	19.3	22.6	17.3	40.5	34.6	18.6	16.7	27.2	52.3	11.7	52.4
1998	18.0	66.4	31.1	23.5	21.4	22.6	16.2	40.0	40.5	17.4	16.9	29.4	55.9	10.8	54.5
1999	18.3	77.6	31.4	24.8	23.5	22.6	15.0	39.6	46.4	16.2	17.2	31.7	59.5	10.0	56.6
2000	18.6	88.8	31.6	26.1	25.6	22.6	13.8	39.2	52.3	15.1	17.5	33.9	63.1	9.1	58.6
2001	18.9	100.0	31.9	27.6	27.3	22.6	12.7	58.3	38.8	13.9	13.1	36.1	66.6	8.3	60.7
2002	17.0	100.0	32.8	31.6	26.0	31.2	14.9	58.8	36.8	12.7	9.7	36.4	67.7	7.6	65.0
2003	15.1	100.0	33.8	35.6	24.6	39.8	17.2	59.3	34.8	11.4	6.4	36.6	68.7	6.9	69.4
2004	13.1	100.0	34.7	39.6	23.2	48.4	19.5	59.8	32.8	10.2	5.8	36.8	69.7	6.2	73.7
2005	11.2	100.0	35.7	43.6	21.9	57.0	21.7	60.4	30.8	9.0	5.2	37.0	70.7	5.5	78.0
2006	9.3	100.0	36.7	47.6	20.5	65.6	24.0	60.9	28.7	7.8	4.5	37.3	71.7	4.7	82.4
2007	7.3	100.0	37.6	51.6	19.1	74.2	26.3	61.4	26.7	6.6	3.9	37.5	72.7	4.0	86.7
2008	5.4	100.0	38.6	55.6	17.7	82.8	28.5	61.9	24.7	5.4	3.3	37.7	73.7	3.3	91.0
2009	3.4	99.9	39.5	59.5	16.3	91.3	30.7	62.4	22.6	4.1	2.6	37.8	74.6	2.5	95.3
2010	1.3	99.7	40.2	63.3	14.7	99.7	32.8	62.7	20.4	2.7	1.4	37.9	75.4	1.6	99.4
2011	1.3	99.7	40.2	63.3	14.7	99.7	32.8	62.7	20.4	2.7	1.4	37.9	75.4	1.6	99.4

Table A.3.3_IV.15. Share of Liquid/Slurry MMS in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990	87.6	88.4	88.6	89.0	89.2	86.7	86.3	88.0	89.4	84.8	86.0	88.8	85.7	88.1	81.3
1991	86.5	85.9	83.9	87.1	88.6	84.4	84.5	80.5	87.8	83.0	85.6	86.5	78.8	87.5	74.4
1992	85.4	83.4	79.2	85.3	88.1	82.0	82.7	73.1	86.3	81.3	85.1	84.2	72.0	86.9	67.6
1993	84.3	80.9	74.5	83.5	87.5	79.7	81.0	65.7	84.7	79.6	84.6	81.8	65.2	86.3	60.7
1994	83.3	78.4	69.9	81.7	87.0	77.3	79.2	58.3	83.2	77.8	84.1	79.5	58.4	85.7	53.9
1995	83.0	67.2	69.6	80.4	84.9	77.4	80.3	58.7	77.3	79.0	83.9	77.3	54.8	86.6	51.8
1996	82.7	56.0	69.4	79.1	82.8	77.4	81.5	59.1	71.3	80.2	83.6	75.0	51.2	87.5	49.7
1997	82.3	44.8	69.1	77.8	80.7	77.4	82.7	59.5	65.4	81.4	83.3	72.8	47.7	88.3	47.6
1998	82.0	33.6	68.9	76.5	78.6	77.4	83.8	60.0	59.5	82.6	83.1	70.6	44.1	89.2	45.5
1999	81.7	22.4	68.6	75.2	76.5	77.4	85.0	60.4	53.6	83.8	82.8	68.3	40.5	90.0	43.4
2000	81.4	11.2	68.4	73.9	74.4	77.4	86.2	60.8	47.7	84.9	82.5	66.1	36.9	90.9	41.4
2001	81.1	0.0	68.1	72.4	72.7	77.4	87.3	41.7	61.2	86.1	86.9	63.9	33.4	91.7	39.3
2002	83.0	0.0	67.2	68.4	74.0	68.8	85.1	41.2	63.2	87.3	90.3	63.6	32.3	92.4	35.0
2003	84.9	0.0	66.2	64.4	75.4	60.2	82.8	40.7	65.2	88.6	93.6	63.4	31.3	93.1	30.6
2004	86.9	0.0	65.3	60.4	76.8	51.6	80.5	40.2	67.2	89.8	94.2	63.2	30.3	93.8	26.3
2005	88.8	0.0	64.3	56.4	78.1	43.0	78.3	39.6	69.2	91.0	94.8	63.0	29.3	94.5	22.0
2006	90.7	0.0	63.3	52.4	79.5	34.4	76.0	39.1	71.3	92.2	95.5	62.7	28.3	95.3	17.6
2007	92.6	0.0	62.4	48.4	80.9	25.8	73.7	38.6	73.3	93.4	96.1	62.5	27.3	96.0	13.3
2008	94.6	0.0	61.4	44.4	82.2	17.2	71.5	38.1	75.3	94.6	96.7	62.3	26.3	96.7	9.0
2009	96.5	0.0	60.4	40.4	83.6	8.6	69.2	37.5	77.3	95.8	97.3	62.1	25.3	97.4	4.6
2010	98.4	0.0	59.5	36.4	85.0	0.0	66.9	37.0	79.3	97.0	98.3	61.8	24.3	98.1	0.3
2011	98.4	0.0	59.5	36.4	85.0	0.0	66.9	37.0	79.3	97.0	98.3	61.8	24.3	98.1	0.3

Table A.3.3_IV.16. Share of Pasture, Range and Paddock in 1990–2011 by county, %

	Harju	Hiiu	Ida-Viru	Jõgeva	Järva	Lääne	Lääne-Viru	Põlva	Pärnu	Rapla	Saare	Tartu	Valga	Viljandi	Võru
1990															
1991															
1992															
1993															
1994															
1995															
1996															
1997															
1998															
1999															
2000															
2001															
2002															
2003															
2004															
2005															
2006															
2007	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
2008	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
2009	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
2010	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
2011	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30

Manure management systems: poultry

The module on MMS for poultry manure storage was developed based on data on poultry population kept by legal and in private agricultural holdings (Table A.3.3._IV.17).

According to the information presented in the environmental permits, which were submitted by large poultry holdings to the Environmental Board, the holdings use 'solid storage MMS' for all amount of waste generated by poultry. Manure, generated by poultry kept by private holdings (farms), is stored in 'solid storage MMS'. However, in addition, in private holdings, in the summer time during solar time, poultry are kept outside of hen-house, which could be classified as 'pasture' MMS (Table A.3.3._IV.18).

Table A.3.3_IV.17. Poultry population in agricultural holdings by form in Estonia in 1990–2010, 1000 heads (SE, 2012)

year	Total population	…incl. in private holdings
1990	6 537	1 170
2001	2 214	479
2003	2 276	328
2005	2 132	296
2007	1 719	147
2010	1 941	139

Table A.3.3_IV.18. Country-specific MMS of poultry in 1990–2010, %

year	Solid storage	Pasture
1990	96.7	3.3
1991	96.6	3.4
1992	96.6	3.4
1993	96.5	3.5
1994	96.5	3.5
1995	96.4	3.6
1996	96.4	3.6
1997	96.3	3.7
1998	96.3	3.7
1999	96.2	3.8
2000	96.2	3.8
2001	96.1	3.9
2002	96.7	3.3
2003	97.2	2.8
2004	97.3	2.7
2005	97.3	2.7
2006	97.8	2.2
2007	98.3	1.7
2008	98.4	1.6
2009	98.4	1.6
2010	98.5	1.5

APPENDIX A.3.3_V. NITROGEN EXCRETION RATES

Table A.3.3_V.1. Nitrogen content of feed, % (Kaasik et al., 2002)

Cattle category	Nitrogen content of feed, %
Dairy cattle	2.4
Mature females	1.6
Mature males	2.3
Bovine animals (aged between 1 and 2 years)	2.3
Calves (0-6 months)	2.3

Table A.3.3_V.2. Content of N in milk, body weight and embryo (Standard Values…, 1997)

	Nitrogen, g/kg
	Dairy cattle
Weight gain	25.6
Embryo	29.6
	Young cattle
Weight gain	29.6

Table A.3.3_V.3. Average protein content of milk in Estonia in 1990–1997, % of mass (EARC, 2011)[238]

Year	Fat content, %
1990	3.22
1991	3.25
1992	3.14
1993	3.11
1994	3.15
1995	3.17
1996	3.20
1997	3.15

[238] Results of animal recording in Estonia in 1997–2011. Annual Reports. Available at: www.jkkeskus.ee/page.php?page=0147.

Table A.3.3_V.4. Protein content of milk in 1998–2011 in Estonia, % in mass (EARC, 2011)

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
The average of Estonia	3.18	3.15	3.28	3.31	3.27	3.30	3.31	3.34	3.35	3.36	3.36	3.37	3.36	3.39
Harju	3.13	3.11	3.25	3.30	3.20	3.22	3.25	3.28	3.28	3.29	3.30	3.32	3.32	3.34
Hiiu	3.21	3.21	3.31	3.30	3.27	3.30	3.29	3.26	3.26	3.26	3.33	3.32	3.30	3.34
Ida-Viru	3.16	3.14	3.29	3.31	3.25	3.25	3.30	3.35	3.39	3.38	3.37	3.38	3.38	3.40
Jõgeva	3.26	3.22	3.36	3.40	3.36	3.39	3.39	3.41	3.41	3.40	3.40	3.41	3.42	3.43
Järva	3.17	3.15	3.26	3.30	3.27	3.31	3.31	3.35	3.34	3.36	3.38	3.37	3.37	3.40
Lääne	3.15	3.10	3.22	3.26	3.20	3.20	3.24	3.24	3.28	3.28	3.30	3.31	3.31	3.31
Lääne-Viru	3.13	3.11	3.22	3.27	3.24	3.25	3.28	3.32	3.36	3.36	3.36	3.34	3.36	3.39
Põlva	3.20	3.19	3.32	3.28	3.32	3.33	3.34	3.34	3.35	3.34	3.34	3.36	3.32	3.39
Pärnu	3.14	3.12	3.26	3.28	3.22	3.26	3.29	3.33	3.33	3.33	3.34	3.34	3.33	3.38
Rapla	3.16	3.12	3.26	3.27	3.25	3.26	3.30	3.30	3.29	3.31	3.32	3.33	3.34	3.36
Saare	3.27	3.24	3.34	3.39	3.36	3.36	3.38	3.38	3.39	3.38	3.40	3.41	3.39	3.39
Tartu	3.18	3.16	3.31	3.34	3.32	3.36	3.37	3.38	3.39	3.39	3.37	3.38	3.39	3.42
Valga	3.14	3.11	3.25	3.29	3.24	3.29	3.32	3.37	3.40	3.41	3.42	3.43	3.44	3.43
Viljandi	3.22	3.17	3.31	3.33	3.29	3.31	3.31	3.34	3.38	3.38	3.38	3.38	3.36	3.39
Võru	3.14	3.12	3.24	3.26	3.23	3.26	3.23	3.29	3.32	3.32	3.34	3.36	3.35	3.42

APPENDIX A.3.3_VI. SYNTHETIC FERTILIZERS APPLIED ON AGRICULTURAL SOILS IN ESTONIAN IN 1990–2011

Table A.3.3_VI.1. Amounts of synthetic fertilizers applied on agricultural soils, tonnes (SE, 2011)

Year	Use of mineral fertilizers (nitrogen) for..						Total
	cereals	industrial crops	potatoes	forage crops	open-field vegetables	orchards and greenhouses	
1990	28 882	108	1 739	40 990	218	102	72 039
1991	30 510	105	1 680	37 091	283	155	69 824
1992	26 257	217	3 028	26 882	607	1 369	58 360
1993	13 168	146	1 457	14 667	323	188	29 949
1994	10 870	216	1 262	13 167	234	319	26 068
1995	9 830	542	300	7 667	333	233	18 905
1996	9 605	443	561	5 775	28	148	16 560
1997	13 053	400	545	6 213	73	187	20 471
1998	15 198	858	565	8 008	172	131	24 932
1999	12 255	1 397	481	5 551	80	131	19 895
2000	14 589	1 655	577	5 373	85	117	22 396
2001	12 023	1 703	507	5 178	107	85	19 603
2002	10 056	1 629	190	4 502	68	255	16 700
2003	14 332	4 146	261	4 260	123	133	23 255
2004	15 262	4 257	488	4 424	223	179	24 833
2005	11 108	2 045	357	6 288	122	163	20 083
2006	13 078	3 320	473	5 304	157	278	22 610
2007	14 069	3 928	455	6 217	147	166	24 982
2008	22 049	7 639	228	5 316	160	63	35 455
2009	16 517	7 516	302	2 702	238	53	27 328
2010	16 200	7 169	454	4 449	257	97	28 626
2011	17 321	7 741	313	4 214	158	56	29 803

APPENDIX A.3.3_VII. PRODUCTION OF CROPS IN ESTONIA IN 1990–2011

Table A.3.3_VII.1. Production of field crops in 1990–2011, 1000 tonnes (SE, 2011)

Year	Cereals	Legumes	Flax stalks	Oil flacks seed	Sugar beet	Rape seed	Vegetables and greens	...green peas	Potatoes	Forage roots
1990	957.3	0.2	1.9	..	0	1.1	105	0	618.1	534.8
1991	939.2	0.2	0	..	0.6	1.1	120.5	0	592.1	493.8
1992	598.1	0.4	0	..	3	2.3	78.4	0	669.1	176.8
1993	810.7	0.7	0	..	2.6	1.7	70	0	538.6	198.5
1994	510.4	1.1	0.3	..	10.6	2.2	78	0.2	563	216.3
1995	513.5	6.3	0.2	..	12.7	7	56.8	0.1	537.4	240.8
1996	629.2	13.8	0.2	..	2.4	10	54.7	0.1	500.2	180.8
1997	650.5	17	0.1	..	0.5	9.6	52.3	0.1	437.5	146.8
1998	576.2	8.3	0	..	0	17.9	50.2	0.1	316.7	96.7
1999	401.6	3.1	0.1	..	0	29.8	44.7	0.1	403.7	58.4
2000	696.6	6.6	0.1	0.1	0	38.6	53.3	0.1	471.7	49.5
2001	558.4	6.5	0.1	0.1	0	41.3	54	0.1	343.1	36.1
2002	524.7	5	0.1	0.1	0	63.9	39.3	0.3	210.9	7.3
2003	505.7	5	0	0.1	0	69.2	57.5	0.1	244.4	7.2
2004	608.1	3.3	0	0.1	0	68.6	53.6	0.2	166.5	6.7
2005	760.1	5.7	0	0.2	0	83.1	62.7	0.1	209.8	3.1
2006	619.3	5.5	0	0.1	0	84.6	61.3	0.2	152.6	2
2007	879.5	9.5	0	0.2	0	133.3	71.6	0.1	191.8	3.4
2008	864.2	3.3	..	0.2	..	111.1	64.5	0.1	125.2	0.4
2009	873.5	7.6	0	0.2	0	136	70.6	0.2	139.1	0.7
2010	678.4	12.6	0	0.2	0	131	73.9	0.1	163.4	0.3
2011	771.6	15.5	0	0.2	0	144.2	88.1	0.1	164.7	0.5

Table A.3.3_VII.2. Sown area of field crops in 1990–2011, 1000 ha (SE, 2011)

Year	Cereals	Legumes	Industrial crops	Open-field vegetables	..green peas	Potatoes	Fodder roots
1990	397	0.1	3.2	5.2	0	45.5	11.1
1991	418.1	0.1	3	5.7	0	52.2	12.3
1992	423.1	0.4	4.7	5.1	0.1	46.3	11.8
1993	375.1	0.4	2.1	4.6	0	42.6	11.4
1994	319.5	0.7	3.6	4.4	0	39.9	12
1995	304.3	3.7	7.3	4.6	0	36.9	10.8
1996	288.8	5.8	9.5	4.2	0	35.3	8.8
1997	326.6	8.7	9	3.9	0	35.2	6.9
1998	354.1	6.4	17.8	4.2	0	32.6	4.7
1999	321	2.9	24.6	3.9	0.1	31.1	3.5
2000	329.3	3.9	29.1	3.8	0	30.9	2.5
2001	274.1	3.7	28.3	3.3	0.1	22.1	1.4
2002	259.2	2.4	33.2	3	0.1	16	0.4
2003	263.2	4.4	46.7	3.4	0.1	17	0.3
2004	261	4.3	50.6	3.5	0.1	16.1	0.2
2005	282.1	4.4	47.1	3	0.1	14	0.2
2006	280.3	4.6	62.9	2.8	0.1	11.5	0.1
2007	292.3	5.7	74.7	2.8	0.1	11.1	0.2
2008	309.3	4.8	78.5	2.4	0.1	8.7	0.1
2009	316.4	4.9	83.4	2.8	0.1	9.1	0.1
2010	275.3	7.3	99.3	2.8	0.1	9.4	0.1
2011							

Table A.3.3_VII.3. Average yields of field crops by field crop in 1990–2010, kg/ha (SE, 2011)

Year	Cereals	Legumes	Flax stalks	Oil flacks seed	Rape seed	Potatoes	Fodder roots
1990	2 411	1 370	950	..	1 780	13 600	48 020
1991	2 247	1 310	2 260	..	991	11 340	40 050
1992	1 414	920	970	..	799	14 450	14 950
1993	2 161	1 550	1 540	..	1 324	12 640	17 350
1994	1 597	1 619	841	..	819	14 096	18 069
1995	1 687	1 711	870	..	1 165	14 559	22 429
1996	2 179	2 398	1 432	..	1 170	14 176	20 651
1997	1 992	1 945	198	..	1 216	12 415	21 333
1998	1 627	1 303	0	..	1 024	9 729	20 297
1999	1 251	1 044	513	..	1 232	12 970	16 489
2000	2 115	1 706	577	267	1 339	15 281	19 596
2001	2 037	1 780	1 180	931	1 499	15 503	25 838
2002	2 024	2 115	1 971	916	1 944	13 160	18 087
2003	1 922	1 131	..	532	1 494	14 393	21 809
2004	2 330	757	..	831	1 362	10 342	30 825
2005	2 694	1 282	..	1 282	1 781	15 028	19 686
2006	2 210	1 198	..	676	1 354	13 261	24 650
2007	3 009	1 668	..	1 169	1 812	17 195	18 934
2008	2 794	691	..	960	1 431	14 315	12 882
2009	2 761	1 547	0	742	1 657	15 275	19 917
2010	2 464	1 713	0	908	1 334	17 456	5 460
2011							

Table A.3.3_VII.3. Production, sown area and yields of clover and alfalfa in 1990–2010 in Estonia (SE, 2011)

Year	Production, 1000 tonnes		Sown area, 1000 ha		Average yields, k/ha	
	Clover (at least >80%)	Alfalfa (at least >80%)	Clover (at least >80%)	Alfalfa (at least >80%)	Clover (at least >80%)	Alfalfa (at least >80%)
1990	*3 034.2*[239]	*253.5*	*224.1*[240]	*19.6*	*13.54*[241]	*12.94*
1991	*3 034.2*	*253.5*	224.1	19.6	*13.54*	*12.94*
1992	*2 920.5*	*227.7*	215.7	17.6	*13.54*	*12.94*
1993	*2 710.7*	*210.8*	200.2	16.3	*13.54*	*12.94*
1994	*1 829.2*	*139.7*	135.1	10.8	*13.54*	*12.94*
1995	*1 589.6*	*122.9*	117.4	9.5	*13.54*	*12.94*
1996	*1 437.9*	*157.8*	106.2	12.2	*13.54*	*12.94*
1997	*1 015.5*	*157.8*	75.0	12.2	*13.54*	*12.94*
1998	*1 600.4*	*165.6*	118.2	12.8	*13.54*	*12.94*
1999	*980.3*	*159.1*	72.4	12.3	*13.54*	*12.94*
2000	*736.6*	*188.9*	54.4	14.6	*13.54*	*12.94*
2001	*649.9*	*106.1*	48.0	8.2	*13.54*	*12.94*
2002	*617.4*	*124.2*	45.6	9.6	*13.54*	*12.94*
2003	*379.1*	*111.2*	28.0	8.6	*13.54*	*12.94*
2004	482.0	143.9	34.5	11.0	13.97	13.08
2005	633.5	176.6	37.7	12.0	16.80	14.72
2006	381.4	139.8	36.2	12.9	10.54	10.84
2007	638.8	165.8	50.8	12.6	12.57	13.16
2008	697.8	181.0	46.8	13.1	14.91	13.82
2009	583.0	142.1	42.5	10.7	13.72	13.28
2010	607.1	128.2	49.5	11.0	12.26	11.65

[239] The production quantities for 1990–2003 were calculated based on the sown areas and the average yields.
[240] The data of 1991.
[241] The yields of 1990–2003 were extrapolated based on the yield values of 2004–2010.

Year	Production, 1000 tonnes		Sown area, 1000 ha		Average yields, k/ha	
	Clover (at least >80%)	Alfalfa (at least >80%)	Clover (at least >80%)	Alfalfa (at least >80%)	Clover (at least >80%)	Alfalfa (at least >80%)
2011	527.4	85.5	40.5	6.1	13.02	14.02

APPENDIX A.3.3_VIII. AVERAGE MONTHLY TEMPERATURE AND PRECIPITATION IN ESTONIA IN 1992–2011

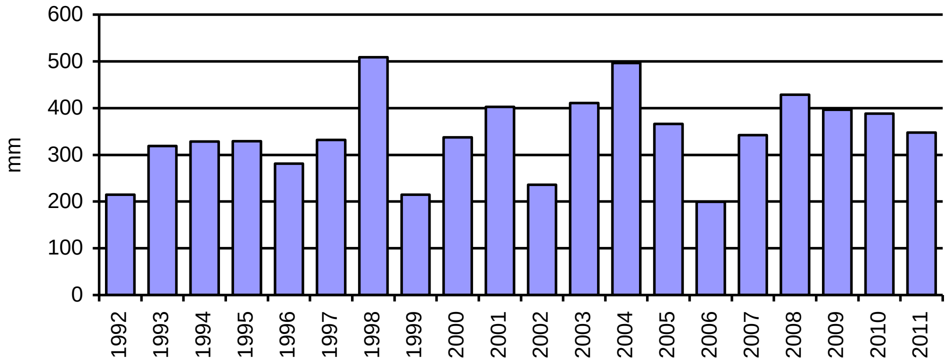

Figure A.3.3_VIII.1. Total precipitation from May to September in Estonia in 1992–2011, mm (SE, 2011)

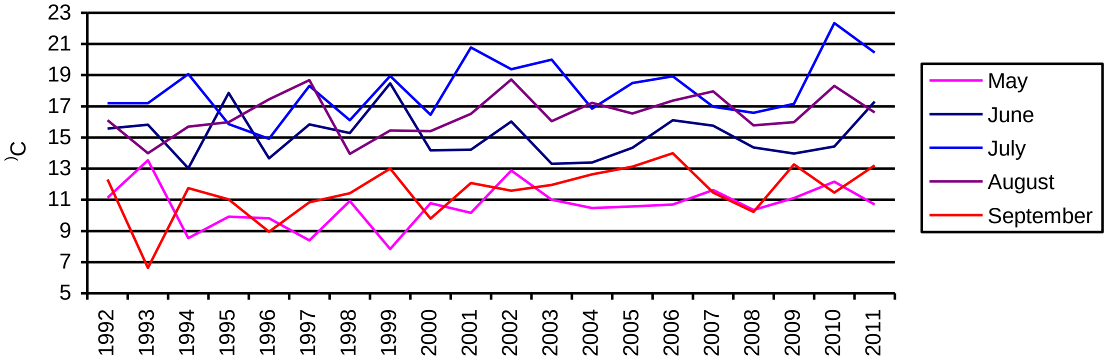

Figure A.3.3_VIII.2. Average monthly temperature in May-September in Estonia in 1992–2011, ^{0}C (SE, 2011)

A.3.4. LULUCF

No additional information.

A.3.5. Waste

No additional information.

A.3.6. KP-LULUCF

No additional information.

Annex 4. CO_2 reference approach and comparison with sectoral approach, and relevant information on the national energy balance

The basis for the Reference Approach calculation in Estonia is data gathered and processed annually by the Statistics Estonia (annual energy balance sheets) since the year 1990. These data are therefore official energy balance data. Reference Approach based on official statistical databases represents top-down data on import, export and stock change balance as published in the Energy Statistics Yearbooks and given in the energy database of the Statistics Estonia home page (www.stat.ee).

In the 2013 inventory, the difference of CO_2 emissions between RA and Sectoral Approach (SA) was 2.23%.

However, differences in solid and liquid fuel consumption between RA and SA are caused by the fact that there is lot of secondary fuels used in final consumption (SA): shale oil, semi coke and oil shale gas – all made from the solid fuel – oil shale.

Information on the CO_2 reference approach, a comparison of that approach with the sectoral approach and relevant information on the national energy balance sheets are given in the NIR chapter 3.2.1 Comparison of the sectoral approach with the reference approach (CRF 1.AB).

Energy Balance 2011 (TJ) updated 05.12.2012

	Coal	Coke **	Oil shale	Milled peat	Sod peat	Peat briquette	Firewood	Wood chips and waste	Wood chips	Wood waste	Briquette and pellets	Briquette	Pellets	Natural gas	Liquefied gas	Heavy fuel oil
In stocks at the beginning of the year	762	78	21 952	851	170	444	183	446	224	222	489	126	363	0	46	362
Production of primary energy	0	0	166 731	2 821	487	0	12 885	18 768	13 359	5 409	6 601	775	5 826	0	0	0
Imports	1 811	10	0	0	0	0	0	0	0	0	0	0	0	21 235	418	6 798
Resources of primary energy	2 573	88	188 683	3 672	657	444	13 068	19 214	13 583	5 631	7 090	901	6 189	21 235	464	7 160
Exports	0	723	0	123	126	1 252	0	0	0	0	5 844	0	5 844	0	0	0
Marine bunkering	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6 809
In stocks at the end of the year	689	47	21 665	693	313	192	221	815	570	245	303	132	171	1	126	298
Supply of primary energy	1 884	-682	167 018	2 856	218	-1 000	12 847	18 399	13 013	5 386	943	769	174	21 234	338	53
Consumption for conversion to other forms of energy	94	0	163 861	2 855	206	17	350	16 187	13 006	3 181	94	29	65	16 162	17	67
..consumption for electricity generation	0	0	116 956	442	0	0	0	2 993	2 372	621	0	0	0	1 229	0	1
..consumption for heat generation	94	0	4 077	1 196	206	17	350	13 194	10 634	2 560	94	29	65	14 933	17	66
..consumption for conversion to other forms of fuels	0	0	42 828	1 217	0	0	0	0	0	0	0	0	0	0	0	0
Production of converted energy	0	695	0	0	0	1 198	0	0	0	0	0	0	0	0	0	6
Own use by energy sector	0	0	0	0	0	0	1	0	0	0	0	0	0	462	2	0
Losses	8	13	0	0	0	0	0	5	1	4	0	0	0	4	0	0
Consumption for non-energy purposes	0	0	113	0	0	0	0	0	0	0	0	0	0	0	0	0
Final consumption calculated	1 782	0	3 044	1	12	181	12 496	2 207	6	2 201	849	740	109	4 606	319	-8
Final consumption observed	1 786	0	3 046	0	7	182	12 496	2 211	8	2 203	743	743	0	4 619	320	4
..final consumption in industry	1 492	0	3 046	0	0	5	40	26	6	20	5	5	0	1 663	135	3
....final consumption in iron and steel industry	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
....final consumption in chemical industry	0	0	0	0	0	0	1	0	0	0	0	0	0	100	85	0
....final consumption in production of non-ferrous metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in production of other non-metallic mineral products	1 485	0	3 046	0	0	0	2	4	0	4	0	0	0	686	1	0
....final consumption in production of transport equipment	0	0	0	0	0	1	3	0	0	0	0	0	0	11	0	0
....final consumption in machinery	0	0	0	0	0	0	17	0	0	0	2	2	0	271	20	0
....final consumption in mining and quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	195	0	0
....final consumption in food processing, beverages and tobacco	0	0	0	0	0	0	1	4	3	1	0	0	0	25	5	3
....final consumption in pulp, paper and printing industry	0	0	0	0	0	0	0	0	0	0	0	0	0	41	1	0

	Coal	Coke **	Oil shale	Milled peat	Sod peat	Peat briquette	Firewood	Wood chips and waste	Wood chips	Wood waste	Briquette and pellets	Briquette	Pellets	Natural gas	Liquefied gas	Heavy fuel oil
....final consumption in production of wood and wood products	0	0	0	0	0	0	11	15	1	14	0	0	0	202	4	0
....final consumption in construction	0	0	0	0	0	4	2	2	2	0	2	2	0	102	3	0
....final consumption in textile, leather and clothing industry	6	0	0	0	0	0	2	0	0	0	1	1	0	3	2	0
....final consumption in other industries	1	0	0	0	0	0	1	1	0	1	0	0	0	25	14	0
..final consumption in agriculture and fishing	1	0	0	0	0	0	16	1	1	0	5	5	0	66	9	0
..final consumption in transport	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0
....final consumption in railway transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in land transport	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	0
......final consumption in urban and suburban passenger land transport	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
....final consumption in waterway transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in air transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
..final consumption in commercial and public services	9	0	0	0	4	2	60	23	1	22	11	11	0	754	16	1
..final consumption in households	284	0	0	0	3	175	12 380	2 161	0	2 161	722	722	0	2 135	154	0
Statistical difference	-4	0	-2	1	5	-1	0	-4	-2	-2	106	-3	109	-13	-1	-12

	Shale oil (heavy fraction)	Shale oil (light fraction)	Light fuel oil and diesel**	Light fuel oil**	Diesel oil	Motor gasoline	Aviation gasoline	Shale oil gas**	Biogas*	Other biomass**	Other fuels**	Total fuels	Electricity **	Heat	Total energy
In stocks at the beginning of the year	1 271	139	3 098	166	2 932	2 062	0	0	6	47	..	32 406	0	0	32 406
Production of primary energy	0	0	0	0	0	0	0	0	137	1 100	..	209 530	1 433	0	210 963
Imports	0	0	25 260	308	24 952	11 503	1 535	0	0	0	..	68 570	6 084	0	74 654
Resources of primary energy	1 271	139	28 358	474	27 884	13 565	1 535	0	143	1 147	..	310 506	7 517	0	318 023
Exports	16 518	0	0	0	0	0	0	0	0	0	..	24 586	18 907	0	43 493
Marine bunkering	0	0	1 029	0	1 029	0	0	0	0	0	..	7 838	0	0	7 838
In stocks at the end of the year	1 667	92	2 792	79	2 713	2 068	88	0	0	15	..	32 085	0	0	32 085
Supply of primary energy	-16 914	47	24 537	395	24 142	11 497	1 447	0	143	1 132	..	245 997	-11 390	0	234 607
Consumption for conversion to other forms of energy	2 331	1 125	296	154	142	0	0	2 555	143	1 096	..	207 456	44	0	207 500
..consumption for electricity generation	443	0	5	0	5	0	0	1 465	90	159	..	123 783	0	0	123 783
..consumption for heat generation	1 882	1 125	265	153	112	0	0	1 090	53	937	..	39 596	44	0	39 640
..consumption for conversion to other forms of fuels	6	0	26	1	25	0	0	0	0	0	..	44 077	0	0	44 077
Production of converted energy	19 447	2 730	0	0	0	0	0	7 204	0	0	..	31 280	44 983	32 882	109 145
Own use by energy sector	50	0	659	6	653	3	0	4 649	0	0	..	5 826	6 314	1 583	13 723
Losses	0	0	4	0	4	9	0	0	0	0	..	43	3 417	3 479	6 939
Consumption for non-energy purposes	0	0	0	0	0	0	0	0	0	0	..	113	0	0	113
Final consumption calculated	152	1 652	23 578	235	23 343	11 485	1 447	0	0	36	..	63 839	23 818	27 820	115 477
Final consumption observed	166	1 652	23 566	224	23 342	11 500	1 450	0	0	34	..	63 782	23 817	27 824	115 423
..final consumption in industry	91	1 024	867	0	867	11	0	0	0	0	..	8 408	7 398	7 279	23 085
....final consumption in iron and steel industry	0	0	0	0	0	0	0	0	0	0	..	2	9	3	14
....final consumption in chemical industry	0	0	23	0	23	0	0	0	0	0	..	209	661	667	1 537
....final consumption in production of non-ferrous metals	0	0	1	0	1	0	0	0	0	0	..	1	25	3	29
....final consumption in production of other non-metallic mineral products	20	0	31	0	31	0	0	0	0	0	..	5 275	717	154	6 146
....final consumption in production of transport equipment	0	0	8	0	8	0	0	0	0	0	..	23	165	113	301
....final consumption in machinery	0	0	13	0	13	1	0	0	0	0	..	324	1 073	454	1 851
....final consumption in mining and quarrying	0	0	157	0	157	1	0	0	0	0	..	353	58	4	415
....final consumption in food processing, beverages and tobacco	0	0	17	0	17	0	0	0	0	0	..	55	977	1 342	2 374
....final consumption in pulp, paper and printing industry	0	0	0	0	0	0	0	0	0	0	..	42	1 212	1 446	2 700

	Shale oil (heavy fraction)	Shale oil (light fraction)	Light fuel oil and diesel**	Light fuel oil**	Diesel oil	Motor gasoline	Aviation gasoline	Shale oil gas**	Biogas*	Other biomass**	Other fuels**	Total fuels	Electricity **	Heat	Total energy
....final consumption in production of wood and wood products	0	167	72	0	72	3	0	0	0	0	..	474	1 048	2 102	3 624
....final consumption in construction	71	857	541	0	541	6	0	0	0	0	..	1 590	264	128	1 982
....final consumption in textile, leather and clothing industry	0	0	0	0	0	0	0	0	0	0	..	14	475	232	721
....final consumption in other industries	0	0	4	0	4	0	0	0	0	0	..	46	714	631	1 391
..final consumption in agriculture and fishing	73	628	2 630	0	2 630	16	0	0	0	0	..	3 445	728	401	4 574
..final consumption in transport	0	0	17 325	0	17 325	3 386	1 431	0	0	0	..	22 149	188	91	22 428
....final consumption in railway transport	0	0	1 442	0	1 442	0	0	0	0	0	..	1 442	18	1	1 461
....final consumption in land transport	0	0	15 682	0	15 682	3 386	0	0	0	0	..	19 075	153	86	19 314
......final consumption in urban and suburban passenger land transport	..	..	..	..	..	..	..	..	..	..	..	..	79	..	79
....final consumption in waterway transport	0	0	201	0	201	0	0	0	0	0	..	201	15	0	216
....final consumption in air transport	0	0	0	0	0	0	1 431	0	0	0	..	1 431	2	4	1 437
..final consumption in commercial and public services	2	0	340	0	340	9	19	0	0	34	..	1 284	8 541	6 125	15 950
..final consumption in households	0	0	2 404	224	2 180	8 078	0	0	0	0	..	28 496	6 962	13 928	49 386
Statistical difference	-14	0	12	11	1	-15	-3	0	0	2	..	57	1	-4	54

Due to rounding, the values of the aggregate data may differ from the sum.
The data on shale oil (light fraction), shale oil gas, biogas and other biomass are added on 21.09.2012.
The data on final consumption in urban and suburban passenger land transport are added on 05.12.2012.
The data on light fuel oil and diesel, light fuel oil, diesel, total fuels, total energy for 2003 and the data on milled peat, wood chips and waste, wood chips, total fuels, total energy for 2011 have been revised on 05.12.2012.
Coke**:
** Oil-shale coke is exported as coke.
Light fuel oil and diesel**:
** The imports of light fuel oil and diesel include marine bunkering.
Light fuel oil**:
** In the production of converted energy, light fuel oil is light fraction of shale oil.
Shale oil gas**:
** Generator gas, coke oven gases.
Biogas*:
* In years 1999-2010 biogas is included under other fuels.
Other biomass**:
** Other biomass includes straw, bone meal, organic waste of animals, black liquor.
Other fuels**:
** Until 2010, other fuels include shale oil gas, biogas and black liquor.
Electricity**:
** In the production of primary energy, electricity includes hydro-electric and wind energy.

Energy Balance 2011 (natural units)

	Coal, thousand tons	Coke**, thousand tons	Oil shale, thousand tons	Milled peat, thousand tons	Sod peat, thousand tons	Peat briquette, thousand tons	Firewood, thousand m³ solid volume	Wood chips and waste, thousand m³ solid volume	Wood chips, thousand m³ solid volume	Wood waste, thousand m³ solid volume	Briquette and pellets, thousand tons	Briquette, thousand tons	Pellets, thousand tons	Natural gas, million m³
In stocks at the beginning of the year	28	3	2 439	86	14	28	24	64	32	32	29	7	22	0
Production of primary energy	0	0	18 734	282	41	0	1 704	2 681	1 908	773	390	46	344	0
Production of converted energy	0	24	0	0	0	75	0	0	0	0	0	0	0	0
Imports	67	0	0	0	0	0	10	13	0	13	17	0	17	632
Resources of energy	94	27	21 173	368	55	103	1 737	2 757	1 940	817	437	53	384	632
Exports	0	25	0	12	11	78	0	0	0	0	362	0	362	0
Marine bunkering	0	0	0	0	0	0	0	0	0	0	0	0	0	0
In stocks at the end of the year	25	2	2 434	69	26	12	29	117	81	36	437	53	384	0
Supply of energy	69	0	18 739	286	18	12	1 708	2 640	1 859	781	56	45	11	632
Gross inland consumption	69	0	18 739	286	18	12	1 708	2 640	1 859	781	56	45	11	632
Consumption for conversion to other forms of energy	3	0	18 469	286	17	1	47	2 320	1 858	462	6	2	4	481
..consumption for electricity generation	0	0	13 923	44	0	0	0	429	339	90	0	0	0	37
..consumption for heat generation	3	0	485	120	17	1	47	1 890	1 519	371	6	2	4	444
..consumption for conversion to other forms of fuels	0	0	4 060	122	0	0	0	0	0	0	0	0	0	0
Own use by energy sector	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Losses	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Consumption for non-energy purposes	0	0	10	0	0	0	0	0	0	0	0	0	0	0
Final consumption calculated	65	0	260	0	1	11	1 661	320	1	319	0	0	0	137
Final consumption observed	66	0	260	0	1	11	1 661	321	1	320	51	44	7	137
..final consumption in industry	55	0	260	0	0	0	5	4	1	3	2	0	2	49
....final consumption in iron and steel industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in chemical industry	0	0	0	0	0	0	0	0	0	0	0	0	0	3
....final consumption in production of non-ferrous metals	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in production of other non-metallic mineral products	54	0	260	0	0	0	0	1	0	1	0	0	0	20
....final consumption in production of transport equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Coal, thousand tons	Coke**, thousand tons	Oil shale, thousand tons	Milled peat, thousand tons	Sod peat, thousand tons	Peat briquette, thousand tons	Firewood, thousand m³ solid volume	Wood chips and waste, thousand m³ solid volume	Wood chips, thousand m³ solid volume	Wood waste, thousand m³ solid volume	Briquette and pellets, thousand tons	Briquette, thousand tons	Pellets, thousand tons	Natural gas, million m³
....final consumption in machinery	0	0	0	0	0	0	2	0	0	0	0	0	0	8
....final consumption in mining and quarrying	0	0	0	0	0	0	0	0	0	0	0	0	0	6
....final consumption in food processing, beverages and tobacco	0	0	0	0	0	0	0	0	0	0	0	0	0	1
....final consumption in pulp, paper and printing industry	0	0	0	0	0	0	0	0	0	0	0	0	0	1
....final consumption in production of wood and wood products	0	0	0	0	0	0	1	2	0	2	0	0	0	6
....final consumption in construction	0	0	0	0	0	0	0	0	0	0	0	0	0	3
....final consumption in textile, leather and clothing industry	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in other industries	0	0	0	0	0	0	0	0	0	0	2	0	2	1
..final consumption in agriculture and fishing	0	0	0	0	0	0	2	0	0	0	0	0	0	2
..final consumption in transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in railway transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in land transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
......final consumption in urban and suburban passenger land transport	..	..	..	..	..	..	..	..	..	..	..	..	..	..
....final consumption in waterway transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
....final consumption in air transport	0	0	0	0	0	0	0	0	0	0	0	0	0	0
..final consumption in commercial and public services	0	0	0	0	0	0	8	3	0	3	1	1	0	22
..final consumption in households	10	0	0	0	0	11	1 646	314	0	314	48	43	5	64
Statistical difference	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Liquefied gas, thousand tons	Heavy fuel oil, thousand tons	Shale oil (heavy fraction), thousand tons	Shale oil (light fraction), thousand tons	Light fuel oil and diesel**, thousand tons	Light fuel oil**, thousand tons	Diesel, thousand tons	Motor gasoline, thousand tons	Aviation gasoline, thousand tons	Shale oil gas**, million m³	Biogas*, million m³	Other biomass**, thousand tons	Other fuels**, thousand tce	Electricity **, GWh	Heat, GWh
In stocks at the beginning of the year	1	9	33	4	73	2	71	47	0	0	0	4	..	0	0
Production of primary energy	0	0	0	0	0	0	0	0	0	0	8	140	..	398	0
Production of converted energy	0	0	496	65	0	0	0	0	0	1 108	0	0	..	12 495	9 134
Imports	9.2	169	0	0	597	7	590	261	36	0	0	0	..	1 690	0
Resources of energy	10.2	178	529	69	670	10	660	308	36	1 108	8	144	..	14 583	9 134
Exports	0	0	422	0	0	0	0	0	0	0	0	0	..	5 252	0
Marine bunkering	0	169	0	0	24	0	24	0	0	0	0	0	..	0	0
In stocks at the end of the year	2.8	7	43	2	66	2	64	47	2	0	0	2	..	0	0
Supply of energy	7.5	1	65	66	580	8	572	261	34	1 108	8	143	..	9 331	9 134
Gross inland consumption	7.5	2	65	66	580	8	572	261	34	1 108	8	143	..	8 382	8 168
Consumption for conversion to other forms of energy	0.4	2	60	27	6	3	3	0	0	393	8	140	..	12	0
..consumption for electricity generation	0	0	11	0	0	0	0	0	0	225	5	21	..	0	0
..consumption for heat generation	0.4	2	48	27	6	3	3	0	0	168	3	120	..	12	0
..consumption for conversion to other forms of fuels	0	0	0	0	1	0	1	0	0	0	0	0	..	0	0
Own use by energy sector	0	0	1	0	15	0	15	0	0	715	0	0	..	1 754	440
Losses	0	0	0	0	0	0	0	0	0	0	0	0	..	949	966
Consumption for non-energy purposes	0	0	0	0	0	0	0	0	0	0	0	0	..	0	0
Final consumption calculated	7	0	4	39	558	5	553	261	34	0	0	3	..	6 616	7 728
Final consumption observed	7.1	0	4	39	558	5	553	261	34	0	0	3	..	6 616	7 728
..final consumption in industry	3	0	2	24	21	0	21	0	0	0	0	0	..	2 055	2 021
....final consumption in iron and steel industry	0	0	0	0	0	0	0	0	0	0	0	0	..	3	1
....final consumption in chemical industry	1.9	0	0	0	1	0	1	0	0	0	0	0	..	184	185
....final consumption in production of non-ferrous metals	0	0	0	0	0	0	0	0	0	0	0	0	..	7	1
....final consumption in production of other non-metallic mineral products	0	0	1	0	1	0	1	0	0	0	0	0	..	199	43
....final consumption in production of transport equipment	0	0	0	0	0	0	0	0	0	0	0	0	..	46	31
....final consumption in machinery	0.4	0	0	0	0	0	0	0	0	0	0	0	..	298	126
....final consumption in mining and quarrying	0	0	0	0	4	0	4	0	0	0	0	0	..	16	1

	Liquefied gas, thousand tons	Heavy fuel oil, thousand tons	Shale oil (heavy fraction), thousand tons	Shale oil (light fraction), thousand tons	Light fuel oil and diesel**, thousand tons	Light fuel oil**, thousand tons	Diesel, thousand tons	Motor gasoline, thousand tons	Aviation gasoline, thousand tons	Shale oil gas**, million m³	Biogas*, million m³	Other biomass**, thousand tons	Other fuels**, thousand tce	Electricity **, GWh	Heat, GWh
....final consumption in food processing, beverages and tobacco	0.1	0	0	0	0	0	0	0	0	0	0	0	..	271	373
....final consumption in pulp, paper and printing industry	0	0	0	0	0	0	0	0	0	0	0	0	..	337	402
....final consumption in production of wood and wood products	0.1	0	0	4	2	0	2	0	0	0	0	0	..	291	584
....final consumption in construction	0.1	0	2	20	13	0	13	0	0	0	0	0	..	73	36
....final consumption in textile, leather and clothing industry	0	0	0	0	0	0	0	0	0	0	0	0	..	132	64
....final consumption in other industries	0.3	0	0	0	0	0	0	0	0	0	0	0	..	198	175
..final consumption in agriculture and fishing	0.2	0	2	15	62	0	62	0	0	0	0	0	..	202	111
..final consumption in transport	0.1	0	0	0	410	0	410	77	33	0	0	0	..	52	25
....final consumption in railway transport	0	0	0	0	34	0	34	0	0	0	0	0	..	5	0
....final consumption in land transport	0.1	0	0	0	371	0	371	77	0	0	0	0	..	42	24
......final consumption in urban and suburban passenger land transport	..	..	..	..	..	..	..	..	..	..	..	..	..	22	..
....final consumption in waterway transport	0	0	0	0	5	0	5	0	0	0	0	0	..	4	0
....final consumption in air transport	0	0	0	0	0	0	0	0	33	0	0	0	..	0	1
..final consumption in commercial and public services	0.4	0	0	0	8	0	8	0	0	0	0	3	..	2 373	1 701
..final consumption in households	3.4	0	0	0	57	5	52	184	0	0	0	0	..	1 934	3 869
Statistical difference	0	0	0	0	0	0	0	0	0	0	0	0	..	0	0

Due to rounding, the values of the aggregate data may differ from the sum.
The data on other biomass are added on 02.01.2012.
The data on shale oil (light fraction), shale oil gas and biogas are added on 21.09.2012.
The data on final consumption in urban and suburban passenger land transport are added on 05.12.2012.
The data on light fuel oil and diesel for 2003 and the data on milled peat, wood chips and waste, wood chips for 2011 have been revised on 05.12.2012.
Coke**, thousand tons:
** Oil-shale coke is exported as coke.
Light fuel oil and diesel**, thousand tons:
** The imports of light fuel oil and diesel include marine bunkering.
Light fuel oil**, thousand tons:
** In the production of converted energy, light fuel oil is light fraction of shale oil.
Shale oil gas**, million m³:
** Generator gas, coke oven gases.
Biogas*, million m³:
* In years 1999-2010 biogas is included under other fuels.
Other biomass**, thousand tons:
** Other biomass includes straw, bone meal, organic waste of animals, black liquor.

Other fuels**, thousand tce:
** Until 2010, other fuels include shale oil gas, biogas and black liquor.
Electricity**, GWh:
** In the production of primary energy, electricity includes hydro-electric and wind energy.

Annex 5. 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 has been estimated by 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*	NO	NO	NO	NO	NO	NO	NO	
1.AA.1.C. Manufacture of Solid Fuels and Other Energy Industries*	X	X	X	X	X	X	X	
1.AA.2. Manufacturing Industries and Construction								
1.AA.2.A. Iron and Steel*	X	X	X	X	X	X	X	There were no production of iron and steel products in 1991, 1992 and 1993.
1.AA.2.B. Non-Ferrous Metals*	X	X	X	X	X	X	X	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 and SO_2 in 1997 was NA.
1.AA.2.E. Food Processing, Beverages and Tobacco	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.2.F. Other (please specify) Other manufacturing sectors and construction	X	X	X	X	X	X	X	
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	NO	NO	NO	NO	NO	NO	NO	
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	
	X	X	X	X	X	X	X	Military Fuels

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	NO	NO	NO	NO	NO	NO	
1.B.1.B. Solid Fuel Transformation	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	NO	NO	X	NO	
1.B.2.B.4 Natural Gas/Distribution	NO	X	NO	NO	NO	NO	NO	
1.B.2.B.5 Other Leakage	NO	NO	NO	NO	NO	NO	NO	
1.B.2.C. Venting and Flaring	NO	IE, NO	NO	NO	NO	NO	NO	Emissions of CH_4 are included in 1.A.1.c.
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	IE	IE	IE	IE	IE	IE	IE	Included elsewhere. The emissions are reported in 2.A.1, 2.A.2 and 2.A.7.
2.A.4. Soda Ash Production and Use	X	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	X	NO	
2.A.7.1. Glass production	X	NO	NO	NO	NO	NO	NE	SO_2 emissions are under investigation.
2.A.7.2a. Bricks and Tiles	X	NO	NO	NE	NE	NE	NE	There is no method available in IPCC Guidelines for NOx, CO, NMVOC and SO_2 emissions estimates.
2.A.7.2b. Lightweight gravel	X	NO	NO	NE	NE	NE	NE	There is no method available in IPCC Guidelines for NOx, CO, NMVOC and SO_2 emissions estimates. There was no production of lightweight gravel in 2011.
2. B. Chemical Industry								
2.B.1. Ammonia Production	X	NO	NO	NO	X	X	X	There was no production of ammonia in 2011.
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	
2.B.4. Carbide Production	NO	NO	NO	NO	NO	NO	NO	
2.B.5. Other Production	NO	NO	NO	NA	NA	NA	NA	
2.C. Metal Production								
2.C.1. Iron and Steel Production	NA, NO	NA, NO	NO	NO	NO	NO	NO	There is only iron and steel casting in Estonia. Energy related emissions are reported in 1.AA.2.A.
2.C.2. Ferroalloys Production	NO	NO	NO	NO	NO	NO	NO	
2.C.3. Aluminium Production	NO	NO	NO	NO	NO	NO	NO	
2.C.4. SF6 Used in Aluminium and Magnesium Foundries	NO	NO	NO	NO	NO	NO	NO	
2.C.5. Other *(please specify)*	NA	NA	NA	NA	NA	NA	NA	
2.D. Other Production								
2.D.1. Pulp and Paper	NO	NO	NO	X	X	X	X	There was no production of pulp in 1993 and 1994.
2.D.2. Food and Drink	NO	NO	NO	NO	NO	X	NO	
2.G. Other (please specify)								
	NO	NO	NO	NO	NO	NO	NO	

F-gases (CRF Reporter 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				
2.E.1. By-product Emissions	NA, NO	NA, NO	NO	There is no production of Halocarbons and SF_6 in Estonia.
2.E.1.1. Production of HCFC-22	NO	NO	NO	
2.E.1.2. Other	NA, NO	NA, NO	NO	
2.F. Consumption of Halocarbons and SF_6				
2.F.1. Refrigeration and Air Conditioning Equipment	X	NO	NO	
2.F.2. Foam Blowing	X	NO	NO	
2.F.3. Fire Extinguishers	X	NO	NO	
2.F.4. Aerosols/ Metered Dose Inhalers	X	NO	NO	
2.F.5. Solvents	NO	NO	NO	
2.F.6. Other applications using ODS substitutes	NO	NO	NO	
2.F.7. Semiconductor Manufacture	NO	NO	NO	
2.F.8. Electrical Equipment	NO	NO	X	
2.F.9. Other Electrical Equipment	NO	NO	X	
2.F.9. Other (sport shoe soles)	NO	NO	NO	PFC emissions from sport shoes with gas cushion occurred in Estonia from 2006 to 2008 and SF_6 emissions from 1995 to 2006.

Solvent and other product use (CRF Reporter 3)

Greenhouse gas source and sink categories	**CO_2**	**CH_4**	**N_2O**	**NOx**	**CO**	**NMVOC**	**SO_2**	**Notes***
3. Solvent and Other Product Use								
3.A. Paint Application	X	NO	NO	NO	NO	X	NO	
3.B. Degreasing and Dry Cleaning	X	NO	NO	NO	NO	X	NO	
3.C. Chemical Products, Manufacture and Processing	X	NO	NO	NO	NO	X	NO	
3.D. Other								
3.D.1. Use of N_2O for Anaesthesia	NO	NO	X	NO	NO	NO	NO	
3.D.2. N_2O from Fire Extinguishers	NO	NO	NO	NO	NO	NO	NO	No use of N_2O in Fire Extinguishers.
3.D.3. N_2O from Aerosol Cans	NO	NO	X	NO	NO	NO	NO	
3.D.4. Other Use of N_2O	NO	NO	IE	NO	NO	NO	NO	Included in Use of N_2O for Anaesthesia.
3.D.5. Other	X	NO	NO	NO	NO	X	NO	
Printing Industry	X	NO	NO	NO	NO	X	NO	
Domestic solvent use	X	NO	NO	NO	NO	X	NO	

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2	Notes*
Other product use	X	NO	NO	NO	NO	X	NO	

Agriculture (CRF Reporter 4)

Greenhouse gas source and sink categories	CH_4	N_2O	NO	CO	NMVOC	SO_2	Notes*
4.A. Enteric Fermentation	X	NO	NO	NO	NO	NO	
4.B. Manure Management	X	X	NO	NO	NE	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	X	NO	NO	NO	NO	
4.D.1.6. Other emissions (Sewage sludge applied on soils)	NO	X	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	NO	NO	NO	NO	NO	NO	

LULUCF (CRF Reporter 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	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	NE	NE	NE	NO	NO	NO	
5(V) Biomass burning	IE, NO	X	X	NO	NO	NO	CO_2 emission estimates are included in FL remaining FL living biomass figures due to *Stock Change method* used for calculations.
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	

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	Notes*
5(II) Non-CO_2 emissions from drainage of soils and wetlands	NE	NE	NE	NO	NO	NO	
5(V) Biomass burning	IE, NO	X	X	NO	NO	NO	CO_2 emission estimates are included in FL remaining FL living biomass figures due to *Stock Change method* used for calculations.
5.A.2. Land converted to Forest Land							
5.A.2.1. Cropland converted to Forest Land	X	NO	NO	NO	NO	NO	
5.A.2.2. Grassland converted to Forest Land	X	NO	NO	NO	NO	NO	
5.A.2.3. Wetlands converted to Forest Land	X	NO	NO	NO	NO	NO	
5.A.2.4. Settlements converted to Forest Land	X	NO	NO	NO	NO	NO	
5.A.2.5. Other Land converted to Forest Land	X	NO	NO	NO	NO	NO	
5.B. Cropland							
Carbon stock change	X	NO	NO	NO	NO	NO	
5(III) N_2O emissions from disturbances associated with land-use conversion to cropland	NO	NO	X	NO	NO	NO	Estimated for the first time in the 2013 submission, Tier 1 applied
5(IV) CO_2 emissions from agricultural lime application	X	NO	NO	NO	NO	NO	
5(V) Biomass burning	NO	NO	NO	NO	NO	NO	
5.B.1. Cropland remaining Cropland							
Carbon Stock Change	X	NO	NO	NO	NO	NO	
5(V) Biomass Burning	NO	NO	NO	NO	NO	NO	
5(IV) CO_2 emissions from agricultural lime application	X	NO	NO	NO	NO	NO	
5.B.2. Land converted to Cropland							
5.B.2.1. Forest Land Converted to Cropland	NO	NO	NO	NO	NO	NO	
5.B.2.2. Grassland converted to Cropland	X	NO	NO	NO	NO	NO	
5.B.2.3. Wetlands converted to Cropland	NO	NO	NO	NO	NO	NO	
5.B.2.4. Settlements converted to Cropland	NO	NO	NO	NO	NO	NO	
5.B.2.5. Other land converted to Cropland	NO	NO	NO	NO	NO	NO	
5(III) N_2O emissions from disturbances associated with land-use conversion to cropland	NO	NO	NO	NO	NO	NO	
5(V) Biomass Burning	NO	NO	NO	NO	NO	NO	
5.C. Grassland							
Carbon Stock Change	X	NO	NO	NO	NO	NO	
5(IV) Carbon emissions from agricultural lime application	NO	NO	NO	NO	NO	NO	
5(V) Biomass Burning	IE, NO	X	X	NO	NO	NO	CO_2 emission estimates are included in GL remaining GL living biomass figures due to *Stock Change method* used for calculations.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	Notes*
5.C.1. Grassland remaining Grassland							
Carbon stock change	X	NO	NO	NO	NO	NO	
5(IV) CO_2 emissions from agricultural lime application	NO	NO	NO	NO	NO	NO	
5 (V) Biomass Burning	IE, NO	X	X	NO	NO	NO	
5.C.2. Land converted to Grassland							
5.C.2.1. Forest Land Converted to Grassland	X	NO	NO	NO	NO	NO	
5.C.2.2. Cropland converted to Grassland	X	NO	NO	NO	NO	NO	
5.C.2.3. Wetlands converted to Grassland	X	NO	NO	NO	NO	NO	
5.C.2.4. Settlements converted to Grassland	X	NO	NO	NO	NO	NO	
5.C.2.5. Other land converted to Grassland	X	NO	NO	NO	NO	NO	
5(V) Biomass Burning	IE, NO	IE, NO	IE, NO	NO	NO	NO	
5.D. Wetlands							
Carbon Stock Change	X	NO	NO	NO	NO	NO	
5(II) Non-CO_2 emissions from drainage of soils and wetlands	X	X	X	NO	NO	NO	Country-specific EFs (CO_2, N_2O, CH_4) were applied for the first time, Salm *et al*, 2012.
5(V) Biomass Burning	IE, NO	IE, NO	IE, NO	NO	NO	NO	Reported under category 5.C.1 Grassland remaining Grassland 5(V) Biomass Burning due to combined statistical data.
5.D.1. Wetlands remaining Wetlands							
Carbon Stock Change/ Peat extraction	X	X	X	NO	NO	NO	
5(V) Biomass Burning	IE, NO	IE, NO	IE, NO	NO	NO	NO	Reported under category 5.C.1 Grassland remaining Grassland 5(V) Biomass Burning due to combined statistical data.
5.D.2. Land converted to Wetlands							
5.D.2.1. Forest Land Converted to Wetlands	X	NO	NO	NO	NO	NO	
5.D.2.2. Cropland converted to Wetlands	NO	NO	NO	NO	NO	NO	
5.D.2.3. Grassland converted to Wetlands	NO	NO	NO	NO	NO	NO	
5.D.2.4. Settlements converted to Wetlands	NO	NO	NO	NO	NO	NO	
5.D.2.5. Other land converted to Wetlands	NO	NO	NO	NO	NO	NO	
5(II) Non-CO_2 emissions from drainage of soils and wetlands	NO	X	X	NO	NO	NO	
5.E. Settlements							
5.E.1. Settlements remaining Settlements	NE	NE	NE	NO	NO	NO	According to the IPCC good practice guidance for LULUC, it is not mandatory for Parties to prepare estimates for the category contained in appendix 3a.4 Settlements

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	Notes*
							Remaining Settlements.
5.E.2. Land converted to Settlements	X	NO	NO	NO	NO	NO	
5.E.2.1. Forest Land Converted to Settlements	X	NO	NO	NO	NO	NO	
5.E.2.2. Cropland converted to Settlements	X	NO	NO	NO	NO	NO	
5.E.2.3. Grassland converted to Settlements	X	NO	NO	NO	NO	NO	
5.E.2.4. Wetlands converted to Settlements	NO	NO	NO	NO	NO	NO	
5.E.2.5. Other land converted to Settlements	X	NO	NO	NO	NO	NO	
5.F. Other Land							
5.F.2.1. Forest Land converted to Other Land	X	NO	NO	NO	NO	NO	
5.F.2.2. Cropland converted to Other Land	X	NO	NO	NO	NO	NO	
5.F.2.3. Grassland converted to Other Land	NO	NO	NO	NO	NO	NO	
5.F.2.4. Wetlands converted to Other Land	X	NO	NO	NO	NO	NO	
5.F.2.5. Settlements converted to Other Land	NO	NO	NO	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. Emissions from Harvested Wood Products were added to the total amount of CH_4 emissions from waste transferred to landfill.

Waste (CRF Reporter 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	NO	X	NO	NE	NE	NE	CO_2 – Decomposition of organic material derived from biomass sources, which are regrown on an annual basis is the primary source of CO_2 realised from waste. Hence, these CO_2 emissions aren't treated as as net emissions from waste in the IPCC Methodology. No method available. NMVOC,NO_x ,CO – emerged emissions are not significant to estimate (emerged emissions value is minimum).
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	

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	Notes*
6.A.3. Uncategorised Waste disposal on Land	NO	X	NO	NE	NE	NE	CO_2 – Decomposition of organic material derived from biomass sources, which are regrown on an annual basis is the primary source of CO_2 realised from waste. Hence, these CO_2 emissions aren't treated as net emissions from waste in the IPCC Methodology. No method available. NMVOC,NO_x ,CO – emerged emissions are not significant to estimate (emerged emissions value is minimum).
6.B. Wastewater handing							
6.B.1. Industrial Wastewater							
Wastewater	NO	X	NO	NO	NO	NO	
Sludge	NO	IE	NO	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. N_2O – no method available.
6.B.2. Domestic and Commercial Wastewater							
6.B.2.1. Domestic and Commercial Wastewater							
Wastewater	NO	X	NA	NO	NO	NO	N_2O – no method available. N_2O emissions are reported under 6.B.2.2. Human sewage category.
Sludge	NO	IE	NO	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. N_2O - due to lack of activity data, the estimation has not been carried out. No method available.
6.B.2.2. Human Sewage	NO	NO	X	NO	NO	NO	
6.C. Waste Incineration							
6.C.1. Biogenic	X	NO	X	NO	NO	NO	CO_2 – emissions from biogenic origin reduces, as CO_2 emissions from non-biogenic origin were added to the inventory. CH_4 – no method available in GPG 2000.
6.C.2. Non-biogenic	X	NO	X	NO	NO	NO	CO_2 – emissions from non-biogenic waste incineration were added to the inventory. CH_4 – no method available in GPG 2000.

Greenhouse gas source and sink categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	Notes*
6.D. Other (Biological Treatment)	NO	X	X	NE	NE	NE	CO_2 – For being biogenic origin, CO_2 emission has not been carried out. NO_x, CO, NMVOC – emerged emissions are not significant to estimate (emerged emissions value is minimum).
6.D Other (Biogas burnt in a flare)	NO	X	X	NE	NE	NE	CH_4 and N_2O emission have been estimated since 2009 for the first time in 2012 Submission. CO_2 - For being biogenic origin, CO_2 emission has not been carried out. NO_x, CO, NMVOC – emerged emissions are not significant to estimate (emerged emissions value is minimum).

Annex 6. Standard Independent Assessment Report

NATIONAL REGISTRY OF ESTONIA

STANDARD INDEPENDENT ASSESSMENT REPORT

To the UNFCCC secretariat

2012

Tallinn 2013

PREFACE

Standard Independent Assessment Report of National Registry (hereinafter as NR) of Estonia under the United Nations Framework Convention on Climate Change (hereinafter as UNFCCC) contains the following parts:

Part I. Description Kyoto Protocol Units

Part II. Changes to National Registry

Part III Appendixes

Mr. Mihkel Visnapuu (Registry System Administrator (hereinafter as RSA) of National Registry of Estonia from Climate and Radiation department of the Ministry of the Environment (hereinafter as MoE)) has compiled the Standard Independent Assessment Report 2012 (hereinafter as SIAR) and other information included in this report.

In this document, 2012 refers to the year for which the data is submitted, and not to the year of submission (publication).

ABBREVIATIONS

UNFCCC – United Nations Framework on Climate Change Convention
EE – Estonia
CDM – Clean Development Mechanism
MoE– Ministry of the Environment
NR – National Registry
CPR – Commitment Period Reserve
RSA – Registry System Administrator
SEF – Standard Electronic Format
ITL – International Transaction Log
CITL – Community Transaction Log
KP – Kyoto Protocol
CR – Community Registry
ERT – Expert Review Team
IAR – Independent Assessment Report
SIAR – Standard Independent Assessment Report
EU ETS – European Union Emission Trading Scheme
NIR – National Inventory Report
CITL – Community Independent Transaction Log
ERU – Emission Reduction Unit
CER – Certified Emission Reduction Unit
lCER – Long-term Certified Emission Reduction Unit
tCER – Temporary Certified Emission Reduction Unit
RMU – Removal Unit

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1. PART I. KYOTO PROTOCOL UNITS

1.2 Information on Accounting of the Kyoto Protocol Units (Chapter 12 of NIR)

The following reports are described in this document and correspond to the requirements of decisions 14/CMP.1 and 15/CMP.1. Information required under Decision 15/CMP.1 paragraph 11 is displayed as required by UNFCCC ITL Administrators' "Standard Independent Assessment Report. Reporting Requirements and Guidance for Registries v4.7" in "SEF_EE_2013_1_17-20-44 10-4-2013.xls". The Standard Electronic Format (hereinafter as SEF) report for 2012 has been submitted to the UNFCCC Secretariat electronically and the contents of the report can also be found as Appendix 1 of this document. The SEF tables include information about AAU, ERU, CER, t-CER, l-CER and RMU in Estonian National Registry (hereinafter as NR) standing 31st of December 2012. Also the SEF includes information on transfers of the units during the year 2012.

The total number of units in the NR at the beginning of the year 2012 was: 144 277 134 AAU, 13 448 ERU and 957 CER. In the end of the year the total balance of units was: 131 081 678 AAU (53 085 500 in retirement and 210 000 in cancellation accounts), 3 758 479 ERU (141 034 in retirement account) and 29 551 CER (16 555 in retirement account).

Estonian NR did not contain any RMUs, t-CERs or l-CERs nor any units were on the Article 3.3/3.4 Net-Source Cancellation accounts and in t-CER and l-CER Replacement accounts. SEF report will be also included in Estonian Standard Independent Assessment Report (hereinafter as SIAR) 2012 report as Appendix 1 (as SIAR Report R-1).

Annual Submission Item	Reporting Guidance
15/CMP.1 annex I.E paragraph 11: Standard electronic format (SEF)	The Standard Electronic Format report for 2012 has been submitted to the UNFCCC Secretariat electronically. SEF, containing the information required in paragraph 11 of the annex to decision 15/CMP.1, is included in the "Greenhouse Gas emissions in Estonia 1990–2011. National Inventory Report under the UNFCCC and the Kyoto Protocol. Common Reporting Formats (CRF) 1990-2011. Tallinn 2013" (hereinafter as NIR) in Chapter 12.2 "Summary of information reported in the SEF tables" and the report is a part of NIR as Annex 6. This SEF report is referenced as report R-1 in this document. See Appendix 1 for more details related to the SEF report.
15/CMP.1 annex I.E paragraph 12: List of discrepant transactions	Information of discrepant transactions is included in the NIR in Chapter 12.3 "Discrepancies and notifications" and the report is a part of NIR as Annex 6. The report of discrepant transactions is referenced as report R-2 in this document. See Appendix 2 for more details related to the discrepant transactions. No discrepant transactions occurred in 2012.

Annual Submission Item	Reporting Guidance
15/CMP.1 annex I.E paragraph 13 & 14: List of CDM notifications	Information on CDM notifications is included in the NIR in Chapter 12.3 "Discrepancies and notifications" and report is a part of NIR as Annex 6. The report of CDM notifications is referenced as report R-3 in this document. See Appendix 3 for more details related to the discrepant transactions. No CDM notifications occurred in 2012.
15/CMP.1 annex I.E paragraph 15: List of non-replacements	Information on non-replacements is included in the NIR as Chapter 12.3 "Discrepancies and notifications" and report is a part of NIR as Annex 6. The report on non-replacements is referenced as report R-4 in this document. See Appendix 3 for more details related to the non-replacements. No non-replacements occurred in 2012.
15/CMP.1 annex I.E paragraph 16: List of invalid units	Information of invalid units is included in the NIR as Chapter 12.3 "Discrepancies and notifications" and report is a part of NIR as Annex 6. The report of invalid units is referenced as report R-5 of this document. See Appendix 3 for more details related to the list of invalid units. No invalid units exist as at 31 December 2012.
15/CMP.1 annex I.E paragraph 17 Actions and changes to address discrepancies	No actions were taken or changes made to address discrepancies for the period under review. No change occurred during the reported period.
15/CMP.1 annex I.E Publicly accessible information	Due to the updates on the publicly available information web page in year 2011, information referred in Decision 13/CMP.1; II Registry requirements; E. Publicly accessible information in paragraphs 45-48 are as following via user interface of the MoE www.envir.ee/ 1170489: • account information (information on paragraph 45 of annex to the decision 13/CMP.1); • JI projects in Estonia (information on paragraph 46 of annex to the decision 13/CMP.1); • information about unit holdings and transactions (information on paragraph 47 of annex to the decision 13/CMP.1); • information about Entities Authorized to Hold Units (information on paragraph 48 of annex to the decision

Annual Submission Item	Reporting Guidance
	13/CMP.1). Information regarding the NR is publicly available to users via MoE web page http://www.envir.ee/register. This information is currently available at: 1) Paragraph 45 of annex to the decision 13/CMP.1 (account information). This information is available to users via user interface of the MoE http://www.envir.ee/1170489 and via CITL http://ec.europa.eu/environment/ets/. Selecting from left hand menu "Accounts" - "Search" - selecting Estonia; 2) Paragraph 46 of annex to the decision 13/CMP.1 (information of JI projects in Estonia). This information is available to users via user interface of the web page of the Ministry of the Environment http://www.envir.ee/1155464; 3) Paragraph 47 of annex to the decision 13/CMP.1 (information about unit holdings and transactions). Following information is publicly accessible via user interface of the CITL http://ec.europa.eu/environment/ets. Selecting from left hand menu "Transactions" - "Search" - selecting Estonia and other relevant parameters displayed in the search field. In accordance with the annex XVI of the EC regulation (No 2216/2004 of 21 Dec. 2004) "the information for each completed transaction relevant for the registries system for year X shall be displayed from 15 January onwards of year X+5". 4) Paragraph 48 of annex to the decision 13/CMP.1 (information about Entities Authorized to hold units under its responsibility). The Decision 280/2004/EC of the European Parliament and of the Council requires EU Member States to provide information on the legal entities authorized to participate in the mechanism under Articles 6, 12 and 17 of the Kyoto Protocol in the NIR. According to the Estonian national legislation (The Ambient Air Protection Act) §117) the Ministry of the Environment as competent authority is authorized to trade with AAUs, RMUs, ERUs and CERs. This information is available at http://www.envir.ee/1170489. Installations falling under the scope of the Directive 2003/87/EC are authorized to use ERUs and CERs for compliance according to the percentage set out in National Allocation Plan for 2008-2012. This information is available to users via user interface of the web page of the Ministry of the Environment http://www.envir.ee/1173994. Public information required by Commission regulation (EC) No 920/2010 (in addition to the above-mentioned public information): 1) Installation and permit details - information about installations and permit details is available to users via user interface of MoE

Annual Submission Item	Reporting Guidance
	http://www.envir.ee/orb.aw/class=file/action=preview/id=1172349/KP+2008-2012+ja+aastad_alloc+ja+VE.pdf and CITL http://ec.europa.eu/environment/ets/ selecting from left hand menu “Operator Holding Accounts” - “Search” - selecting Estonia; 2) Information about verified emissions, surrenders and compliance status of installations - information about verified emissions, surrenders and compliance status of installations is available to users via user interface of the MoE web page at http://www.envir.ee/cp1 (selecting „Ülevaade kauplemisperioodil 2008-2012 eraldatud LHÜ-de, tõendatud KHG heitkoguste ja tagastatatud LHÜ-de kohta on leitav siit„) and from the interface of the CITL http://ec.europa.eu/environment/ets/ selecting from left hand menu “Allocation/Compliance” - “Search” - selecting Estonia; 3) National allocation plan for Estonia - information on national allocation plan for Estonia is available via user interface of the MoE web page at http://www.envir.ee/cp1 (selecting from headline „*Eesti riiklik kasvuhoonegaaside lubatud heitkoguse jaotuskava aastatel 2008-2012*“ last three headings in English and via CITL web page http://ec.europa.eu/environment/ets/ selecting from left hand menu “NAP-info” - “Search” - selecting Estonia. NIMs list is available at http://www.envir.ee/orb.aw/class=file/action=preview/id=1181767/NIMs List+EE_v3_avalikustamine.pdf.
15/CMP.1 annex I.E paragraph 18 CPR Calculation	The commitment period reserve, in accordance with the annex to decision 18/CP.7, is included in the NIR as Chapter 12.5 "Calculation of the commitment period reserve (CPR)." The commitment period reserve can be calculated in accordance with decision 11/CMP.1 as 90% of the proposed assigned amount or 100% of its most recently reviewed inventory times five, whichever is lowest. Estonia has interpreted the “most recently reviewed inventory” the inventory for the year 2011. This would mean that five times the emissions from the total inventory of 2011 will be lower, than 90% of the assigned amount. This would give an estimated commitment period reserve of **104 777 884 tonnes CO_2 equivalents.** 20 955 576.877 x 5 = 104 777 884 t $CO_{2\ eq}$.

2. PART II. CHANGES IN THE NATIONAL REGISTRY

2.1 Information on Changes in National Registry (Chapter 14 of NIR)

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

(1) Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

(2) Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

(3) Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

(4) Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

(5) The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

(6) The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

(7) All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

  (a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);

(b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;

(c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;

(d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;

(e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry of Estonia have therefore occurred in 2012, as a consequence of the transition to the CSEUR platform:

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Change of name or contact	National administrator is: Mr Mihkel Visnapuu khgregister@envir.ee tel. +372 6262 829

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(b) Change regarding cooperation arrangement	The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: • **Readiness questionnaire** • **Application logging** • **Change management procedure** • **Disaster recovery** • **Manual Intervention** • **Operational Plan** • **Roles and responsibilities** • **Security Plan** • **Time Validation Plan** • **Version change Management** The documents above are provided as an appendix to this document. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to **successful certification on 1 June 2012.**
15/CMP.1 annex II.E paragraph 32.(d) Change regarding conformance to technical standards	The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012,
15/CMP.1 annex II.E paragraph 32.(e) Change to discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated **manual intervention** document and **the operational plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission..

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(f) Change regarding security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated **security plan**. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(g) Change to list of publicly available information	No change to the list of publicly available information occurred for the reported period.
15/CMP.1 annex II.E paragraph 32.(h) Change of Internet address	The new internet address of the Estonian registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/EE/index.xhtml
15/CMP.1 annex II.E paragraph 32.(i) Change regarding data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated **disaster recovery plan.** The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(j) Change regarding test results	On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.
The previous Annual Review recommendations	There were no recommendations proposed in previous Annual Review Report.

3. PART III. APPENDIXES

Appendix 1 – Report R-1: SEF_2012

Due to the technical problems in the centralized European Union registry the SEF report may include minor inaccuracies. Therefore Estonia is planning to resubmit SEF as soon as final corrected data becomes available.

UNFCCC SEF application

Version 1.2

Workflow

Unlock file

Completeness Check

Consistency Check

Lock file

Functions

Mandatory data

Import XML

Reset SEF

Export XML

Settings

Party:	Estonia
ISO:	EE
Submission year:	2013
Reported year:	2012
Commitment period:	1
Completeness check:	YES
Consistency check:	YES
File locked:	YES
Lock timestamp:	10.04.2013 17:20
Submission version number:	1
Submission type:	Official

Party	Estonia
Submission year	2013
Reported year	2012
Commitment period	1

Table 1. Total quantities of Kyoto Protocol units by account type at beginning of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	ICERs
Party holding accounts	101775558	13448	NO	NO	NO	NO
Entity holding accounts	4278459	NO	NO	957	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	210000	NO	NO	NO	NO	NO
Retirement account	38013117	NO	NO	NO	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
ICER replacement account for expiry	NO	NO	NO	NO		
ICER replacement account for reversal of storage	NO	NO	NO	NO		NO
ICER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	144277134	13448	NO	957	NO	NO

Party	Estonia
Submission year	2013
Reported year	2012
Commitment period	1

Table 2 (a). Annual internal transactions

Transaction type	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Article 6 issuance and conversion												
Party-verified projects		580442					580442		NO			
Independently verifed projects		NO					NO		NO			
Article 3.3 and 3.4 issuance or cancellation												
3.3 Afforestation and reforestation			NO				NO	NO	NO	NO		
3.3 Deforestation			NO				NO	NO	NO	NO		
3.4 Forest management			NO				NO	NO	NO	NO		
3.4 Cropland management			NO				NO	NO	NO	NO		
3.4 Grazing land management			NO				NO	NO	NO	NO		
3.4 Revegetation			NO				NO	NO	NO	NO		
Article 12 afforestation and reforestation												
Replacement of expired tCERs							NO	NO	NO	NO	NO	
Replacement of expired lCERs							NO	NO	NO	NO		
Replacement for reversal of storage							NO	NO	NO	NO		NO
Replacement for non-submission of certification report							NO	NO	NO	NO		NO
Other cancellation							NO	NO	NO	NO	NO	NO
Sub-total		580442	NO				580442	NO	NO	NO	NO	NO

Transaction type	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Retirement	1,5E+07	141034	NO	16555	NO	NO

Party	Estonia
Submission year	2013
Reported year	2012
Commitment period	1

Add registry   Delete registry

Table 2 (b). Annual external transactions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Transfers and acquisitions												
CZ	32000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
FR	11000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SK	686000	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CH	NO	52566	NO	NO	NO	NO	1546450	NO	NO	NO	NO	NO
FI	NO	NO	NO	15598	NO	NO	76098	121913	NO	NO	NO	NO
NL	NO	52323	NO	12996	NO	NO	82931	99469	NO	NO	NO	NO
GB	6465	90482	NO	NO	NO	NO	4000	NO	NO	NO	NO	NO
DE	NO	NO	NO	NO	NO	NO	698000	NO	NO	NO	NO	NO
AT	NO	NO	NO	NO	NO	NO	1,1E+07	120220	NO	NO	NO	NO
UA	NO	3440008	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
EU	NO	24837	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SE	NO	NO	NO	NO	NO	NO	NO	154025	NO	NO	NO	NO
Sub-total	735465	3660216	NO	28594	NO	NO	1,3E+07	495627	NO	NO	NO	NO

Additional information

Independently verified ERUs								NO				

Table 2 (c). Total annual transactions

Total (Sum of tables 2a and 2b)	735465	4240658	NO	28594	NO	NO	1,4E+07	495627	NO	NO	NO	NO

Party	Estonia
Submission year	2013
Reported year	2012
Commitment period	1

Table 3. Expiry, cancellation and replacement

Transaction or event type	Expiry, cancellation and requirement to replace		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Temporary CERs (tCERS)								
Expired in retirement and replacement accounts	NO							
Replacement of expired tCERs			NO	NO	NO	NO	NO	
Expired in holding accounts	NO							
Cancellation of tCERs expired in holding accounts	NO							
Long-term CERs (lCERs)								
Expired in retirement and replacement accounts		NO						
Replacement of expired lCERs			NO	NO	NO	NO		
Expired in holding accounts		NO						
Cancellation of lCERs expired in holding accounts		NO						
Subject to replacement for reversal of storage		NO						
Replacement for reversal of storage			NO	NO	NO	NO		NO
Subject to replacement for non-submission of certification report		NO						
Replacement for non-submission of certification report			NO	NO	NO	NO		NO
Total			NO	NO	NO	NO	NO	NO

Party	Estonia
Submission year	2013
Reported year	2012
Commitment period	1

Table 4. Total quantities of Kyoto Protocol units by account type at end of reported year

Account type	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Party holding accounts	77786178	98263	NO	NO	NO	NO
Entity holding accounts	NO	3519182	NO	12996	NO	NO
Article 3.3/3.4 net source cancellation accounts	NO	NO	NO	NO		
Non-compliance cancellation accounts	NO	NO	NO	NO		
Other cancellation accounts	210000	NO	NO	NO	NO	NO
Retirement account	53085500	141034	NO	16555	NO	NO
tCER replacement account for expiry	NO	NO	NO	NO	NO	
lCER replacement account for expiry	NO	NO	NO	NO		
lCER replacement account for reversal of storage	NO	NO	NO	NO		NO
lCER replacement account for non-submission of certification report	NO	NO	NO	NO		NO
Total	131081678	3758479	NO	29551	NO	NO

Party	Estonia
Submission year	2013
Reported year	2012
Commitment perio(	1

Table 5 (a). Summary information on additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
Starting values	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Issuance pursuant to Article 3.7 and	2E+08											
Non-compliance cancellation							NO	NO	NO	NO		
Carry-over	NO	NO		NO								
Sub-total	2E+08	NO		NO			NO	NO	NO	NO		
Annual transactions												
Year 0 (2007)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 1 (2008)	1238538	NO	NO	NO	NO	NO	90538	NO	NO	NO	NO	NO
Year 2 (2009)	309318	44934	NO	957	NO	NO	1056151	NO	NO	NO	NO	NO
Year 3 (2010)	2,3E+07	337510	NO	NO	NO	NO	4,2E+07	184371	NO	NO	NO	NO
Year 4 (2011)	5443848	334550	NO	NO	NO	NO	3,8E+07	519175	NO	NO	NO	NO
Year 5 (2012)	735465	4240658	NO	28594	NO	NO	1,4E+07	495627	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Sub-total	3,1E+07	4957652	NO	29551	NO	NO	9,6E+07	1199173	NO	NO	NO	NO
Total	2,3E+08	4957652	NO	29551	NO	NO	9,6E+07	1199173	NO	NO	NO	NO

Table 5 (b). Summary information on replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Previous CPs			NO	NO	NO	NO	NO	NO
Year 1 (2008)		NO	NO	NO	NO	NO	NO	NO
Year 2 (2009)		NO	NO	NO	NO	NO	NO	NO
Year 3 (2010)		NO	NO	NO	NO	NO	NO	NO
Year 4 (2011)		NO	NO	NO	NO	NO	NO	NO
Year 5 (2012)	NO	NO	NO	NO	NO	NO	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO	NO	NO
Total	NO	NO	NO	NO	NO	NO	NO	NO

Table 5 (c). Summary information on retirement

	Retirement					
	Unit type					
Year	AAUs	ERUs	RMUs	CERs	tCERs	lCERs
Year 1 (2008)	NO	NO	NO	NO	NO	NO
Year 2 (2009)	1,4E+07	NO	NO	NO	NO	NO
Year 3 (2010)	1E+07	NO	NO	NO	NO	NO
Year 4 (2011)	1,4E+07	NO	NO	NO	NO	NO
Year 5 (2012)	1,5E+07	141034	NO	16555	NO	NO
Year 6 (2013)	NO	NO	NO	NO	NO	NO
Year 7 (2014)	NO	NO	NO	NO	NO	NO
Year 8 (2015)	NO	NO	NO	NO	NO	NO
Total	5,3E+07	141034	NO	16555	NO	NO

Party Estonia
Submission year 2013
Reported year 2012
Commitment period 1

Add transaction | Delete transaction | No corrective transaction

Table 6 (a). Memo item: Corrective transactions relating to additions and subtractions

	Additions						Subtractions					
	Unit type						Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Add transaction | Delete transaction | No corrective transaction

Table 6 (b). Memo item: Corrective transactions relating to replacement

	Requirement for replacement		Replacement					
	Unit type		Unit type					
	tCERs	lCERs	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Add transaction | Delete transaction | No corrective transaction

Table 6 (c). Memo item: Corrective transactions relating to retirement

	Retirement					
	Unit type					
	AAUs	ERUs	RMUs	CERs	tCERs	lCERs

Appendix 2 – Report R-2: List of Discrepant Transactions

No discrepant transactions to list for the reporting period.

Appendix 3 – Report R-3, Report R-4 and Report R-5

List of CDM Notifications - No CDM notifications where received during the reporting period.

List of Non-replacements - No non-replacements occurred during the reporting period.

List of Invalid Units - No invalid units to list for the reporting period.

Appendix 4 – Further Detailed Information about Reporting Changes to National Registry

The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012.

A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes:

- **Readiness questionnaire**
- **Application logging**
- **Change management procedure**
- **Disaster recovery**
- **Manual Intervention**
- **Operational Plan**
- **Roles and responsibilities**
- **Security Plan**
- **Time Validation Plan**
- **Version change Management**

The documentation is annexed to this submission separately.

REFERENCES

1. Greenhouse Gas emissions in Estonia 1990–2011. National Inventory Report under the UNFCCC and the Kyoto Protocol. Common Reporting Formats (CRF) 1990-2011. Tallinn 2013 (http://www.envir.ee/1156156);

2. Report of the individual review of the annual submission of Estonia submitted in 2012. FCCC/ARR/2012/EST. Distr.: General 15 February 2013.

Annex 7. Uncertainty analysis

Annex 7 provides the mandatory reporting table for uncertainty analysis. As Estonia reports the results of tier 1 analysis, table 6.1 of IPCC good practice guidance is used.

Table A.7.1. Tier 1 uncertainty analysis excluding LULUCF sector

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO2	4 825,04	339,06	1,70%	1,80%	2,48%	0,04%	-0,0531	0,0084	-0,10%	0,02%	0,10%	E1
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO2	21 889,13	13 162,32	3,30%	38,90%	39,04%	24,52%	0,0453	0,3247	1,76%	1,52%	2,33%	E1
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	CO2	1 968,74	913,99	1,40%	3,60%	3,86%	0,17%	-0,0026	0,0225	-0,01%	0,04%	0,05%	E1
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CH4	3,97	0,28	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CH4	1,28	1,32	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	CH4	0,75	0,35	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.1.a	Energy Industries/Electricity and Heat Production - Biomass	CH4	1,54	11,17	5,00%	50,00%	50,25%	0,03%	0,0003	0,0003	0,01%	0,00%	0,01%	E2, E4
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	N2O	11,72	0,84	5,00%	60,00%	60,21%	0,00%	-0,0001	0,0000	-0,01%	0,00%	0,01%	E2, E4
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	N2O	3,98	9,04	5,00%	60,00%	60,21%	0,03%	0,0002	0,0002	0,01%	0,00%	0,01%	E2, E4
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	N2O	1,11	0,52	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.1.a	Energy Industries/Electricity and Heat Production - Biomass	N2O	3,03	21,99	5,00%	60,00%	60,21%	0,06%	0,0005	0,0005	0,03%	0,00%	0,03%	E2, E4
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO2	65,20	413,74	3,30%	38,90%	39,04%	0,77%	0,0094	0,0102	0,36%	0,05%	0,37%	E1
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CH4	0,07	0,41	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	N2O	0,10	0,60	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.a	Manufacturing Industries and Constructions - Iron and steel - Solid Fuels	CO2	3,07	0,00	3,30%	38,90%	39,04%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.a	Manufacturing Industries and Constructions - Iron and steel - Gaseous Fuels	CO2	0,00	0,11	1,40%	3,60%	3,86%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.a	Manufacturing Industries and Constructions - Iron and steel - Solid Fuels	CH4	0,01	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.a	Manufacturing Industries and Constructions/Iron and steel - Gaseous Fuels	CH4	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.a	Manufacturing Industries and Constructions/Iron and steel - Solid Fuels	N2O	0,01	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.a	Manufacturing Industries and Constructions/Iron and steel - Gaseous Fuels	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	CO2	0,00	0,07	1,70%	1,80%	2,48%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	CH4	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO2	620,79	0,00	3,30%	38,90%	39,04%	0,00%	-0,0079	0,0000	-0,31%	0,00%	0,31%	E1
1.A.2.c	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	CO2	12,50	6,99	1,70%	1,80%	2,48%	0,00%	0,0000	0,0002	0,00%	0,00%	0,00%	E1

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Gaseous Fuels	CO2	165,88	5,50	1,40%	3,60%	3,86%	0,00%	-0,0020	0,0001	-0,01%	0,00%	0,01%	E1
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CH4	0,35	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.c	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	CH4	0,01	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Gaseous Fuels	CH4	0,32	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Biomass	CH4	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	N2O	0,13	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Liquid Fuels	N2O	0,03	0,01	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Gaseous Fuels	N2O	0,09	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Biomass	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print - Liquid Fuels	CO2	0,00	0,06	1,70%	1,80%	2,48%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print- Gaseous Fuels	CO2	0,00	2,25	1,40%	3,60%	3,86%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	E1
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print - Liquid Fuels	CH4	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print- Gaseous Fuels	CH4	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print - Liquid Fuels	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print- Gaseous Fuels	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Solid Fuels	CO2	4,62	0,00	3,30%	38,90%	39,04%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	438,64	1,79	1,70%	1,80%	2,48%	0,00%	-0,0055	0,0000	-0,01%	0,00%	0,01%	E1
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	14,79	1,37	1,40%	3,60%	3,86%	0,00%	-0,0002	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Solid Fuels	CH4	0,01	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	0,25	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0,03	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Biomass	CH4	0,10	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Solid Fuels	N2O	0,02	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	1,11	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0,01	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Biomass	N2O	0,20	0,01	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO2	792,78	448,98	3,30%	38,90%	39,04%	0,84%	0,0010	0,0111	0,04%	0,05%	0,06%	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Liquid Fuels	CO2	324,77	146,17	1,70%	1,80%	2,48%	0,02%	-0,0005	0,0036	0,00%	0,01%	0,01%	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Gaseous Fuels	CO2	99,68	82,20	1,40%	3,60%	3,86%	0,02%	0,0008	0,0020	0,00%	0,00%	0,00%	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CH4	1,71	0,96	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.f	Manufacturing Industries and Constructions/Other - Liquid Fuels	CH4	0,18	0,09	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.f	Manufacturing Industries and Constructions/Other - Gaseous Fuels	CH4	0,19	0,16	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.f	Manufacturing Industries and Constructions/Other - Biomass	CH4	0,06	0,14	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	N2O	3,59	2,02	5,00%	60,00%	60,21%	0,01%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Liquid Fuels	N2O	0,80	0,36	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Gaseous Fuels	N2O	0,06	0,05	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Biomass	N2O	0,11	0,29	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CO2	0,00	88,51	5,00%	60,00%	60,21%	0,25%	0,0022	0,0022	0,13%	0,02%	0,13%	E2, E4
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CH4	0,00	0,71	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2	Manufacturing Industries and Constructions - Other Fuels	N2O	0,00	1,39	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.3.A	Civil Aviation - Liquid Fuels	CO2	5,69	2,77	1,70%	1,80%	2,48%	0,00%	0,0000	0,0001	0,00%	0,00%	0,00%	E1
1.A.3.B	Road Transport - Liquid Fuels	CO2	2236,11	2113,72	1,70%	1,80%	2,48%	0,25%	0,0236	0,0521	0,04%	0,13%	0,13%	E1
1.A.3.C	Railway - Liquid Fuels	CO2	143,06	105,74	1,70%	1,80%	2,48%	0,01%	0,0008	0,0026	0,00%	0,01%	0,01%	E1
1.A.3.C	Railways - Solid Fuels	CO2	11,46	0,00	3,30%	38,90%	39,04%	0,00%	-0,0001	0,0000	-0,01%	0,00%	0,01%	E1
1.A.3.D.	Navigation - Liquid fuels	CO2	21,86	14,74	1,70%	1,80%	2,48%	0,00%	0,0001	0,0004	0,00%	0,00%	0,00%	E1
1.A.3.A	Civil Aviation - Liquid Fuels	CH4	0,01	0,00	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.B	Road Transport - Liquid Fuels	CH4	19,08	4,19	5,00%	40,00%	40,31%	0,01%	-0,0001	0,0001	-0,01%	0,00%	0,01%	E5
1.A.3.B	Road Transport - Biomass (Biofuels)	CH4	0,00	0,01	5,00%	100,00%	100,12%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5, E4
1.A.3.C	Railway - Liquid Fuels	CH4	0,20	0,15	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.C	Railways - Solid Fuels	CH4	0,02	0,00	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.D.	Navigation - Liquid fuels	CH4	0,03	0,02	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
1.A.3.A	Civil Aviation - Liquid Fuels	N2O	0,06	0,03	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.B	Road Transport - Liquid Fuels	N2O	22,43	18,17	5,00%	50,00%	50,25%	0,04%	0,0002	0,0004	0,01%	0,00%	0,01%	E5
1.A.3.B	Road Transport - Biomass (Biofuels)	N2O	0,00	0,03	5,00%	150,00%	150,08%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5, E4
1.A.3.C	Railway - Liquid Fuels	N2O	0,36	0,27	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.C	Railways - Solid Fuels	N2O	0,05	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.D.	Navigation - Liquid fuels	N2O	0,06	0,04	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.4.a	Other Sectors/Commercial - Solid Fuels	CO2	8,07	1,45	3,30%	38,90%	39,04%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	E1
1.A.4.a	Other Sectors/Commercial - Liquid Fuels	CO2	18,73	1,23	1,70%	1,80%	2,48%	0,00%	-0,0002	0,0000	0,00%	0,00%	0,00%	E1
1.A.4.a	Other Sectors/Commercial - Gaseous Fuels	CO2	20,34	41,46	1,40%	3,60%	3,86%	0,01%	0,0008	0,0010	0,00%	0,00%	0,00%	E1
1.A.4.a	Other Sectors/Commercial - Solid Fuels	CH4	0,05	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.a	Other Sectors/Commercial - Liquid Fuels	CH4	0,05	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.a	Other Sectors/Commercial - Gaseous Fuels	CH4	0,04	0,08	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.a	Other Sectors/Commercial - Biomass	CH4	2,49	0,81	10,00%	150,00%	150,33%	0,01%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.a	Other Sectors/Commercial - Solid Fuels	N2O	0,06	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.a	Other Sectors/Commercial - Liquid Fuels	N2O	0,05	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.a	Other Sectors/Commercial - Gaseous Fuels	N2O	0,01	0,02	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.a	Other Sectors/Commercial - Biomass	N2O	0,49	0,16	10,00%	150,00%	150,33%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO2	669,20	44,11	3,30%	38,90%	39,04%	0,08%	-0,0074	0,0011	-0,29%	0,01%	0,29%	E1
1.A.4.b	Other Sectors/Residential - Liquid Fuels	CO2	549,84	40,95	1,70%	1,80%	2,48%	0,00%	-0,0060	0,0010	-0,01%	0,00%	0,01%	E1
1.A.4.b	Other Sectors/Residential - Gaseous Fuels	CO2	116,28	117,38	1,40%	3,60%	3,86%	0,02%	0,0014	0,0029	0,01%	0,01%	0,01%	E1
1.A.4.b	Other Sectors/Residential - Solid Fuels	CH4	25,92	1,98	5,00%	50,00%	50,25%	0,00%	-0,0003	0,0000	-0,01%	0,00%	0,01%	E2, E3
1.A.4.b	Other Sectors/Residential - Liquid Fuels	CH4	1,53	0,47	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.b	Other Sectors/Residential - Gaseous Fuels	CH4	0,22	0,22	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.b	Other Sectors/Residential - Biomass	CH4	33,67	96,16	10,00%	150,00%	150,33%	0,69%	0,0019	0,0024	0,29%	0,03%	0,29%	E2, E4
1.A.4.b	Other Sectors/Residential - Solid Fuels	N2O	8,72	0,57	5,00%	50,00%	50,25%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.b	Other Sectors/Residential - Liquid Fuels	N2O	1,24	0,55	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.b	Other Sectors/Residential - Gaseous Fuels	N2O	0,07	0,07	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.b	Other Sectors/Residential - Biomass	N2O	6,63	18,93	10,00%	150,00%	150,33%	0,14%	0,0004	0,0005	0,06%	0,01%	0,06%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Solid Fuels	CO2	16,08	0,10	3,30%	38,90%	39,04%	0,00%	-0,0002	0,0000	-0,01%	0,00%	0,01%	E1

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			1990	2011	AD	EF					due to EF	due to AD		
1.A.4.c	Other Sectors/Agriculture - Liquid Fuels	CO2	476,37	246,21	1,70%	1,80%	2,48%	0,03%	0,0000	0,0061	0,00%	0,01%	0,01%	E1
1.A.4.c	Other Sectors/Agriculture - Gaseous Fuels	CO2	3,68	3,63	1,40%	3,60%	3,86%	0,00%	0,0000	0,0001	0,00%	0,00%	0,00%	E1
1.A.4.c	Other Sectors/Agriculture - Solid Fuels	CH4	1,05	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.c	Other Sectors/Agriculture - Liquid Fuels	CH4	2,31	0,40	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.c	Other Sectors/Agriculture - Gaseous Fuels	CH4	0,01	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.c	Other Sectors/Agriculture - Biomass	CH4	1,25	0,14	10,00%	150,00%	150,33%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Solid Fuels	N2O	0,07	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Liquid Fuels	N2O	43,64	23,46	5,00%	50,00%	50,25%	0,06%	0,0000	0,0006	0,00%	0,00%	0,00%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Gaseous Fuels	N2O	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Biomass	N2O	0,25	0,03	10,00%	150,00%	150,33%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.5	Other - Liquid Fuels	CO2	43,54	19,82	1,70%	1,80%	2,48%	0,00%	-0,0001	0,0005	0,00%	0,00%	0,00%	E1
1.A.5	Other - Liquid Fuels	CH4	0,05	0,02	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.5	Other - Liquid Fuels	N2O	0,77	0,33	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.B.2	Oil and Natural Gas	CH4	181,10	75,14	10,00%	25,00%	26,93%	0,10%	-0,0005	0,0019	-0,01%	0,03%	0,03%	E6
2.A.1	Cement Production	CO2	483,04	416,12	2,00%	5,00%	5,39%	0,11%	0,0041	0,0103	0,02%	0,03%	0,04%	I1
2.A.2	Lime Production	CO2	131,30	23,14	5,00%	5,00%	7,07%	0,01%	-0,0011	0,0006	-0,01%	0,00%	0,01%	I2
2.A.4.2	Soda Ash Use	CO2	0,31	0,52	10,00%	5,00%	11,18%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I2
2.A.7.1	Glass Production	CO2	1,23	10,87	10,00%	10,00%	14,14%	0,01%	0,0003	0,0003	0,00%	0,00%	0,00%	I2
2.A.7.2a	Ceramics Production - Bricks and Tiles	CO2	12,30	1,98	10,00%	5,00%	11,18%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	I3
2.B.1	Ammonia Production	CO2	420,05	0,00	5,00%	10,00%	11,18%	0,00%	-0,0054	0,0000	-0,05%	0,00%	0,05%	I2
2.F.1.1	Domestic Refrigeration	HFCs	0,00	0,15	10,00%	10,00%	14,14%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.1.2	Commercial Refrigeration	HFCs	0,00	45,78	20,0%	10,0%	22,36%	0,05%	0,0011	0,0011	0,01%	0,03%	0,03%	I4
2.F.1.3	Transport Refrigeration - Refrigerated Vehicles	HFCs	0,00	15,39	8,5%	5,0%	9,86%	0,01%	0,0004	0,0004	0,00%	0,00%	0,00%	I4
2.F.1.3	Transport Refrigeration - Reefer Containers	HFCs	0,00	0,96	8,4%	5,0%	9,78%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.1.4	Industrial Refrigeration	HFCs	0,00	29,35	26,00%	15,00%	30,02%	0,04%	0,0007	0,0007	0,01%	0,03%	0,03%	I4
2.F.1.5	Stationary Air-Conditioning - Heat Pumps	HFCs	0,00	2,92	9,00%	5,00%	10,30%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.1.5	Stationary Air-Conditioning - Stationary and Room Air-Conditioning	HFCs	0,00	15,80	15,00%	18,00%	23,43%	0,02%	0,0004	0,0004	0,01%	0,01%	0,01%	I4
2.F.1.6	Mobile Air-Conditioning - Passenger Cars	HFCs	0,00	24,00	8,5%	5,0%	9,86%	0,01%	0,0006	0,0006	0,00%	0,01%	0,01%	I4
2.F.1.6	Mobile Air-Conditioning - Trucks	HFCs	0,00	4,85	8,5%	5,0%	9,86%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4

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			1990	2011	AD	EF					due to EF	due to AD		
2.F.1.6	Mobile Air-Conditioning - Buses	HFCs	0,00	2,05	8,7%	5,0%	10,03%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.1.6	Mobile Air-Conditioning - Ships	HFCs	0,00	4,40	3,0%	4,0%	5,00%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.1.6	Mobile Air-Conditioning - Railcars	HFCs	0,00	0,26	3,0%	5,0%	5,83%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.1.6	Mobile Air-Conditioning - Wheel Tractors and Mobile Machinery	HFCs	0,00	3,33	14,5%	10,0%	17,61%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.2	...PU Insulation Panels	HFCs	0,00	0,10	10,0%	10,0%	14,14%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.2	...Spray and Injection PU Foam	HFCs	0,00	0,00	10,0%	10,0%	14,14%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.2	...XPS Insulation Foam	HFCs	0,00	0,07	20,0%	10,0%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.2	...One Component PU Foam	HFCs	0,00	5,15	15,0%	0,0%	15,00%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.3	Fire Extinguishers	HFCs	0,00	1,87	10,00%	10,00%	14,14%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.4	...Metered Dose Inhalers	HFCs	0,00	2,94	10,0%	0,0%	10,00%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.8	Electrical equipment	SF6	0,00	1,75	3,00%	10,00%	10,44%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.9	Other Electrical Equipment	SF6	0,00	0,07	21,00%	21,00%	29,70%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
3.D	Solvent and Other Product Use	N2O	5,67	4,90	5,00%	2,00%	5,39%	0,00%	0,0000	0,0001	0,00%	0,00%	0,00%	S1
3	Solvent and Other Product Use (indirect CO2 emissions from NMVOC)	CO2	20,77	13,95	25,00%	10,00%	26,93%	0,02%	0,0001	0,0003	0,00%	0,01%	0,01%	S2
4.A	Enteric Fermentation - Dairy Cattle	CH4	583,676	259,14	10,00%	50,00%	50,99%	0,63%	-0,0010	0,0064	-0,05%	0,09%	0,10%	A1
4.A	Enteric Fermentation - Non-Dairy Cattle	CH4	389,022	126,82	10,00%	50,00%	50,99%	0,31%	-0,0018	0,0031	-0,09%	0,04%	0,10%	A2
4.A	Enteric Fermentation - Sheep	CH4	23,184	14,10	10,00%	25,00%	26,93%	0,02%	0,0001	0,0003	0,00%	0,00%	0,01%	A3
4.A	Enteric Fermentation - Goats	CH4	0,189	0,45	10,00%	25,00%	26,93%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A4
4.A	Enteric Fermentation - Horses	CH4	3,251	2,46	10,00%	25,00%	26,93%	0,00%	0,0000	0,0001	0,00%	0,00%	0,00%	A5
4.A	Enteric Fermentation - Swine	CH4	17,492	7,59	10,00%	50,00%	50,99%	0,02%	0,0000	0,0002	0,00%	0,00%	0,00%	A6
4.A	Enteric Fermentation - Fur animals	CH4	0,200	0,12	10,00%	50,00%	50,99%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A7
4.B	Manure Management - Dairy Cattle	CH4	14,324	20,84	10,00%	25,00%	26,93%	0,03%	0,0003	0,0005	0,01%	0,01%	0,01%	A8
4.B	Manure Management -Non-Dairy Cattle	CH4	7,997	5,37	10,00%	25,00%	26,93%	0,01%	0,0000	0,0001	0,00%	0,00%	0,00%	A9
4.B	Manure Management - Sheep	CH4	0,551	0,33	10,00%	20,00%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A10
4.B	Manure Management - Goats	CH4	0,005	0,01	10,00%	20,00%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A11
4.B	Manure Management - Horses	CH4	0,253	0,19	10,00%	20,00%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A12
4.B	Manure Management - Swine	CH4	41,562	15,19	10,00%	25,00%	26,93%	0,02%	-0,0002	0,0004	0,00%	0,01%	0,01%	A13
4.B	Manure Management - Poultry	CH4	10,707	3,33	10,00%	20,00%	22,36%	0,00%	-0,0001	0,0001	0,00%	0,00%	0,00%	A14
4.B	Manure Management - Fur animals	CH4	0,266	0,16	10,00%	20,00%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A15

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
4.B	Manure Management - Anaerobic Lagoon	N2O	0,000	0,00	26,93%	100,00%	103,56%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A16
4.B	Manure Management - Liquid system	N2O	3,467	2,85	26,93%	100,00%	103,56%	0,01%	0,0000	0,0001	0,00%	0,00%	0,00%	A17
4.B	Manure Management - Solid Storage and Dry Lot	N2O	303,383	96,13	26,93%	100,00%	103,56%	0,48%	-0,0015	0,0024	-0,15%	0,09%	0,17%	A18
4.B	Manure Management - Other AWMS	N2O	0,000	5,70	26,93%	100,00%	103,56%	0,03%	0,0001	0,0001	0,01%	0,01%	0,02%	A19
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N2O	394,799	163,33	5,00%	85,44%	85,59%	0,67%	-0,0010	0,0040	-0,09%	0,03%	0,09%	A20
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N2O	186,358	79,37	26,93%	89,44%	93,41%	0,35%	-0,0004	0,0020	-0,04%	0,07%	0,08%	A21
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N2O	247,950	47,75	0,00%	80,00%	80,00%	0,18%	-0,0020	0,0012	-0,16%	0,00%	0,16%	A22
4.D.1.4	Direct Soil Emissions - Crop Residue	N2O	68,372	26,14	0,00%	80,00%	80,00%	0,10%	-0,0002	0,0006	-0,02%	0,00%	0,02%	A23
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N2O	88,927	82,89	0,00%	80,00%	80,00%	0,32%	0,0009	0,0020	0,07%	0,00%	0,07%	A24
4.D.1.6	Direct Soil Emissions - Sludge	N2O	0,200	0,89	10,00%	79,00%	79,63%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A25
4.D.2	Pasture, Range and Paddock Manure	N2O	202,302	74,45	26,93%	100,00%	103,56%	0,37%	-0,0007	0,0018	-0,07%	0,07%	0,10%	A26
4.D.3.1	Indirect Emissions - Atmospheric Deposition	N2O	92,631	38,00	57,01%	100,00%	115,11%	0,21%	-0,0002	0,0009	-0,02%	0,08%	0,08%	A27
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N2O	478,964	196,93	169,23%	380,00%	415,98%	3,91%	-0,0012	0,0049	-0,47%	1,16%	1,26%	A28
4.F.1	Field Burning of Agricultural Residues - Cereals	CH4	4,979	0,00	20,00%	40,00%	44,72%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	A29
4.F.1	Field Burning of Agricultural Residues - Cereals	N2O	1,017	0,00	20,00%	29,00%	35,23%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A30
4.F.2	Field Burning of Agricultural Residues - Pulse	CH4	0,001	0,00	20,00%	40,00%	44,72%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A31
4.F.2	Field Burning of Agricultural Residues - Pulse	N2O	0,001	0,00	20,00%	29,00%	35,23%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A32
4.F.3	Field Burning of Agricultural Residues - Tuber and Root	CH4	0,506	0,00	20,00%	40,00%	44,72%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A33
4.F.3	Field Burning of Agricultural Residues - Tuber and Root	N2O	0,310	0,00	20,00%	29,00%	35,23%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A34
6.A	Solid Waste Disposal on Land	CH4	179,67	254,31	10,00%	83,07%	83,67%	1,02%	0,0040	0,0063	0,33%	0,09%	0,34%	W1
6.B.1	Industrial Wastewater	CH4	106,73	5,21	25,00%	104,40%	107,35%	0,03%	-0,0012	0,0001	-0,13%	0,00%	0,13%	W2
6.B.2	Domestic and Commercial Wastewater (anaerobic)	CH4	8,13	0,77	5,00%	42,43%	42,72%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	W3
6.B.2.2	Domestic and Commercial Wastewater - human sewage	N2O	45,84	34,40	5,00%	100,00%	100,12%	0,16%	0,0003	0,0008	0,03%	0,01%	0,03%	W4
6.C	Waste incineration	CO2	0,03	0,00	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	W5
6.C	Waste incineration	N2O	2,06	0,00	5,00%	100,00%	100,12%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	W5
6.D	Biological Treatment	CH4	0,60	45,59	10,00%	100,00%	100,50%	0,22%	0,0011	0,0011	0,11%	0,02%	0,11%	W6
6.D	Biological Treatment	N2O	0,66	50,47	10,00%	100,00%	100,50%	0,24%	0,0012	0,0012	0,12%	0,02%	0,12%	W6
6.D	Biogas burnt in a flare	CH4	0,00	0,01	5,00%	25,00%	25,50%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	W7
6.D	Biogas burnt in a flare	N2O	0,00	0,00	5,00%	25,00%	25,50%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	W7

Table A.7.2. Tier 1 uncertainty analysis including LULUCF sector

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CO2	4 825,04	339,06	1,70%	1,80%	2,48%	0,05%	-0,0694	0,0107	-0,12%	0,03%	0,13%	E1
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CO2	21 889,13	13 162,32	3,30%	38,90%	39,04%	30,78%	0,0512	0,4153	1,99%	1,94%	2,78%	E1
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	CO2	1 968,74	913,99	1,40%	3,60%	3,86%	0,21%	-0,0039	0,0288	-0,01%	0,06%	0,06%	E1
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	CH4	3,97	0,28	5,00%	50,00%	50,25%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	CH4	1,28	1,32	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	CH4	0,75	0,35	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.1.a	Energy Industries/Electricity and Heat Production - Biomass	CH4	1,54	11,17	5,00%	50,00%	50,25%	0,03%	0,0003	0,0004	0,02%	0,00%	0,02%	E2, E4
1.A.1.a	Energy Industries/Electricity and Heat Production - Liquid Fuels	N2O	11,72	0,84	5,00%	60,00%	60,21%	0,00%	-0,0002	0,0000	-0,01%	0,00%	0,01%	E2, E4
1.A.1.a	Energy Industries/Electricity and Heat Production - Solid Fuels	N2O	3,98	9,04	5,00%	60,00%	60,21%	0,03%	0,0002	0,0003	0,01%	0,00%	0,01%	E2, E4
1.A.1.a	Energy Industries/Electricity and Heat Production - Gaseous Fuels	N2O	1,11	0,52	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.1.a	Energy Industries/Electricity and Heat Production - Biomass	N2O	3,03	21,99	5,00%	60,00%	60,21%	0,08%	0,0006	0,0007	0,04%	0,00%	0,04%	E2, E4
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CO2	65,20	413,74	3,30%	38,90%	39,04%	0,97%	0,0120	0,0131	0,47%	0,06%	0,47%	E1
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	CH4	0,07	0,41	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.1.c	Energy Industries/Other Energy Industries - Solid Fuels	N2O	0,10	0,60	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.a	Manufacturing Industries and Constructions - Iron and steel - Solid Fuels	CO2	3,07	0,00	3,30%	38,90%	39,04%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.a	Manufacturing Industries and Constructions - Iron and steel - Gaseous Fuels	CO2	0,00	0,11	1,40%	3,60%	3,86%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.a	Manufacturing Industries and Constructions - Iron and steel - Solid Fuels	CH4	0,01	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.a	Manufacturing Industries and Constructions/Iron and steel - Gaseous Fuels	CH4	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.a	Manufacturing Industries and Constructions/Iron and steel - Solid Fuels	N2O	0,01	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.a	Manufacturing Industries and Constructions/Iron and steel - Gaseous Fuels	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	CO2	0,00	0,07	1,70%	1,80%	2,48%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	CH4	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.b	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CO2	620,79	0,00	3,30%	38,90%	39,04%	0,00%	-0,0103	0,0000	-0,40%	0,00%	0,40%	E1
1.A.2.c	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	CO2	12,50	6,99	1,70%	1,80%	2,48%	0,00%	0,0000	0,0002	0,00%	0,00%	0,00%	E1

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Gaseous Fuels	CO2	165,88	5,50	1,40%	3,60%	3,86%	0,00%	-0,0026	0,0002	-0,01%	0,00%	0,01%	E1
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	CH4	0,35	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.c	Manufacturing Industries and Constructions/Non-Ferrous Metals - Liquid Fuels	CH4	0,01	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Gaseous Fuels	CH4	0,32	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Biomass	CH4	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Solid Fuels	N2O	0,13	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Liquid Fuels	N2O	0,03	0,01	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Gaseous Fuels	N2O	0,09	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.c	Manufacturing Industries and Constructions/Chemicals - Biomass	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print - Liquid Fuels	CO2	0,00	0,06	1,70%	1,80%	2,48%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print-Gaseous Fuels	CO2	0,00	2,25	1,40%	3,60%	3,86%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	E1
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print - Liquid Fuels	CH4	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print-Gaseous Fuels	CH4	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print - Liquid Fuels	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.d	Manufacturing Industries and Constructions/Pulp, Paper and Print-Gaseous Fuels	N2O	0,00	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Solid Fuels	CO2	4,62	0,00	3,30%	38,90%	39,04%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Liquid Fuels	CO2	438,64	1,79	1,70%	1,80%	2,48%	0,00%	-0,0072	0,0001	-0,01%	0,00%	0,01%	E1
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Gaseous Fuels	CO2	14,79	1,37	1,40%	3,60%	3,86%	0,00%	-0,0002	0,0000	0,00%	0,00%	0,00%	E1
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Solid Fuels	CH4	0,01	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Liquid Fuels	CH4	0,25	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Gaseous Fuels	CH4	0,03	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Biomass	CH4	0,10	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Solid Fuels	N2O	0,02	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Liquid Fuels	N2O	1,11	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Gaseous Fuels	N2O	0,01	0,00	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.e	Manufacturing Industries and Constructions/Food Processing, Beverages and Tobacco - Biomass	N2O	0,20	0,01	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CO2	792,78	448,98	3,30%	38,90%	39,04%	1,05%	0,0010	0,0142	0,04%	0,07%	0,08%	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Liquid Fuels	CO2	324,77	146,17	1,70%	1,80%	2,48%	0,02%	-0,0008	0,0046	0,00%	0,01%	0,01%	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Gaseous Fuels	CO2	99,68	82,20	1,40%	3,60%	3,86%	0,02%	0,0009	0,0026	0,00%	0,01%	0,01%	E1
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	CH4	1,71	0,96	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.f	Manufacturing Industries and Constructions/Other - Liquid Fuels	CH4	0,18	0,09	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.f	Manufacturing Industries and Constructions/Other - Gaseous Fuels	CH4	0,19	0,16	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.2.f	Manufacturing Industries and Constructions/Other - Biomass	CH4	0,06	0,14	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Solid Fuels	N2O	3,59	2,02	5,00%	60,00%	60,21%	0,01%	0,0000	0,0001	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Liquid Fuels	N2O	0,80	0,36	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Gaseous Fuels	N2O	0,06	0,05	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2.f	Manufacturing Industries and Constructions/Other - Biomass	N2O	0,11	0,29	5,00%	60,00%	60,21%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CO2	0,00	88,51	5,00%	60,00%	60,21%	0,32%	0,0028	0,0028	0,17%	0,02%	0,17%	E2, E4
1.A.2	Manufacturing Industries and Constructions - Other Fuels	CH4	0,00	0,71	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.2	Manufacturing Industries and Constructions - Other Fuels	N2O	0,00	1,39	5,00%	60,00%	60,21%	0,01%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.3.A	Civil Aviation - Liquid Fuels	CO2	5,69	2,77	1,70%	1,80%	2,48%	0,00%	0,0000	0,0001	0,00%	0,00%	0,00%	E1
1.A.3.B	Road Transport - Liquid Fuels	CO2	2 236,11	2 113,72	1,70%	1,80%	2,48%	0,31%	0,0295	0,0667	0,05%	0,16%	0,17%	E1
1.A.3.C	Railway - Liquid Fuels	CO2	143,06	105,74	1,70%	1,80%	2,48%	0,02%	0,0010	0,0033	0,00%	0,01%	0,01%	E1
1.A.3.C	Railways - Solid Fuels	CO2	11,46	0,00	3,30%	38,90%	39,04%	0,00%	-0,0002	0,0000	-0,01%	0,00%	0,01%	E1
1.A.3.D.	Navigation - Liquid fuels	CO2	21,86	14,74	1,70%	1,80%	2,48%	0,00%	0,0001	0,0005	0,00%	0,00%	0,00%	E1
1.A.3.A	Civil Aviation - Liquid Fuels	CH4	0,01	0,00	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.B	Road Transport - Liquid Fuels	CH4	19,08	4,19	5,00%	40,00%	40,31%	0,01%	-0,0002	0,0001	-0,01%	0,00%	0,01%	E5
1.A.3.B	Road Transport - Biomass (Biofuels)	CH4	0,00	0,01	5,00%	100,00%	100,12%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5, E4
1.A.3.C	Railway - Liquid Fuels	CH4	0,20	0,15	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
1.A.3.C	Railways - Solid Fuels	CH4	0,02	0,00	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.D.	Navigation - Liquid fuels	CH4	0,03	0,02	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.A	Civil Aviation - Liquid Fuels	N2O	0,06	0,03	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.B	Road Transport - Liquid Fuels	N2O	22,43	18,17	5,00%	50,00%	50,25%	0,05%	0,0002	0,0006	0,01%	0,00%	0,01%	E5
1.A.3.B	Road Transport - Biomass (Biofuels)	N2O	0,00	0,03	5,00%	150,00%	150,08%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5, E4
1.A.3.C	Railway - Liquid Fuels	N2O	0,36	0,27	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.C	Railways - Solid Fuels	N2O	0,05	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.3.D.	Navigation - Liquid fuels	N2O	0,06	0,04	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.4.a	Other Sectors/Commercial - Solid Fuels	CO2	8,07	1,45	3,30%	38,90%	39,04%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	E1
1.A.4.a	Other Sectors/Commercial - Liquid Fuels	CO2	18,73	1,23	1,70%	1,80%	2,48%	0,00%	-0,0003	0,0000	0,00%	0,00%	0,00%	E1
1.A.4.a	Other Sectors/Commercial - Gaseous Fuels	CO2	20,34	41,46	1,40%	3,60%	3,86%	0,01%	0,0010	0,0013	0,00%	0,00%	0,00%	E1
1.A.4.a	Other Sectors/Commercial - Solid Fuels	CH4	0,05	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.a	Other Sectors/Commercial - Liquid Fuels	CH4	0,05	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.a	Other Sectors/Commercial - Gaseous Fuels	CH4	0,04	0,08	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.a	Other Sectors/Commercial - Biomass	CH4	2,49	0,81	10,00%	150,00%	150,33%	0,01%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.a	Other Sectors/Commercial - Solid Fuels	N2O	0,06	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.a	Other Sectors/Commercial - Liquid Fuels	N2O	0,05	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.a	Other Sectors/Commercial - Gaseous Fuels	N2O	0,01	0,02	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.a	Other Sectors/Commercial - Biomass	N2O	0,49	0,16	10,00%	150,00%	150,33%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.b	Other Sectors/Residential - Solid Fuels	CO2	669,20	44,11	3,30%	38,90%	39,04%	0,10%	-0,0097	0,0014	-0,38%	0,01%	0,38%	E1
1.A.4.b	Other Sectors/Residential - Liquid Fuels	CO2	549,84	40,95	1,70%	1,80%	2,48%	0,01%	-0,0078	0,0013	-0,01%	0,00%	0,01%	E1
1.A.4.b	Other Sectors/Residential - Gaseous Fuels	CO2	116,28	117,38	1,40%	3,60%	3,86%	0,03%	0,0018	0,0037	0,01%	0,01%	0,01%	E1
1.A.4.b	Other Sectors/Residential - Solid Fuels	CH4	25,92	1,98	5,00%	50,00%	50,25%	0,01%	-0,0004	0,0001	-0,02%	0,00%	0,02%	E2, E3
1.A.4.b	Other Sectors/Residential - Liquid Fuels	CH4	1,53	0,47	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.b	Other Sectors/Residential - Gaseous Fuels	CH4	0,22	0,22	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.b	Other Sectors/Residential - Biomass	CH4	33,67	96,16	10,00%	150,00%	150,33%	0,87%	0,0025	0,0030	0,37%	0,04%	0,37%	E2, E4
1.A.4.b	Other Sectors/Residential - Solid Fuels	N2O	8,72	0,57	5,00%	50,00%	50,25%	0,00%	-0,0001	0,0000	-0,01%	0,00%	0,01%	E2, E4
1.A.4.b	Other Sectors/Residential - Liquid Fuels	N2O	1,24	0,55	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.b	Other Sectors/Residential - Gaseous Fuels	N2O	0,07	0,07	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4

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			1990	2011	AD	EF					due to EF	due to AD		
1.A.4.b	Other Sectors/Residential - Biomass	N2O	6,63	18,93	10,00%	150,00%	150,33%	0,17%	0,0005	0,0006	0,07%	0,01%	0,07%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Solid Fuels	CO2	16,08	0,10	3,30%	38,90%	39,04%	0,00%	-0,0003	0,0000	-0,01%	0,00%	0,01%	E1
1.A.4.c	Other Sectors/Agriculture - Liquid Fuels	CO2	476,37	246,21	1,70%	1,80%	2,48%	0,04%	-0,0001	0,0078	0,00%	0,02%	0,02%	E1
1.A.4.c	Other Sectors/Agriculture - Gaseous Fuels	CO2	3,68	3,63	1,40%	3,60%	3,86%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	E1
1.A.4.c	Other Sectors/Agriculture - Solid Fuels	CH4	1,05	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.c	Other Sectors/Agriculture - Liquid Fuels	CH4	2,31	0,40	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.c	Other Sectors/Agriculture - Gaseous Fuels	CH4	0,01	0,01	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E3
1.A.4.c	Other Sectors/Agriculture - Biomass	CH4	1,25	0,14	10,00%	150,00%	150,33%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Solid Fuels	N2O	0,07	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Liquid Fuels	N2O	43,64	23,46	5,00%	50,00%	50,25%	0,07%	0,0000	0,0007	0,00%	0,01%	0,01%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Gaseous Fuels	N2O	0,00	0,00	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.4.c	Other Sectors/Agriculture - Biomass	N2O	0,25	0,03	10,00%	150,00%	150,33%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E2, E4
1.A.5	Other - Liquid Fuels	CO2	43,54	19,82	1,70%	1,80%	2,48%	0,00%	-0,0001	0,0006	0,00%	0,00%	0,00%	E1
1.A.5	Other - Liquid Fuels	CH4	0,05	0,02	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.A.5	Other - Liquid Fuels	N2O	0,77	0,33	5,00%	50,00%	50,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	E5
1.B.2	Oil and Natural Gas	CH4	181,10	75,14	10,00%	25,00%	26,93%	0,12%	-0,0006	0,0024	-0,02%	0,03%	0,04%	E6
2.A.1	Cement Production	CO2	483,04	416,12	2,00%	5,00%	5,39%	0,13%	0,0051	0,0131	0,03%	0,04%	0,05%	I1
2.A.2	Lime Production	CO2	131,30	23,14	5,00%	5,00%	7,07%	0,01%	-0,0015	0,0007	-0,01%	0,01%	0,01%	I2
2.A.4.2	Soda Ash Use	CO2	0,31	0,52	10,00%	5,00%	11,18%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I2
2.A.7.1	Glass Production	CO2	1,23	10,87	10,00%	10,00%	14,14%	0,01%	0,0003	0,0003	0,00%	0,00%	0,01%	I2
2.A.7.2a	Ceramics Production - Bricks and Tiles	CO2	12,30	1,98	10,00%	5,00%	11,18%	0,00%	-0,0001	0,0001	0,00%	0,00%	0,00%	I3
2.B.1	Ammonia Production	CO2	420,05	0,00	5,00%	10,00%	11,18%	0,00%	-0,0070	0,0000	-0,07%	0,00%	0,07%	I2
2.F.1.1	Domestic Refrigeration	HFCs	0,00	0,15	10,00%	10,00%	14,14%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.1.2	Commercial Refrigeration	HFCs	0,00	45,78	20,0%	10,0%	22,36%	0,06%	0,0014	0,0014	0,01%	0,04%	0,04%	I4
2.F.1.3	Transport Refrigeration - Refrigerated Vehicles	HFCs	0,00	15,39	8,5%	5,0%	9,86%	0,01%	0,0005	0,0005	0,00%	0,01%	0,01%	I4
2.F.1.3	Transport Refrigeration - Reefer Containers	HFCs	0,00	0,96	8,4%	5,0%	9,78%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.1.4	Industrial Refrigeration	HFCs	0,00	29,35	26,00%	15,00%	30,02%	0,05%	0,0009	0,0009	0,01%	0,03%	0,04%	I4
2.F.1.5	Stationary Air-Conditioning - Heat Pumps	HFCs	0,00	2,92	9,00%	5,00%	10,30%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.1.5	Stationary Air-Conditioning - Stationary and Room Air-Conditioning	HFCs	0,00	15,80	15,00%	18,00%	23,43%	0,02%	0,0005	0,0005	0,01%	0,01%	0,01%	I4

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			1990	2011	AD	EF					due to EF	due to AD		
2.F.1.6	Mobile Air-Conditioning - Passenger Cars	HFCs	0,00	24,00	8,5%	5,0%	9,86%	0,01%	0,0008	0,0008	0,00%	0,01%	0,01%	I4
2.F.1.6	Mobile Air-Conditioning - Trucks	HFCs	0,00	4,85	8,5%	5,0%	9,86%	0,00%	0,0002	0,0002	0,00%	0,00%	0,00%	I4
2.F.1.6	Mobile Air-Conditioning - Buses	HFCs	0,00	2,05	8,7%	5,0%	10,03%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.1.6	Mobile Air-Conditioning - Ships	HFCs	0,00	4,40	3,0%	4,0%	5,00%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.1.6	Mobile Air-Conditioning - Railcars	HFCs	0,00	0,26	3,0%	5,0%	5,83%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.1.6	Mobile Air-Conditioning - Wheel Tractors and Mobile Machinery	HFCs	0,00	3,33	14,5%	10,0%	17,61%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.2	...PU Insulation Panels	HFCs	0,00	0,10	10,0%	10,0%	14,14%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.2	...Spray and Injection PU Foam	HFCs	0,00	0,00	10,0%	10,0%	14,14%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.2	...XPS Insulation Foam	HFCs	0,00	0,07	20,0%	10,0%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
2.F.2	...One Component PU Foam	HFCs	0,00	5,15	15,0%	0,0%	15,00%	0,00%	0,0002	0,0002	0,00%	0,00%	0,00%	I4
2.F.3	Fire Extinguishers	HFCs	0,00	1,87	10,00%	10,00%	14,14%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.4	...Metered Dose Inhalers	HFCs	0,00	2,94	10,0%	0,0%	10,00%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.8	Electrical equipment	SF6	0,00	1,75	3,00%	10,00%	10,44%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	I4
2.F.9	Other Electrical Equipment	SF6	0,00	0,07	21,00%	21,00%	29,70%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	I4
3.D	Solvent and Other Product Use	N2O	5,67	4,90	5,00%	2,00%	5,39%	0,00%	0,0001	0,0002	0,00%	0,00%	0,00%	S1
3	Solvent and Other Product Use (indirect CO2 emissions from NMVOC)	CO2	20,77	13,95	25,00%	10,00%	26,93%	0,02%	0,0001	0,0004	0,00%	0,02%	0,02%	S2
4.A	Enteric Fermentation - Dairy Cattle	CH4	583,676	259,14	10,00%	50,00%	50,99%	0,79%	-0,0015	0,0082	-0,08%	0,12%	0,14%	A1
4.A	Enteric Fermentation - Non-Dairy Cattle	CH4	389,022	126,82	10,00%	50,00%	50,99%	0,39%	-0,0025	0,0040	-0,12%	0,06%	0,14%	A2
4.A	Enteric Fermentation - Sheep	CH4	23,184	14,10	10,00%	25,00%	26,93%	0,02%	0,0001	0,0004	0,00%	0,01%	0,01%	A3
4.A	Enteric Fermentation - Goats	CH4	0,189	0,45	10,00%	25,00%	26,93%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A4
4.A	Enteric Fermentation - Horses	CH4	3,251	2,46	10,00%	25,00%	26,93%	0,00%	0,0000	0,0001	0,00%	0,00%	0,00%	A5
4.A	Enteric Fermentation - Swine	CH4	17,492	7,59	10,00%	50,00%	50,99%	0,02%	-0,0001	0,0002	0,00%	0,00%	0,00%	A6
4.A	Enteric Fermentation - Fur animals	CH4	0,200	0,12	10,00%	50,00%	50,99%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A7
4.B	Manure Management - Dairy Cattle	CH4	14,324	20,84	10,00%	25,00%	26,93%	0,03%	0,0004	0,0007	0,01%	0,01%	0,01%	A8
4.B	Manure Management -Non-Dairy Cattle	CH4	7,997	5,37	10,00%	25,00%	26,93%	0,01%	0,0000	0,0002	0,00%	0,00%	0,00%	A9
4.B	Manure Management - Sheep	CH4	0,551	0,33	10,00%	20,00%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A10
4.B	Manure Management - Goats	CH4	0,005	0,01	10,00%	20,00%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A11
4.B	Manure Management - Horses	CH4	0,253	0,19	10,00%	20,00%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A12
4.B	Manure Management - Swine	CH4	41,562	15,19	10,00%	25,00%	26,93%	0,02%	-0,0002	0,0005	-0,01%	0,01%	0,01%	A13

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			1990	2011	AD	EF					due to EF	due to AD		
4.B	Manure Management - Poultry	CH4	10,707	3,33	10,00%	20,00%	22,36%	0,00%	-0,0001	0,0001	0,00%	0,00%	0,00%	A14
4.B	Manure Management - Fur animals	CH4	0,266	0,16	10,00%	20,00%	22,36%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A15
4.B	Manure Management - Anaerobic Lagoon	N2O	0,000	0,00	26,93%	100,00%	103,56%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A16
4.B	Manure Management - Liquid system	N2O	3,467	2,85	26,93%	100,00%	103,56%	0,02%	0,0000	0,0001	0,00%	0,00%	0,00%	A17
4.B	Manure Management - Solid Storage and Dry Lot	N2O	303,383	96,13	26,93%	100,00%	103,56%	0,60%	-0,0020	0,0030	-0,20%	0,12%	0,23%	A18
4.B	Manure Management - Other AWMS	N2O	0,000	5,70	26,93%	100,00%	103,56%	0,04%	0,0002	0,0002	0,02%	0,01%	0,02%	A19
4.D.1.1	Direct Soil Emissions - Synthetic Fertilizers	N2O	394,799	163,33	5,00%	85,44%	85,59%	0,84%	-0,0014	0,0052	-0,12%	0,04%	0,13%	A20
4.D.1.2	Direct Soil Emissions - Animal Manure Applied to Soils	N2O	186,358	79,37	26,93%	89,44%	93,41%	0,44%	-0,0006	0,0025	-0,05%	0,10%	0,11%	A21
4.D.1.3	Direct Soil Emissions - N-fixing Crops	N2O	247,950	47,75	0,00%	80,00%	80,00%	0,23%	-0,0026	0,0015	-0,21%	0,00%	0,21%	A22
4.D.1.4	Direct Soil Emissions - Crop Residue	N2O	68,372	26,14	0,00%	80,00%	80,00%	0,13%	-0,0003	0,0008	-0,02%	0,00%	0,02%	A23
4.D.1.5	Direct Soil Emissions - Cultivation of Histosols	N2O	88,927	82,89	0,00%	80,00%	80,00%	0,40%	0,0011	0,0026	0,09%	0,00%	0,09%	A24
4.D.1.6	Direct Soil Emissions - Sludge	N2O	0,200	0,89	10,00%	79,00%	79,63%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A25
4.D.2	Pasture, Range and Paddock Manure	N2O	202,302	74,45	26,93%	100,00%	103,56%	0,46%	-0,0010	0,0023	-0,10%	0,09%	0,14%	A26
4.D.3.1	Indirect Emissions - Atmospheric Deposition	N2O	92,631	38,00	57,01%	100,00%	115,11%	0,26%	-0,0003	0,0012	-0,03%	0,10%	0,10%	A27
4.D.3.2	Indirect Emissions - Nitrogen Leaching and Run-off	N2O	478,964	196,93	169,23%	380,00%	415,98%	4,91%	-0,0017	0,0062	-0,66%	1,49%	1,63%	A28
4.F.1	Field Burning of Agricultural Residues - Cereals	CH4	4,979	0,00	20,00%	40,00%	44,72%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	A29
4.F.1	Field Burning of Agricultural Residues - Cereals	N2O	1,017	0,00	20,00%	29,00%	35,23%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A30
4.F.2	Field Burning of Agricultural Residues - Pulse	CH4	0,001	0,00	20,00%	40,00%	44,72%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A31
4.F.2	Field Burning of Agricultural Residues - Pulse	N2O	0,001	0,00	20,00%	29,00%	35,23%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A32
4.F.3	Field Burning of Agricultural Residues - Tuber and Root	CH4	0,506	0,00	20,00%	40,00%	44,72%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A33
4.F.3	Field Burning of Agricultural Residues - Tuber and Root	N2O	0,310	0,00	20,00%	29,00%	35,23%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	A34
5.A.1	Forest Land remaining Forest Land - living biomass	CO2	-8492,18	-3921,22	1,84%	46,95%	46,98%	-11,04%	0,0174	-0,1237	0,82%	-0,32%	0,88%	L1
5.A.1	Forest Land remaining Forest Land - mineral soils	CO2	-1016,79	-1009,78	2,16%	35,00%	35,07%	-2,12%	-0,0150	-0,0319	-0,52%	-0,10%	0,53%	L2
5.A.1	Forest Land remaining Forest Land - organic soils	CO2	458,05	455,02	4,96%	35,00%	35,35%	0,96%	0,0067	0,0144	0,24%	0,10%	0,26%	L2
5.A.1	Forest Land remaining Forest Land - dead wood	CO2	-152,51	-685,76	2,12%	12,89%	13,07%	-0,54%	-0,0191	-0,0216	-0,25%	-0,06%	0,25%	L3
5.A.2.1	Cropland converted to Forest Land - living biomass	CO2	0,00	-1,81	33,19%	46,95%	57,50%	-0,01%	-0,0001	-0,0001	0,00%	0,00%	0,00%	L1
5.A.2.1	Cropland converted to Forest Land - mineral soil	CO2	3,51	50,02	28,17%	35,00%	44,93%	0,13%	0,0015	0,0016	0,05%	0,06%	0,08%	L2
5.A.2.1	Cropland converted to Forest Land - dead wood	CO2	-1,24	-18,07	42,49%	12,89%	44,41%	-0,05%	-0,0005	-0,0006	-0,01%	-0,03%	0,03%	L3
5.A.2.2	Grassland converted to Forest Land - living biomass	CO2	-8,33	-30,30	38,10%	46,95%	60,46%	-0,11%	-0,0008	-0,0010	-0,04%	-0,05%	0,06%	L1

IPCC Source Category		Gas	Emission, Gg CO_2 eq.		Uncertainty		Combined uncertainty	Combined uncertainty as % of total national emissions in year t	Type A sensitivity	Type B sensitivity	Trend uncertainty		Uncertainty introduced into the trend in total national emissions	Ref. numbers
			1990	2011	AD	EF					due to EF	due to AD		
5.A.2.2	Grassland converted to Forest Land - mineral soils	CO2	0,69	17,39	24,20%	35,00%	42,55%	0,04%	0,0005	0,0005	0,02%	0,02%	0,03%	L2
5.A.2.2	Grassland converted to Forest Land - organic soils	CO2	0,07	3,44	87,15%	35,00%	93,92%	0,02%	0,0001	0,0001	0,00%	0,01%	0,01%	L2
5.A.2.2	Grassland converted to Forest Land - dead wood	CO2	-1,01	-25,55	29,02%	12,89%	31,75%	-0,05%	-0,0008	-0,0008	-0,01%	-0,03%	0,03%	L3
5.A.2.3	Wetlands converted to Forest Land - living biomass	CO2	0,00	-0,24	60,57%	46,95%	76,63%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	L1
5.A.2.3	Wetlands converted to Forest Land - organic soils	CO2	0,25	10,90	48,08%	35,00%	59,47%	0,04%	0,0003	0,0003	0,01%	0,02%	0,03%	L2
5.A.2.3	Wetlands converted to Forest Land - dead wood	CO2	-0,13	-5,76	69,23%	12,89%	70,42%	-0,02%	-0,0002	-0,0002	0,00%	-0,02%	0,02%	L3
5.A.2.4	Settlements converted to Forest Land - living biomass	CO2	0,00	-0,58	67,34%	46,95%	82,09%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	L1
5.A.2.4	Settlements converted to Forest Land - mineral soils	CO2	-0,31	-2,15	57,96%	35,00%	67,71%	-0,01%	-0,0001	-0,0001	0,00%	-0,01%	0,01%	L2
5.A.2.4	Settlements converted to Forest Land - organic soils	CO2	0,27	1,60	138,58%	35,00%	142,93%	0,01%	0,0000	0,0001	0,00%	0,01%	0,01%	L2
5.A.2.4	Settlements converted to Forest Land - dead wood	CO2	-0,68	-4,68	87,78%	12,89%	88,72%	-0,02%	-0,0001	-0,0001	0,00%	-0,02%	0,02%	L3
5.A.2.5	Other Land converted to Forest Land - living biomass	CO2	0,00	0,01	43,86%	46,95%	64,25%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	L1
5.A.2.5	Other Land converted to Forest Land - mineral soil	CO2	-0,66	-6,02	34,81%	35,00%	49,36%	-0,02%	-0,0002	-0,0002	-0,01%	-0,01%	0,01%	L2
5.A.2.5	Other Land converted to Forest Land - dead wood	CO2	-1,17	-10,69	38,89%	12,89%	40,97%	-0,03%	-0,0003	-0,0003	0,00%	-0,02%	0,02%	L3
5.B.1	Cropland remaining Cropland - living biomass	CO2	3,17	13,44	32,42%	46,95%	57,05%	0,05%	0,0004	0,0004	0,02%	0,02%	0,03%	L1
5.B.1	Cropland remaining Cropland - mineral soils	CO2	-355,97	-302,68	3,19%	50,00%	50,10%	-0,91%	-0,0036	-0,0096	-0,18%	-0,04%	0,19%	L4
5.B.1	Cropland remaining Cropland - organic soils	CO2	418,34	375,41	25,82%	90,00%	93,63%	2,11%	0,0049	0,0118	0,44%	0,43%	0,62%	L5
5.B.2.2	Grassland converted to Cropland - living biomass	CO2	0,00	14,07	59,67%	46,95%	75,92%	0,06%	0,0004	0,0004	0,02%	0,04%	0,04%	L1
5.B.2.2	Grassland converted to Cropland - mineral soils	CO2	0,00	48,41	37,89%	30,00%	48,33%	0,14%	0,0015	0,0015	0,05%	0,08%	0,09%	L4
5.B.2.2	Grassland converted to Cropland - organic soils	CO2	0,00	14,51	138,58%	90,00%	165,24%	0,14%	0,0005	0,0005	0,04%	0,09%	0,10%	L5
5.B.2.2	Grassland converted to Cropland - (5III) mineral soils	N2O	0,00	5,36	37,89%	50,00%	62,73%	0,02%	0,0002	0,0002	0,01%	0,01%	0,01%	L4
5.C.1	Grassland remaining Grassland - living biomass	CO2	-25,36	291,84	10,62%	46,95%	48,13%	0,84%	0,0096	0,0092	0,45%	0,14%	0,47%	L1
5.C.1	Grassland remaining Grassland - organic soils	CO2	119,16	106,54	19,18%	35,00%	39,91%	0,25%	0,0014	0,0034	0,05%	0,09%	0,10%	L2
5.C.1	Grassland remaining Grassland - dead wood	CO2	-1,23	2,00	21,62%	12,89%	25,17%	0,00%	0,0001	0,0001	0,00%	0,00%	0,00%	L3
5.C.2	Land converted to Grassland - living biomass	CO2	14,85	-14,93	27,92%	46,95%	54,62%	-0,05%	-0,0007	-0,0005	-0,03%	-0,02%	0,04%	L1
5.C.2	Land converted to Grassland - mineral soils	CO2	-2,60	-138,63	16,75%	35,00%	38,80%	-0,32%	-0,0043	-0,0044	-0,15%	-0,10%	0,18%	L2
5.C.2	Land converted to Grassland - organic soils	CO2	2,15	21,04	57,53%	35,00%	67,34%	0,08%	0,0006	0,0007	0,02%	0,05%	0,06%	L2
5.C.2	Land converted to Grassland - dead wood	CO2	-0,08	14,44	67,73%	30,07%	74,10%	0,06%	0,0005	0,0005	0,01%	0,04%	0,05%	L3
5.D.1	Wetlands remaining Wetlands\Peatland - organic soils managed for peat extraction	CO2	102,60	102,60	26,34%	50,00%	56,51%	0,35%	0,0015	0,0032	0,08%	0,12%	0,14%	L6
5.D.2	Land converted to Wetlands - (5II) Non-CO2 emissions from drainage of	CH4	0,05	0,06	26,34%	50,00%	56,51%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	L6

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			1990	2011	AD	EF					due to EF	due to AD		
	soils and wetlands\Peatland													
5.D.2	Land converted to Wetlands - (5II) Non-CO2 emissions from drainage of soils and wetlands\Peatland	N2O	1,49	1,63	26,34%	50,00%	56,51%	0,01%	0,0000	0,0001	0,00%	0,00%	0,00%	L6
5.D.2.1	Forest Land converted to Wetlands - living biomass	CO2	25,70	16,53	85,82%	46,95%	97,83%	0,10%	0,0001	0,0005	0,00%	0,06%	0,06%	L1
5.D.2.1	Forest Land converted to Wetlands - organic soils managed for peat extraction	CO2	0,00	9,52	87,64%	50,00%	100,90%	0,06%	0,0003	0,0003	0,02%	0,04%	0,04%	L6
5.D.2.1	Forest Land converted to Wetlands - dead wood	CO2	0,93	0,70	61,62%	12,89%	62,95%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	L3
5.E.2	Land converted to Settlements – living biomass	CO2	0,00	115,58	72,75%	46,95%	86,58%	0,60%	0,0036	0,0036	0,17%	0,38%	0,41%	L1
5.E.2	Land converted to Settlements – soils	CO2	0,00	102,42	28,74%	35,00%	45,29%	0,28%	0,0032	0,0032	0,11%	0,13%	0,17%	L2
5.E.2	Land converted to Settlements – dead wood	CO2	0,00	44,01	28,74%	12,89%	31,50%	0,08%	0,0014	0,0014	0,02%	0,06%	0,06%	L3
5.F.2	Land converted to Other Land – living biomass	CO2	0,00	34,23	72,75%	46,95%	86,58%	0,18%	0,0011	0,0011	0,05%	0,11%	0,12%	L1
5.F.2	Land converted to Other Land – soils	CO2	0,00	18,87	61,03%	35,00%	70,36%	0,08%	0,0006	0,0006	0,02%	0,05%	0,06%	L2
5.F.2	Land converted to Other Land – dead wood	CO2	0,00	11,72	78,78%	12,89%	79,83%	0,06%	0,0004	0,0004	0,00%	0,04%	0,04%	L3
5 (V)	Biomass Burning	CO2	0,00	0,00	34,50%	70,00%	78,04%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	L7
5 (V)	Biomass Burning	CH4	0,34	0,05	34,50%	70,00%	78,04%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	L7
5 (V)	Biomass Burning	N2O	0,06	0,01	34,50%	70,00%	78,04%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	L7
5 (IV)	Liming	CO2	59,84	12,66	29,15%	50,00%	57,88%	0,04%	-0,0006	0,0004	-0,03%	0,02%	0,03%	L8
6.A	Solid Waste Disposal on Land	CH4	179,67	254,31	10,00%	83,07%	83,67%	1,27%	0,0050	0,0080	0,42%	0,11%	0,43%	W1
6.B.1	Industrial Wastewater	CH4	106,73	5,21	25,00%	104,40%	107,35%	0,03%	-0,0016	0,0002	-0,17%	0,01%	0,17%	W2
6.B.2	Domestic and Commercial Wastewater (anaerobic)	CH4	8,13	0,77	5,00%	42,43%	42,72%	0,00%	-0,0001	0,0000	0,00%	0,00%	0,00%	W3
6.B.2.2	Domestic and Commercial Wastewater - human sewage	N2O	45,84	34,40	5,00%	100,00%	100,12%	0,21%	0,0003	0,0011	0,03%	0,01%	0,03%	W4
6.C	Waste incineration	CO2	0,03	0,00	5,00%	40,00%	40,31%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	W5
6.C	Waste incineration	N2O	2,06	0,00	5,00%	100,00%	100,12%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	W5
6.D	Biological Treatment	CH4	0,60	45,59	10,00%	100,00%	100,50%	0,27%	0,0014	0,0014	0,14%	0,02%	0,14%	W6
6.D	Biological Treatment	N2O	0,66	50,47	10,00%	100,00%	100,50%	0,30%	0,0016	0,0016	0,16%	0,02%	0,16%	W6
6.D	Biogas burnt in a flare	CH4	0,00	0,01	5,00%	25,00%	25,50%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	W7
6.D	Biogas burnt in a flare	N2O	0,00	0,00	5,00%	25,00%	25,50%	0,00%	0,0000	0,0000	0,00%	0,00%	0,00%	W7

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A32 - **AD**: IPCC 2000. Agriculture. pp.4.20; **EF:** Table 4-16 of the IPCC 1996 Guidelines, pp.4.31

A33 - **AD:** IPCC 2000. Agriculture. pp.4.20; **EF:** Table 4-16 of the IPCC 1996 Guidelines, pp.4.31

A34 - AD: IPCC 2000. Agriculture. pp.4.20; **EF:** Table 4-16 of the IPCC 1996 Guidelines, pp.4.31

L1 - AD: calculations for submission, NFI; unpublished, **EF:** parameters used from IPCC 2006, however due to lack of information in the IPCC 2006, the same EF uncertainty as in the GPG-LULUCF 2003 for calculating living biomass emissions was assumed

L2 - AD: calculations for submission, NFI, unpublished; **EF:** National Inventory Report Sweden 2012, Table 7.5, p. 291

L3 - AD: calculations for submission, NFI, unpublished; **EF:** Sandström *et al*. Biomass conversion factors (density and carbon concentration) by decay classes for dead wood of *Pinus sylvestris*, *Picea abies* and *Betula* spp. in boreal forests of Sweden. Forest

L4 - AD: calculations for submission, NFI, unpublished; **EF:** expert judgement, NFI

L5 - AD: calculations for submission, NFI, unpublished; **EF:** IPCC 2006, Table 5.6 (Boreal/Cool temperate), p. 5.19

L6 - AD: calculations for submission, NFI, unpublished; **EF:** Salm, *et al*. 2012. Emissions of CO2, CH4 and N2O from undisturbed, drained and mined peatlands in Estonia. Hydrobiology (692), p 41-55

L7 - AD: Veiko Adermann, EEIC (expert judgement); **EF:** LULUCF, 2003, p. 3.50; Table 3A.1.12, p. 3.179

L8 - AD: Veiko Adermann, EEIC (expert judgement); **EF:** IPCC 2006, p. 11.27

W1 - AD: IPCC, 2000. Waste, pp. 5.12; 2006 IPCC, Waste, Chapter 3, pp 3.27; **EF:** IPCC, 2000. Waste, pp. 5.12; 2006 IPCC. Waste, pp. 3.27; 2006 IPCC. Waste, Table 3.3, pp 3.17

W2 - AD: IPCC GPG 2000,pp 5.23, table 5.5; **EF:** IPCC GPG 2000,pp 5.23, table 5.5

W3 - **AD:** IPCC GPG 2000,pp 5.19, table 5.3; pp 6.27 table 611, **EF:** IPCC GPG 2000,pp 5.19, table 5.3; pp 6.27 table 6.11

W4 - **AD:** IPCC GPG 2000,pp 5.19, table 5.3; **EF**: IPCC GPG 2000, Agriculture,pp 4.75

W5 - AD: IPCC 2006, Waste, pp. 5.24; **EF**: IPCC 2006, Waste, pp. 5.23

W6 - **AD:** IPCC, 2006. Waste, pp. 3.27; **EF**: 2006 IPCC, Waste, Cahpter 4, pp. 4.6

W7 - **AD:** IPCC 2000. Energy, pp. 2.92; **EF**: IPCC 2000. Energy, pp. 2.92